AN EXPERIMENTAL INVESTIGATION INTO THE RESTORATION OF ANCIENT AND TRADITIONAL MORTARS FOR STACKWALL CONSTRUCTION

BY

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A thesis submitted to the Faculty of Graduate Studies of the University of Manitoba in partial fulfillment of the requirements of the degree of

MASTER OF SCIENCE

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A thesis
presented to the University of Manitoba
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Appendix A

ESSENTIAL PROPERTIES FOR A GOOD QUALITY MORTAR

All mortars should meet a number of important requirements, regardless of the type of building units used. An examination of the essential properties for a good quality mortar, as used in conventional masonry (see Definitions), was used as the basis for developing an alternative mortar for stackwall construction. It was assumed that stackwall construction be classified as masonry work and that a person constructing a stackwall building be called a mason. The 11 essential properties considered in this study are: 1) workability, 2) water retention, 3) bond, 4) strength, 5) autogenous healing, 6) elasticity and flexibility (internal accommodation), 7) efflorescence, 8) durability, 9) volumetric changes (shrinkage), 10) economy, and 11) appearance.

A.1 WORKABILITY [38, 40, 48, 57, 60, 68]

Probably the single most important property of a good quality plastic mortar is workability. Workability may be defined as the characteristic of a mortar which makes it free-flowing and easy to spread without the separation of water or segregation of the solid materials of the mix.

Mortar with good workability should spread easily on the masonry unit, cling to vertical surfaces, extrude readily from joints without dropping as the building unit is placed and at the same time have body so that it can support the units and many courses without undergoing distortion. A mortar with good workability allows the mason to fill the joints without undue effort, thereby promoting better quality workmanship and increased productivity.

Interrelated factors affecting workability are: 1) the quality of the aggregate, 2) the amount of water used, 3) the consistency, 4) setting time, 5) flowability, 6) adhesion, 7) mass, and 8) the ability of the mortar to retain water.

A.2 WATER RETENTION [38, 40, 48, 57, 60, 68]

Water retentivity is the property of mortar that allows it to retain its water -- to resist loss to the air or to absorptive masonry units.

Mortar with high water retention means that the mortar resists suction or absorption by the masonry unit. Conversely, a mortar with low water retention loses its moisture quickly and may lead to a condition of "pancaking". Pancaking is a term used when the mortar stiffens so quickly that intimate contact is not made with the building unit and hence results to leaky walls.

High water retention is also important with low-absorption masonry units since it minimizes bleeding or formations of a water plane at the interface -- a condition which also leads towards poor bond. High water retention has one construction advantage, it minimizes the need for retempering (see Definitions).

Poor water retentivity may be caused by: 1) poorly graded aggregate, 2) aggregate of too large a size, 3) insufficient mixing, or 4) the wrong type of cement.

A.3 BOND [9, 38, 40, 48, 57, 60, 68]

The bond between mortar and a masonry unit involves a combination of the degree of contact and the adhesion of the two materials. Bond strength has no relation to the crushing or tensile strength of mortar. A wall built with good bond strength will be weathertight (non-leaking between the masonry unit and the mortar). It will also be strong enough to withstand stresses from high winds, vibrations, volume changes and temperature changes.

Three requirements are required for a good bond: 1) the bond must have adequate tensile bond strength, 2) the extent of the bond must be complete (mortar in complete contact with the masonry unit, with no discontinuities), and 3) the bond must be durable so as to last the lifetime of the structure. Of the above, 2) and 3) are more important, as they are key factors which promote watertight walls and wall integrity.

Factors affecting bond in masonry are: 1) the type of mortar used, 2) the type of masonry unit used, and 3) the workmanship. Only the mortar aspect of masonry will be dealt with. Some of the properties of mortar that affect the quality of bond are its workability (or initial flow), water retention, setting characteristics, air content, strength, volume change and resilience. Other factors affecting the bond strength are the workmanship, the ambient temperature and relative humidity.

In general, studies have shown that high bond strength is attained through use of mortars having high workability, high water retention, high strength and low air content. Protection must also be provided against harmful hot or cold weather and extra moisture must be provided during times of low relative humidity.

Summarizing, two key properties are required for a mortar to have good bonding capabilities: 1) the mortar should be a highly workable plastic material that tends to fill the interstices and irregularities of the masonry unit; this will provide a "keying" action which strengthens the bond, and 2) the mortar should be able to retain its moisture so as to produce a more intimate bond (see water retention).

A.4 STRENGTH [12, 38, 40, 48, 57, 60, 68]

Before 1920 mortars were tested approximately equally for both tensile and compressive strengths, and to a much lesser extent, in transverse (shear tension) strength. In the past 60 years though, most strength tests have been in compression.

With conventional Portland cement-lime-sand mortars, the compressive strength increases as the amount of cement in the mix is increased in relation to the amount of water used. This is true provided the mix remains workable. An increase in water content, air entrainment or lime content will reduce the compressive strength of a mortar.

Some have the false impression that the stronger a mortar is in compressive strength, the better it is. Actually as mortars are made stronger, they become more rigid and brittle, and consequently become unable to accommodate the movements and stresses caused by settlement, strong winds, vibrations, earthquakes, thermal changes, wetting and drying. In areas of strong winds, vibrations and earthquakes, reinforcement may however be required, in addition to tough mortar.

Knowing that mortar must support various kinds and degrees of loads, it must possess an adequate strength with a generous safety factor. At the same time, the other properties listed in this appendix must be considered just as important or even more so.

A.5 AUTOGENOUS HEALING [38, 48, 68]

Autogenous healing is the ability of a mortar to reknit itself after fine cracking has occurred. This is important if voids are present or if small cracks develop in the mortar or between the mortar and the masonry unit. To have this property, a mortar should have the composition and properties which allow it to combine with constituents extracted from its environment to rebuild breaks and to restore integrality and stability.

A.6 ELASTICITY AND FLEXIBILITY [38, 48, 68]

A mortar with a modest but **adequate** strength has greater elasticity and flexibility than stronger/harder mortars which are more brittle. Mortar with good elasticity and flexibility will resist deflections such as wind-sway and lateral pressures with a minimal amount of cracking in the bond between the mortar and the units.

If a mortar can overcome or absorb a reasonable degree of movement, it is said that it possess a degree of internal accommodation to resist stress. As the density and rigidity (lack of flexibility) of a mortar increases, the chances of internal accommodation decreases.

If the mortar is dense and rigid, lateral movements, whether due to deflection or to expansion and contraction, induce stresses exceeding the bond strength resulting in leaky walls. The reason for this is that rigid mortars pro-

vide no relief planes to absorb the applied strains and deformations. As a result, these strains and deformations are passed along the brick courses in an accumulative fashion, often resulting in cracks such as a step crack.

If the density and rigidity are low, the strains and deformations are accommodated at a large number of levels and tend to prevent excessive accumulated bond stresses. In addition, the stresses due to expansion or contraction are much lower because of the capacity of the mortar to yield.

A.7 EFFLORESCENCE [11, 38, 48, 60, 68]

Efflorescence of masonry appears as ugly white coatings or scum that randomly accumulates on the exterior walls of buildings. Some forms of efflorescence are temporary or short-lived but there also exists a troublesome permanent form. The permanent form will subside or even disappear as a result of rains, but will recur again and again for many years. This latter form will not only destroy the appearance of the structure, but will in time cause the disintegration of the mortar and spalling of the masonry units. The end result is leaky walls and costly restorative maintenance.

The composition of these deposits known as permanent efflorescence is usually some salt of either the sulfate, carbonate or chloride variety. These salts may be those of sodium, potassium or calcium. The primary types of soluble

alkali salts is usually sodium sulfate and potassium sulfate. Less often these salts are found in the carbonate and even bicarbonate forms, ones of sodium or potassium. Other chemical forms of efflorescence exist, but to a much lesser degree than those mentioned above.

The permanent form of efflorescence is due primarily to the soluble alkali salts that migrate from the masonry interior as a solution, and upon drying recrystallize on the masonry facade, leaving the stains. The tendency for this to occur is enhanced by the presence of water in a masonry wall and by sufficient time to allow the water to dissolve the salts and seep to the outside.

Without going into great detail, the causes of efflorescence can be broken down into four categories: 1) faulty workmanship/construction practices/design that a) allow excessive moisture to penetrate the building units during construction, and/or, b) allow excessive moisture to penetrate into the finished masonry work, and/or, c) prevent the masonry from drying out in the event of excessive moisture penetration; 2) efflorescence potential within the masonry units containing any form of alkali salt; 3) efflorescence potential from the mortar materials — Portland cement, lime, unwashed mason's sand, water that is partially salty or extremely hard; and 4) environmental conditions such as areas of high rainfall or air containing sulfurous pollution.

A.8 DURABILITY [10, 38, 40, 48, 60, 68]

In any form of masonry, durability refers to the ability of a structure to maintain substantially its original appearance, strength and soundness for years. A mortar that is durable should be able to resist elements of weather such as high winds, freezing, thawing, wetting and drying cycles. Chemical attack from atmospheric contamination (air pollution) and sulfate soils may also affect masonry's durability.

A mortar that forms a permanent and complete bond, and is properly tooled so not to produce ledges to collect and hold water, thereby making the structure watertight, is a prime prerequisite for durability. Under freezing conditions, weathertightness prevents the disruptive effect of subsequent ice crystals in the wall.

For about 20 years some researchers have attempted to correlate durability of masonry solely on laboratory (artificial) cycles of freezing and thawing. If the mortar disintegrates in relatively few cycles, they declare that it lacks durability.

When dealing with the subject of durability of mortars, one must really consider all of the following interrelated considerations: empirical information, statistical data, autogenous healing, efflorescence, air content, effect of freezing and permeability.

Empirical information on the durability of mortars is based purely on history, observation and experience. tistical data is also empirical but based on a statistical analysis of the mortar practices that have been both successful and unsuccessful. Autogenous healing -- the ability of a mortar to reknit or reconstitute itself after fine cracking or in filling up original mortar voids, is a definite asset towards durability. Existence of permanent forms of efflorescence contribute to the disintegration of mortar and masonry. Air entrainment improves the durability of mortars but the volumetric content should be limited to five to 10 percent so as not to affect the bond at the mortar and building unit interface. Dried mortars are sensitive to freezing only if they get completely saturated with water (due to separation cracking or poor workmanship) and are not able to lose this moisture rapidly. Permeability is the absorption of moisture through pores in mortar and building units and by leaks through voids and cracks in the mortar joints. Permeability is detrimental to the durability of mortar or building unit if it has a difficult time drying out rapidly.

A.9 <u>VOLUMETRIC CHANGES</u> (SHRINKAGE) [40, 48, 68]

Cyclic volume changes occur in all mortars when subjected to wetting and drying. However, there is less shrinkage with mortars of lower but adequate strength. Hard, high-strength mortars tend to shrink after hardening, producing separation cracking between the mortar and building units, resulting in a loss of bond.

Weaker mortars are also able to accommodate greater building unit shrinkage than stronger mortars through longer time lapse (greater creep effects) prior to failure. It has been shown that walls containing weaker mortars, when subjected to full shrinkage restraint, have a higher tensile strength [40].

A.10 <u>ECONOMY [38, 48]</u>

A mortar should be economical to use. The initial cost to obtain the materials to make the mortar is one factor to consider. However, this is not enough. Secondary economic factors must also be taken into account.

If the mortar tends to stick well to the building units, this is an economic factor since there is less mortar wasted by droppings. If labour cost is involved, high workability will lower the labour time spent in mixing and laying the mortar. Mortar that has slow setting characteristics also offers economy by minimizing the time spent in retempering (see Definitions). Finally, a mortar that is

durable and requires a minimum amount of maintenance contributes to an economical mortar.

A.11 APPEARANCE [60]

The overall appearance of a masonry structure is affected by the appearance of the mortar joints. It follows that the mortar itself must then have a pleasant appearance. Factors contributing to the appearance of mortar joints include uniformity of color and shade, uniformity of texture and thickness and the workmanship involved in tooling the joints.

The color and shade of the joints are affected by the moisture content of the masonry, admixtures in the mortar, atmospheric conditions, uniformity of proportions of the mortar mix and the time of tooling. Good uniformity of texture depends on careful measurement of batch proportions from batch to batch and also on thorough mixing. Even joint thickness and consistent tooling, both the results of good workmanship, contribute to good appearance.

Appendix B

TESTING DATA AND PROPERTIES OF CLAYS

For the clay mortar testing, the volume of tests dictated the use of two bags of clay. Although the two bags of clay came from the same area of sampling, just different boreholes, a set of soil property testing was carried out for each bag. The clays used from the first and second bag were designated as Clay Samples and/or Nos. 1 and 2 respectively. The property testing done on each of the clays were: moisture content, hydrometer analysis (for the equivalent grain size distribution curve), Atterberg limits (liquid and plastic limit) and specific gravity.

Clay Nos. 1 and 2 both came from the southwest part of Winnipeg, Canada. Upon inspection of the samples, Clay No. 1 was described as a firm, varved, greyish-brown, silty clay with traces of gypsum and organic matter; Clay No. 2 was described as a soft, varved, brown and grey, silty clay with traces of gypsum, organic matter and pebbles. The depth at which Clay Nos. 1 and 2 were sampled was one to nine feet, and one to 10 feet respectively. Clay Nos. 1 and 2 were used for Mix Nos. 1 to 5 and 6 to 11 respectively.

To preserve its in-situ moisture content, the soil was always kept in closed, clear thick plastic bags. The length

of storage before the first use in a mortar mixture was approximately six months.

Periodic moisture content tests showed Clay Nos. 1 and 2 to remain at a constant moisture content of 33 and 39 percent respectively -- this indicated that the thick plastic bags were effective in preserving the natural moisture content. Tables B-I and B-II shows the first series, as an example, of the moisture content tests performed for Clay Nos. 1 and 2 respectively.

The hydrometer analysis, liquid limit, plastic limit and specific tests were performed following the procedures used by the Soil Mechanics Laboratory of the University of Manitoba. These procedures follow closely the following ASTM standards: ASTM D 421-58, Standard Method for Dry Preparation of Soil Samples for Particle-Size Analysis and Determination of Soil Constants [1] -- Photograph B-1 shows the mortar and pestle used for breaking up aggregations of soil particles for the clay property tests; ASTM D 422-63, Standard Method for Particle-Size Analysis of Soils [2]; ASTM D 423-66, Standard Test Method for Liquid Limit of Soils [3]; ASTM D 424-59, Standard Test Method for Plastic Limit and Plasticity Index of Soils [4]; and ASTM D 854-58, Standard Test Method for Specific Gravity of Soils [5].

For the hydrometer analysis, changes were made to Sections 8.2 and 8.3 of Standard ASTM D 422-63 [2]. With

	ble B-I tent of Clay N	∛o. 1	
Sample No. Tare No. Weight Tare and Wet Soil (g.) Weight Tare and Dry Soil (g.) Weight Water (g.) Weight Tare (g.) Weight Dry Soil Solids (g.) Moisture Content (%)	1 XV11 1,676 1,326 350 266 1,060 33.0	2 A29 38.99 32.16 6.83 10.51 21.65 31.5	3 HV11 999 814 185 266 548 33.8
Average Moisture Content (%)		33	

Та	ble B-II		
Moisture Con	tent of Clay	No. 2	
Sample No.	1	2	3
Tare No.	AJ	AP	59
Weight Tare and Wet Soil (g.)	120.58	132.14	122.73
Weight Tare and Dry Soil (g.)	93.43	102.22	95.29
Weight Water (g.)	27.15	29.92	27.44
Weight Tare (g.)	24.64	23.05	24.30
Weight Dry Soil Solids (g.)	68.79	79.17	70.99
Moisture Content (%)	39.47	37.79	38.65
Average Moisture Content (%)		39	



Photograph B-1: Mortar and Pestle Used for Breaking Up Aggregations of Soil Particles for Clays Property Tests -- Pestle Also Used in Clay Mortar Mixing and in Breaking Up Hardened Lime-Sand Mortar for Remix Mixes

respect to Section 8.2, a 60 grams-per-litre solution of sodium hexametaphosphate was used to disperse the clay sample instead of the specified 40 grams per litre. When calibrating the hydrometer, the same solution of 60 grams per litre was used. This stronger solution is recommended for Winnipeg area clays. With Section 8.3, the soil mixture was dispersed in Apparatus A (electric mechanical mixer) for two minutes instead of the specified one minute.

Two independent hydrometer analyses were performed for each clay. For Clay No. 1, the resultant first and second hydrometer analyses are respectively shown in Tables B-III and B-IV. The respective equivalent grain-size distribution curves for these two tests are shown in Figures B-1 and B-2. Comparing these two figures, negligible difference is seen, thereby indicating the accuracy of the two tests.

For Clay No. 2, the resultant first and second hydrometer analyses are respectively shown in Tables B-V and B-VI. The respective equivalent grain-size distribution curves for these two tests are shown in Figures B-3 and B-4. The similarity of the two curves indicates the accuracy of the two tests.

Figures B-1 to B-4 indicate that both soils are silty clays. The level of silt in both clays are about the same; for Clay Nos. 1 and 2, the level was eight and 10 percent respectively. Percentage of clay particles in Clay Nos. 1 and 2 were respectively 82 and 72 percent by weight. This 10 percent difference gave the vertical shift between the grain-size distribution curves of the two clays. Besides this shift difference, the shape of the grain-size distribution curves for the two clays are identical.

The results of the liquid and plastic limit (Atterberg limits) tests for Clay No. 1 are shown respectively in Tables B-VII and B-VIII. Resultant liquid limit $(w_{T_{\bullet}})$ from

the flow curve at 25 blows is 88 percent. The plastic limit (w_p) was found to be 36 percent. With these results for Clay No. 1, the plasticity index (I_p) , defined as

$$I_{P} = w_{L} - w_{P},$$
yields $I_{P} = 88 - 36$
 $I_{P} = 52\%.$

For Clay No. 2, the results of the liquid and plastic limit tests are shown respectively in Tables B-IX and B-X. These tables show the liquid limit to be 81 percent and the plastic limit to be 32 percent. The plasticity index (I_p) of Clay No. 2 is calculated to be 49 percent.

With respect to the Atterberg limits and the plasticity index, little difference was noted between the two clays.

The results of the specific gravity tests for Clay Nos. 1 and 2 are shown respectively in Tables B-XI and B-XII. These tables show the specific gravity for Clay Nos. 1 and 2 to be 2.85 and 2.81 respectively. Little difference is noted between these values.

Using the soil testing results of the two clays examined, and the Unified Soil Classification table (which includes a plasticity chart) in Reference 6 [p. 16], both clays are classified as inorganic clays of high plasticity: fat clays (CH). This type of clay, as recorded in the

Engineering Use Chart in Reference 6 [p. 17], is listed as being poor in terms of its workability as a construction material.

Table B-III

Hydrometer Analysis No. 1 for Clay No. 1

	I	HYDROMETER	AETER		ANALYSIS		No. I	Date	Data Sheet	- - -	7
HYDROWETER DATA	PROJECT	MC THESE TIES	MORTAR	1	THE NORTHERN HOUSING	THERM	House	Ü,	COMMITTEE		
Hydrometer No.	DESCRIPT	TON OF SOIL FIRM MARKED, GREEN	FIRM	MOLE MU. EVED(GRE)	DESCRIPTION OF SOIL FIRMS WERE GRESSIAN-BOOWN, JULY CLAY WITH BALES OF SYRRING MAD DECAME MATTER	SAMPLE NO.	.eeeeeeeeee.	Beces	E SYFEUM	IND DECAME MAY	Marteg
Dispersing Agent Used St. Spanum Hand Cotton	SAMPLE PR REMARKS	Seut Mas	Sperce of	E OVEN-	SAMPLE OVEN-LYBIED AND GROUPD TO 100% BASSIMILY NO 110 SIEVE. GROWIND IN A MORTAR WITH A CAST-180M PESTLE.	ALL CRO	A CASA -	Bon P	STAE	2 OI .	<u>.</u>
Outstity of Dispersing Apprt										PEPTENT CINCA	1000
Dispersing Agent Correction, c . 0.0041	J. M.	7116	ELAPSED	TEMPERATURE	READING	K - E +c	DIAMETER	TEMPERATURE	α	Ä	FILM
DRY WEIGHT OF HYDROMETER SAMPLE			11ME	ပ	i,e		l	۳	i	SIEVED	ORIGINAL SAMPLE.
(Use Appropriate Method)	25/20/52	35/02/B2 16:23									
IGHT	25/03/82	25/02/82 16:23.5	0.5 Mm	24.2	1.0360	1.0360 1.0361	0.058	0.84	32.84	89.4	
METRICIALITY WE UT ALK-UNI SAWLE	11	16:24	- ML	24.2	1.0360	1.0360 1.0361 0.040	0.040	0.84	32.84	89.4	
Wt. Soil + Tare, ga	-	(6: 25	2 Mms.	24.2	1.0360	1.0361	1.0360 1.0361 0.0282	0.84	32.84	89.4	
Tare No. Tare Weight, ge	Ξ	16:27	4 M.2.	24.2	1.0360	1.03601.0361 0.0201	0.0201	0.84	32.84	89.4	
Nt. Soil, 98	"	16:31	8 X	24.2	1.03601.0361 0.0141	1.03601	0.0141	0.84	32.84	89.4	
Percent Moisture, w% "	=	16:53	30 Mms	24.1	1.0357	1.0357 1.0358 0.0074	0.0074	0.82	32.52	88.5	
ME IGHT OF SAMPLE USED ME After Dry Sample + Tare on an an	=	17:23	一吊	23.9	1.0355 1.0356 0.0053	1.0356	0.0053	98.0	32.30	87.9	
Tare No. Tare Weight, gm	u	18:23	2 HRS.	23.7	1.0350 1.0351 0.0037	1.0351	0.0037	0.74	31. 74	86.4	
Nt. Air-Dry Sample, M _A on	11	20:23	4 HRS	23.5	1.0345	1.0346	1.0345 1.0346 0.0026		31.14	84.8	
Z/JOD	E2:00 28/20/92	62:00	8 HRS.	22.7	1.0330 1.0331	1.6331	6.00.0	0.52	29.52	80.4	
FOR	26/02/82	24/02/82 09:23 17 Has 21.8	17 Has	21.8	1.0310 1.0311 0.00133	1.0311	0.00133	0.35	27.35	74.5	
Oven-Dry Sample + Terre, gn 340.50	11	16:23 24 HRS 22.9	24 HRS	22.9	1.02991.0300.0000	.0300	0.0000	75.0	26.47	72.1	
	27/02/182	27/02/82 16:23 48 HRS 22.0	48 HRS	22.0	1.0280 1.0281 0.00016 0.40	18701	0.00078	0.40	24.40	66.4	
RESULTS OF SIEVE TEST	* FORMULA USED	ORMULA USED R. + B C. v. 100%	2 - 4	Ι.		ā	Diameter From Momograph	Momograph			
Percent Passing Steve No. 200 . 99.7 %	· X Fin	er Than = -	2			٠	Mr. Cm.Cd. From Charts	m Charts			
SPECIFIC GRAVITY From Test of Account 2.85	TESTED: A.	R. R. R.	2.	1A0	26/02/82 DATE: - 91/03/82 DATE: 23/11/82	/82 282 182	SOIL M	Ž ¥	I	LABORATORY ENGNEERING	
)	CHECKED:	B: R.	7	₩	DATE: 24/11/82	787	Š	FORT CARRY	OF MANITORA MANITORA	MANITOBA	
* Formula for bouyoucos hydrometer only.	er onl	· ×									

Table B-III

(Continued)

	I	YDROI	HYDROMETER		ANALYSIS	IS No	No. 1	Data	Data Sheet	2_ of	7
HYDRONETER DATA	PROJECT	C. C. Mos. Mos. As	RIAR	314	THE NORTHEBY HOUSE	BEN Hav	3 3000	SET LINGUES		١	
Hydrometer No. Constant No. 0.0001		DESCRIPTION OF SOIL E	Erray Assert	HOLE NO.	SWEET ON CASE THANKS THANKS TO THE SWEET ON THE TRANSPORT TO STREET OF STREE	Superior Caronna	NO. WITH VA	M Sand	Sylvan I	To 7	Marrea
Dispersing Agent Used the Jenuer Handwaterness 12 c	ᆚ	100	THOUSE .	4	MINTER SOIL MASS GROWND IN A MARTAK WITH A LAST - IRON FESTLE	24	1 - 180H	7	-		
Quantity of Dispersing Agent, ml = 163	1	1	U.S. W.S. L.	TEMPERATION	HYDROMETER		DIAMETER	TEMPERATURE	œ	PERCENT FINER THAN	rines A
DRY METCHT OF HYDROMETER SAMOLE	Š	!		ပ		,	1	, i	:	STEVED	ORIGINAL
(Use Appropriate Method)	27/02/82 23:23	23:23	55 HRS	,,	1.0276 1.0277 0.00074	1.0277	0.00074	0.22	23.82	64.9	
HETHOD NO 1 - W BASED ON AIR-DRY WEIGHT	01/03/82	99:23	01/03/82 09: 23 89 Hrs.		1.0266 1.0267 0.00060	1.0267	0.00060		22.78	62.0	
REPRESENTATIVE WE OF AIR-DRY SAMPLE	01/03/62	20:23	01/03/62 20:23 100 Hes.	22.4		1.0266	0.00055	0.46	22.%	62.5	
Kr. Soll + Tare, ga											
Tare No. Tare Weight, gm -											
Wt. Water, gm											
Percent Holsture, M.											
WEIGHT OF SAMPLE USED											
Mt. Air-Dry Sample + Tare, gm											
Tare No. Tare Neight, gm											
Mr. Air-Dry Sample, M. Gm											
18											
NETHOD MO.2 - W BASED ON OVEN-DRY WEIGHT											
Oven-bry Sample + Tare, gm 397.08											
Dry Sample, M gm 56.58											***************************************
RESULTS OF SIEVE TEST	* FORMULA USED	SED R	ORBULA USED R + Mc - Cd x 1005	d × 100K .		6	Diameter From Momograph	Nomograph on Charts			
Percent Passing Steve No. 400 - 72.1 10			=			ŀ					
SPECIFIC GRAVITY 2.85	TESTED:	A 65	2.	¥	75/62/62 DATE: <u>-91/03/AZ</u> DATE: <u>23/11/62</u>	182 182	SOIL N	SOIL MECHANICS I		LABORATORY ENGINEERING	
	CHECKED:	9	. 2	40	DATE: 24/11/82	78/	ũ	>	3	08A	
* Formula for bouyoucos hydrometer only.	ter onl			·							

Table B-IV

Hydrometer Analysis No. 2 for Clay No. 1

Propertie and Propertie an		I	YDRON	HYDROMETER	₹	ANALYSIS		No. 2	ä	Data Sheet	- - -	7
		PROJECT	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	MORIAR	1 H	North	ERN HO	US/14C	Commi	TTEE	4	
	в	DESCRIPTI	TON OF SOIL	Figure 1891	POLE NO.	Berry S.		1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	1 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	Paul Aug	DEGAMIC T	ANTIER
13:50 1100	Dispersing Agent Usedale Sopura HEXAMETACHOTHER	REMARKS	3011	PS GROS	A M GH	Monte	rika en	A P	A - 150	PES PES	J. L. E.	
13:50 110 10	Quantity of Dispersing Agent, ml . 125					HYDROMETER		93.54	TEMPERATURE		IN3CRIA	FINER
13:549 13:	Dispersing Agent Correction, cd . 0.0041.	DATE	114	0354713	TEMPERATURE	READING	3+3-4	1	COMPECTION	æ		ORIGINA
13:49 13:4	DRY HEIGHT OF HYDROMETER SAMPLE			1116	ပ	·F			۳		SAMPLE	SAMPLE
13:49.5 0.5 M _{max} 29.4 1.0335 1.0336 0.056 2.15 31.1 13:50 M _{max} 29.4 1.0335 1.0336 0.0292 2.15 31.1 13:51 2 M _{max} 29.4 1.0335 1.0336 0.0193 2.15 31.1 13:51 8 M _{max} 29.4 1.0335 1.0336 0.0193 2.15 31.1 13:57 8 M _{max} 29.4 1.0335 1.0336 0.0193 2.15 31.1 14:04 15 M _{max} 29.4 1.0335 1.0336 0.0100 2.14 31.1 14:04 15 M _{max} 29.7 1.0335 1.0336 0.0000 2.05 31.1 14:04 1 Hr. 29.1 1.0333 0.0050 2.05 31.1 17:049 2 Hr. 29.1 1.0330 1.0313 0.0050 2.05 31.1 17:049 2 Hr. 29.0 1.0312 0.0005 2.03 2.03 2.03 19/67 83 13:49 24 Hr. 29.0 1.0213 0.0000 3.0000 3.0000 3.0000 3.0000 3		18/07/83	13:49									
	METHOD IIO I - M BASED OM AIR-DRY WEIGHT	=	13:49.5	0.5 Mm.	29.4	1.0335	.0336	0.056	2.15	31.65		
	REPRESENTATIVE AT OF AIR-DRY SAMPLE	=	13:50	Σ		1.0335	1.0336	0.0392	2.15	31.65	90.5	
13:53 4 M _{mas} 29. 4 1.0335 1.0336 0.0193 2.15 31. 13:57 8 M _{mas} 29. 4 1.0335 1.0336 0.0138 2.15 31. 14:04 5 M _{mas} 29. 3 1.0335 1.0336 0.0100 2.14 31. 14:19 30 M _{mas} 29. 1 1.0333 1.0334 0.0052 2.05 31. 14:49 1 Hr. 29. 1 1.0333 1.0351 0.0050 2.05 31. 17:49 2 Hr. 29. 1 1.0332 1.0352 0.0056 2.05 31. 17:49 4 Hr. 29. 1 1.0332 1.0352 0.0056 2.05 30. 19/17/83 13:49 44 Hr. 29. 0 1.0312 1.0303 0.00163 1.93 28. 24/07/83 13:49 48 Hr. 29. 0 1.0217 1.0219 0.00163 1.93 25. 25/07/83 13:49 48 Hr. 29. 0 1.0217 1.0219 0.00163 2.03 25. 25/07/83 13:49 48 Hr. 29. 0 1.0217 1.0219 0.00163 2.03 25. 25/07/83 13:49 48 Hr. 29. 0 1.0217 1.0219 0.00163 2.03 25. 25/07/83 23. 24.	ut. 5011 + Tare, 9	=		2 M 12		1.0335	.0336	0.0274	2.15	31.65	90.2	
11 13:57 8 M., 29. 4 1.0335 1.0336 0.0138 2.15 31. 11 14:04 15 M., 29. 3 1.0335 1.0336 0.0138 2.15 31. 11 14:04 15 M., 29. 1 1.0333 1.0334 0.0072 2.05 31. 11 14:09 2 Hrs. 29. 1 1.0330 1.0331 0.0050 2.05 31. 11 17:09 2 Hrs. 29. 1 1.0330 1.0331 0.0050 2.05 31. 11 17:09 4 Hrs. 29. 0 1.0312 1.0312 0.0055 2.03 29. 10 21:09 2 Hrs. 29. 0 1.0312 1.0313 0.0013 2.05 20. 20 10313 13:09 24 Hrs. 29. 0 1.0217 1.02180 0.0013 2.03 25. 20 10313 13:09 48 Hrs. 29. 0 1.0277 11.02780 0.0013 2.03 25. 20 1.0277 11.02780 0.0013 2.03 25. 20 1.0277 11.02780 0.0013 2.03 25. 20 1.0277 11.02780 0.0013 2.03 25. 20 1.0277 11.02780 0.0013 2.03 25. 20 1.0277 11.02780 0.0013 2.03 25. 20 1.0277 11.02780 0.00148 1.03 25. 20 1.0277 11.033 1.03 25. 20 1.0277 11.033 1.03 25. 20 1.0277 11.033 1.03 25. 20 1.0277 11.033 1.03 25. 20 1.0277 11.033 1.03 25. 20 1.0277 11.033 1.03 25. 20 1.0277 11.033 1.03 25. 20 1.0277 11.033 1.03 25. 20 1.0277 11.033 1.03 25. 20 1.0277 11.033 1.03 25. 20 1.0277 11.033 1.03 25. 20 1.0277 11.033 1.03 25. 20 1.0277 11.033 1.03 25. 20 1.0277 11.033 1.03 25. 20 1.0277 11.033 1.03 25. 20 1.0277 11.033 1.03 25. 20 1.0277 11.033 1.03 25. 20 1.0277 11.033 1.03 25. 20 1.0277 11.033 1.03 25. 20 1.0277	Tare No. Tare Weight, on	=	13:53	4 Mws		1.0335	1.0336	0.0193	2.15	31.65	90.2	
11 14:04 15 M ₁₁₅₅ 29.3 1.0335 1.0336 0.0100 2.14 31. 11 14:19 30 M ₁₁₅₅ 29.1 1.0333 1.0334 0.0072 2.05 31. 11 14:49 2 Hgs, 29.1 1.0321 1.0322 0.0036 2.05 31. 11 17:49 2 Hgs, 29.0 1.0312 1.0313 0.0025 2.05 30. 11 17:49 4 Hgs, 29.0 1.0312 1.0313 0.0025 2.03 29. 11 17:49 24 Hgs, 29.0 1.0312 1.0313 0.0013 2.03 29. 2807[83] 13:49 24 Hgs, 29.0 1.0217 1.02180.0013 2.03 25. 2807[83] 13:49 48 Hgs, 29.0 1.0217 1.02180.0013 2.03 25. TESTEO: A 100x 1	Wt. Soil, 98		13:57	8 X 8		1.0335	9550.	0.0138	2.15	31.65	90.2	
	Percent Moisture, wit	=	14:04	15 M.45	29.3	1.0335	.0336	0.0100	2.14	31.64	1.06	
1. 15:49 2 Hrs. 29.1 1.0330 1.0331 0.0050 2.05 31 1. 15:49 2 Hrs. 29.1 1.0321 1.0322 0.0036 2.05 30 1. 17:49 4 Hrs. 29.0 1.0312 1.0313 0.0025 2.03 29 19/67/83 13:49 48 Hrs. 29.0 1.0280 1.0281 0.0016 1.73 25 24/67/83 13:49 48 Hrs. 29.0 1.027711.02780 0.0016 1.73 25 * FORMAL USED * FORM		=	14:19	30 M.ms.		1.0333	.0334	0.0072	2.05	31.35	89.3	
15:49 2 4ks, 29.1 1.0321 1.0322 0.0036 2.05 30. 17:49 4 4ks, 29.0 1.0312 1.0313 0.0025 2.03 29. 19/67/83 13:49 24 4ks, 28.6 1.0302 1.0303 0.00143 1.93 28. 28/67/83 13:49 24 4ks, 29.0 1.0277 1.0278 0.00143 1.73 25. 28/67/83 13:49 48 4ks, 29.0 1.0277 1.0278 0.00143 2.03 25.	Tare No. Tare Metght, gm	=	14:49	I HR.	1.62	1.0330	1.0331	0.0050	2.05	31.05		
11. 17.49 4 Hrs, 29.0 1.0312 1.0313 0.0025 2.03 29. 12.149 8 Hrs, 28.6 1.0302 1.0303 0.00163 1.93 28. 136/07/83 13:49 24 Hrs, 29.0 1.0217 1.02180 0.00163 1.73 25. 28/07/83 13:49 48 Hrs, 29.0 1.0217 1.02180 0.0013 2.03 25. * FOODMLA USED * FOODMLA US	Nt. Air-Dry Sample, M _A ga e	=	15:49		29.1	1.0321	1.0322	0.0036	2.05	30.15	85.9	
1. 21: 49 8 Hez, 28.6 1.0302 1.0303 0.00193 1.93 28. 19/67/83 13: 49 24 Hes, 27.8 1.0280 1.0281 0.001048 1.73 25. 24/67/83 13: 49 48 Hes, 29.0 1.02771.02780.00073 2.03 25. * FIDENTIAL USED * FIDENTIAL OF THAIN - B C. A 1008 . DIMETER From Monograph * FIDENTIAL OF COMPUTED: * A.	4700	=	17:49	4 HRs	29.0		1.0313	0.0025	2.03	29.23		
19/07/83 13: 49 24 Hgs, 27.8 1.0280 1.0281 0.0016 1.73 25. 28/07/83 13: 49 48 Hgs, 29.0 1.0277 1.02780.00073 2.03 25. * FODMIA USED * Finer Than - R ₁ + R ₂ - C _d × 100x . * Finer Than - R ₁ + R ₂ - C _d × 100x . * Finer Than - R ₁ + R ₂ - C _d × 100x . * Finer Than - R ₁ + R ₂ - C _d × 100x . * Finer Than - R ₁ + R ₂ - C _d × 100x . * Finer Than - R ₂ + R ₃ - C _d × 100x . * Finer Than - R ₂ + R ₃ - C _d × 100x . * Finer Than - R ₂ + R ₃ - C _d × 100x . * Finer Than - R ₂ + R ₃ - C _d × 100x . * Finer Than - R ₂ + R ₃ - C _d × 100x . * Finer Than - R ₂ + R ₃ - C _d × 100x . * Finer Than - R ₃ + R ₃ - C _d × 100x . * Finer Than - R ₃ + R ₃ - C _d × 100x . * Finer Than - R ₃ + R ₃ - C _d × 100x . * Finer Than - R ₃ + R ₃ - C _d × 100x . * Finer Than - R ₃ + R ₃ - C _d × 100x . * Finer Than - R ₃ - C	METHOD NO.2 - W BASED ON OVEN-DRY WEIGHT	=	21: 49		28.6	1.0302	1.0303	0.00m3		28.13	90.1	
** FORBULA USED *** + *** - *** - *** - *** - *** - *** - *** 1.0217 1.0218 0.00013 2.03 25. ** FORBULA USED *** + *** - *** - *** - *** 100x		19/07/83		24 HRS.	23.8	1.0280	1.0281	0.0010		25.73	73.3	
200 99.6% From Voncer Than B H + B - Cd x 100x . Interest From Nanograph TESTED: A 2 DATE: 19.22/03/82 SOIL MECHANICS COMPUTED: A 2 DATE: 13/09/82 ONLINE STOP CONT. ONLINE	•	29/07/83		48 HRS.		1.0277	1.0278	5.00073	2.03	25.73	13.3	
200 99.6% From than W N. C.		* FORMULA (3 - 6	7001		a to	meter From	Momograph			
Assumed 2.85 COMPUTED: R. Z. DATE: 13/9/83 DEPARTMENT OF CIVIL CHECKED: R. Z. DATE: 04/10/83 FORT GARRY	200	· I Fin	er Than	*			m.	C#*Cd** Fre	on Charts			
DATE: 04/10/85	Assumed 🔘 •	TESTEC	10 10 10 10 10 10 10 10 10 10 10 10 10 1	77	TAG	60/51 :3. 0/22-81 :3.	£8/E	SOIL N DEPART UNIV	ECHANI MENT OF		ORATOR) NEERING AITOBA	
		CHECKE	γ. Υ	Α		04/10	<u>S</u>	5	CARRY	MAN	400	

Table B-IV

(Continued)

HYDROMETER DATA HYDROMETER NO. ST639 JOHN W. MS. Law. JOHN W. LINE USA Appropriate Method Z1/07/83 13: 49		HOLE NO.	THE NORTHERN HOUSING	1 Hou	Н	COMMITTEE	1766		
255 00941 ONTE 21/07/83	REMAKS SOUL WAS GROWNE IN A MORTOR WITH A CAST - I ROM PESTLE.	ARTIMETED HERSHAM BENNH LAND HEN HIM TRACKS OF GITTMA DEGANGE TO SAMPLE OVEN DRIED AND GROAMB TO 100% PASSIMG. NO. 10. SAMPLE ORANGE HALTH. A GAST - 180M. PESTLE.	BROWNIS	ATTA	SAMPLE NO. 1	(CLAX) OFFIT 120 9 FEET IS OF GETTING OF GETTING AND OFFICE MO. 10 SIGHT ST 1891 PESTLE.	PESTI	No. 10 No. 10	Sicutor Sicutor
21/07/83	TIME CLAWSED	TEMERATURE	ETCR	3 - 5 + c	DIAMETER	TEMPERATURE CORRECTION	x	PERCENT FINER TANK	FINER
21/03/83	TIRE	٥.	i,e			۳		SAPPLE	SAMPLE
THOU THE THE TANK AND THE TON	13: 49 72 HRS.	29.7	1.02761.0277	1520.	0.00058	2.23	25.83	73.6	
58/10/22	13:49 96 HAS.	29.9	1.0275 1.0276 0.00052	.0276	0.00052	2.30	25.80	73.5	
ME SOI + Mater + Tare on									
Wt. Soil + Tare, gm									
Tare No. Tare Weight, gm									
Wt. Water, gm									
Mt. Soil, 98									
Percent Moisture, WS									
WEIGHT OF SAMPLE USED									
Wt. Air-Dry Sample + Tare, gm									
Tare No. Tare Weight, on									
Mr. Air-Dry Sample, M. gm w									
1 + WA/100									
METHOD MO.2 - M BASED ON OVEN-DRY WEIGHT									
Oven-Dry Sample + Tare, 9m 404.26									
Tare No HXIV Tare Meight, 98 550-13									
П									
RESULTS OF STEVE TEST	Rh + L - Cd x 100X	x 100%		<u>.</u>	Diameter From Nomograph	Nomograph			
Percent Passing Sieve No. 200 . 79.6%	3				L. Cm.cd. From Charts	e Charts			
From Test (2) Assumed (1) 2.85 COMPUTED: A	1867	1 1	DATE: 18-22/03/83 DATE: 13/09/83 DATE: 04/10/83	(8) (8) (8)	SOIL N DEPART UNIV	SOIL MECHANICS IS DEPARTMENT OF CUV. UNIVERSITY OF FORT GARRY W	CS LABORA CIVIL ENGINEERI OF MANITOR	LABORATORY ENGREFING MANITOBA	

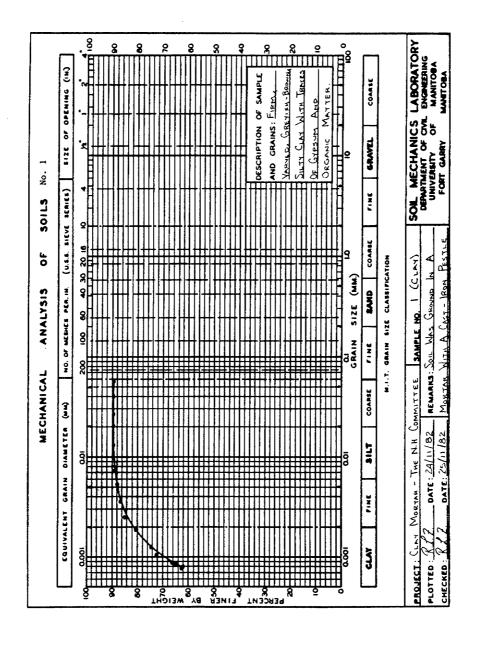
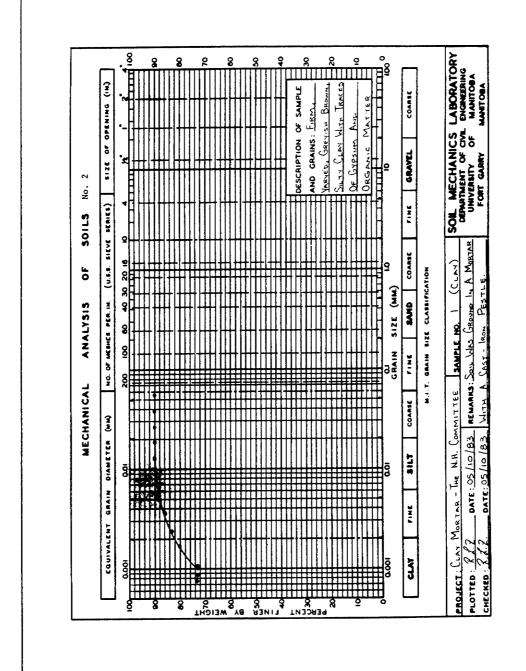


Figure B-1: Equivalent Grain Size Distribution Curve for Hydrometer l of Clay No. 1 Analysis No.



Equivalent Grain Size Distribution Curve for Hydrometer 2 of Clay No. 1 $\,$ Analysis No. Figure B-2:

Table B-V

Hydrometer Analysis No. 1 for Clay No. 2

	I	YDRON	HYDROMETER		ANALYSI	ွ	No		Data Sheet	st / Of	7
HYDROWETER DATA	PROJECT JOB No.	MS Justis 185	AS THE ASSTANT THE MAS THE	HOLE NO.	THE NORTHERN HOUSING COMMITTER	HOUSTING O	6 Comm	33110	о₹ / нт 930	7 01 27	FEET
Hydrometer No. Cm. Cm. O.OOO.	DESCRIPTI SAMPLE, PR REMARKS	DESCRIPTION OF SOIL SE SAMPLE PREPARATION REMARKS SOIL YANS	Sparts	A EL A	FIL YESTED BROWN AND GREET, SWIT CLEY WITH TRACES OF GERVING DOES SAMPLE ONEN DRIED, AND GROUND TO, 100 TO PASSING NO. GROWND IN A MORTAR WITH A CASSI. TROM PESTINE.	A ATTINA	2 10 G	S Se	DESCRIPTION OF SOIL SOIL SOIL, THEY ROUDDEN DESCRIPTION TO TO TOO TO THE PROPERTY OF SOIL OF PROPERTY SOIL SOIL SOIL OF THEY BROWN SOIL SOIL SOIL SOIL SOIL SOIL SOIL SOIL	NO SIENE	Prants.
Quantity of Dispersing Agent, al - 125		,			-		DIAMETER	TEMPERATURE		PERCENT FINER	FINER
Dispersing Agent Correction, cd.	2	¥		TEMERATURE	36 14 14	+		CORRECTION "t	æ	SIEVED	ORIGINAL
(Use Appropriate Method)	18/07/83	11:06									
METHOD NO 1 - W BASED ON AIR-DRY WEIGHT	=	11:06.5	0.5 M.M.	29.1	1.0311	1.0312	0.058	2.05	29.15	82.2	
REPRESENTATIVE AZ OF AIR-DRY SAUPLE	=	11:07	- M	1.62	1.0311	1.0312	0.041	2.05	29.15	82.2	
Nt. Soil + Tare, ga	=	11:08	2 Mins.	29.1	1.6311	1.0312	0.0282	5 0 5	29.15	82.2	
Tare No. Tare Weight, gm	N	01:11	4 MINS	29.1	1.0311	1.0312	0.0200	2.05	29.15	82.2	
Nt. Soil, 9m	=	11:14	8 Mins	29.1	1.69.1	1.0312	0.0141	2.05	29.15	82.2	
Percent Moisture, W	2	11:21	15 Mus.	29.0	1.0309	1.0310	0.0104	2.03	28.93	9. i8	
METGHT OF SAMPLE USED	=	11:36	30 MINS	28.8	1.0304	1.0305	0.0075	1.98	28.38	80.0	
Tare No. Tare Weight, gm	=	12:06	- HR	7.87	1.0296	1.0297	6.005€	1.95	27.55	77.7	
Mt. Afr-Dry Sample, M. On	=	13:06	2 HRS.	28.5	1.0291	1.0292	0.0038	1.89	26.99	76.1	
A A C	=	15:0%	4 HRS.	28.8	1.0284	1.0285	0.00264	1.98	26.38	74.4	
EM-DRY	=	19:06	8 HRS.	28.9	1.0271	1.0272	0.00191	2.00	25.10	70.8	
Oven-Dry Sample + Tare, 9m 166.79	19/04/83	90:11	24 HRS.	272	1.0251	1.0252	1.02520.00111	1.58	22.68	63.9	
Dry Sample, M gm 55.07	20/01/AZ 11:06 48 HRS.	11:06	48 HRS.	27.9	1.0235	1.0236	1.02360.00079	1.75	21.25	6.65	
200	* FORMULA USED	- La	R, + E - Cd x 100X	x 100% .		,	Diameter From Nomograph M., C.,C., From Charts	Nomograph 2m Charts			
ng Sieve NO.	TESTED:_	676	47	TAG	DATE: 18-22/07/83		SOIL	SOIL MECHANICS		LABORATORY	
From Test A Assumed	CHECKED:		62	PAT	DATE: 12/09/82	(83 (83	N O	UNIVERSITY FORT GARRY		MANITOBA	
Formula for bouyoucos hydrometer only.											

Table B-V

(Continued)

Propertie bill Prop	5 <u>7639</u>			L							
SEGNETIAN OF SOIL SOTAL MESTS BROWN DESCRIPTION TO CASE AND PAGE STATEMENT AND PAGE STA	1000.0	B No. MSe	MOPIAH LHEST SEST	HOLE NO.	NOR THE	SAMPLE	5,13G	(CLAY)	0€РТИ	70 01	123
DATE TIME ELUSED TOPEGATURE RADING R V. + C. DIMETR CORRECTION R. STREED TOPEGATURE RADING R V. + C. DIMETR CORRECTION R. STREED TOPEGATURE R V. + C. DIMETR CORRECTION R. STREED		SCRIPTION OF S MPLE PREPARATION OF SIMPLE SOUTH	OIL SOFT VARY	E OVEN D	MARTAR	See LE	7. 100 % A CAL	PASSING IRON	No 10	SIEVE	*5788
21/07/83 11:00. 12 18:5. 28.8 1.0223 1.0224 0.00064 1.98 20.28 57.2 22/07/83 11:00. 12 18:5. 29.1 1.0215 1.0216 0.00056 2.05 19.55 55.1 22/07/83 11:00. 12 18:5. 29.1 1.0215 1.0216 0.00056 2.05 19.55 55.1 22/07/83 11:00. 12 19:00.	<u> </u>		France	2011.00	HYDRONETER		DIAMETER	TEMPERATURE	2	ł	FINER
22/07/83 11:06 96 4ks, 29.1 1.0215 1.0216 0.00064 1.98 20. 22/07/83 11:06 96 4ks, 29.1 1.0215 1.0216 0.00056 2.05 19. 22/07/83 11:06 96 4ks, 29.1 1.0215 1.0216 0.00056 2.05 19. 22/07/83 11:06 96 4ks, 29.1 1.0215 1.0216 0.00056 2.05 19. 22/07/83 11:06 96 4ks, 29.1 1.0215 1.0216 0.00056 2.05 19. 22/07/83 11:06 9ks, 29.1 1.0215 1.0216 0.00056 2.05 19. 22/07/83 11:06 9ks, 29.1 1.0215 1.0216 0.00056 2.05 19. 22/07/83 11:06 9ks, 29.1 1.0215 1.0216 0.00056 2.05 19. 22/07/83 11:06 9ks, 29.1 1.0215 1.0216 0.00056 2.05 19. 22/07/83 11:06 9ks, 29.1 1.0215 1.0216 0.00056 2.05 19. 22/07/83 11:06 9ks, 29.1 1.0215 1.0216 0.00056 2.05 19. 22/07/83 11:06 9ks, 29.1 1.0216 1.0216 0.00056 2.05 19. 22/07/83 11:06 9ks, 29.1 1.0216 1.0216 0.00056 2.05 19. 22/07/83 11:06 9ks, 29.1 1.0216 1.0216 0.00056 2.05 19. 22/07/83 11:06 9ks, 29.1 1.0216 1.0216 0.00056 2.05 19. 22/07/83 11:06 9ks, 29.1 10.00056 2.05 19. 22/07/83 11:06 9ks, 20.1 10.00056 2.05 19. 22/07/83 11:06 9ks,			11.K	o.		ያ + ያ		u u	:		ORIGINAL SAMPLE
22/07/83 11:06 96 44cs, 29.1 1.0215 1.0216 0.00056 2.05 19. 22/07/83 11:06 96 44cs, 29.1 1.0215 1.0216 0.00056 2.05 19. 1		,		28.8	1.0223	1.0224	0.00064	1.98	20.28	57.2	
# FIDEWILA LISED ** Finer Than ** * * * * * * * * * * * * * * * * *	-1	1 1	96 HRS.	29.1	1.0215	1.0216	0.00056		19.55	55.1	
# FIDEWILA USED ** Finer Than ** * * * * * * * * * * * * * * * * *	KICKESCHINITE WAS UT MINIORI SANTIE										
# FIDEMLA USED * Finer Than * B, + B, - Cd x 100x , M, C a, Cg, From Charts TESTED: A 2 DATE: \8.222\oldsymbol{2}/29\Begin{array}{c} & SOIL MECHANICS & DEPARTMENT OF CHARTS & DATE: \8.22\oldsymbol{2}/29\Begin{array}{c} & SOIL MECHANICS & DATE: \8.22\oldsymbol{2}/29\Begin{array}{c} & SOIL MECHANICS & DATE: \8.22\oldsymbol{2}/29\Begin{array}{c} & SOIL MECHANICS & DATE: \8.24\sqrt{2}/29\Begin{array}{c} & SOIL MANOTHINGS & DATE: \8.24\sqrt{2}/29\Begin{array}{c} & SOIL MECHANICS & DATE: \8.24\sqrt{2}/29\Begin{array}{c} & SOIL MANOTHINGS & DATE: \8.24\sqrt{2}/29\Begin{array}{c} & SOI	Hr. Soil + Tare, ga										
# FIDEWILA USED ** Finer Than ** ** ** ** ** ** ** ** ** ** ** ** **	Tare No. Tare Weight, gm -										
# FIDEWILA USED # FIDEWILA USED # TESTED: A 100X .	Mt. Vater, gm										
# FORWILA USED	Percent Holsture, w										
# FIDEWILA USED ** Finer Than ** * * * * * * * * * * * * * * * * *	KEIGHT OF SAMPLE USED										
# FIDEWILA USED	Mt. Air-Dry Sample + Tere, gm =										
# FIDEWILA USED	Tare No. Tare Weight, gm										
# FIDEWILA USED	Mt. Air-Dry Sample, MA gm "										
# FIDEWILA USED * Finer Than * * * * * * * * * * * * * * * * * * *	1										
# FORMULA USED * Finer Than * * * * * * * * * * * * * * * * * * *	ETHOD NO.2 - W BASED ON OVEN-DRY WEIGHT										
# FORWILA USED # FORWILA USED ** I finer Than ** ** ** ** ** ** ** ** ** ** ** ** **	ven-Dry Sample + Terre, gm # 422 - 98	-									
	ry Sample, M gm										
COMPUTED: A L. DATE: 12/03/83 SOIL MECHANICS COMPUTED: A L. DATE: 12/03/83 SOIL MECHANICS CHECKED: A L. L. DATE: 94/19/83 FORT GABRY	* %9(BAULA USED & Finer Than	, a	<u>d</u> × 100% .		5 .	emeter From	Nomograph om Charts			
	18.	ESTED: A	12	TAG TAG	E: 13/09 E: 13/09	1/8.3 1/8.3 1/8.3	SOIL N DEPART UNIT	AECHANI IMENT OF VERSITY MET GABRY		ORATOR) NEERING NITOBA TOBA	

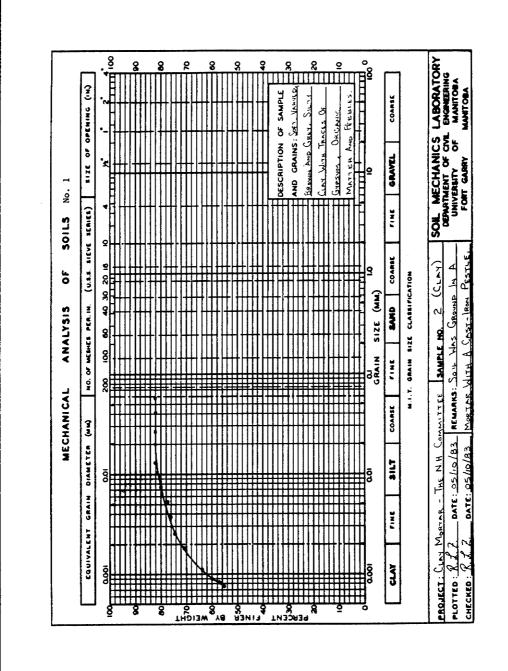
Table B-VI

Hydrometer Analysis No. 2 for Clay No. 2

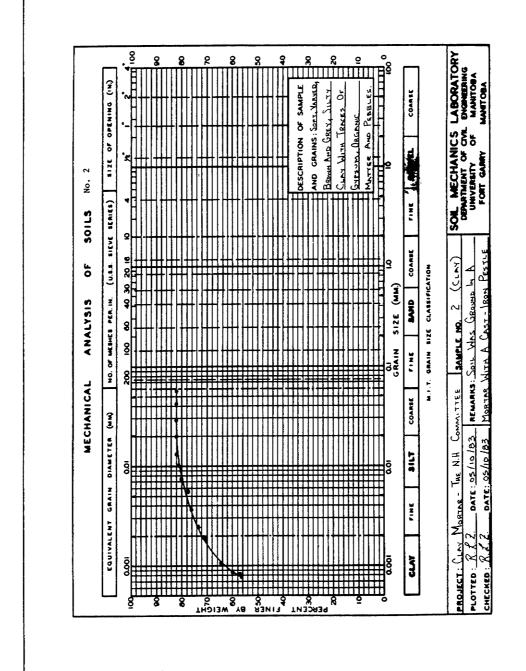
	I	YDRO	HYDROMETER		ANALYSIS		No. 2	Dat	Data Sheet) -	7
Hydrometer No. Cm. 57639 Mydrometer No. Cm. Cm. Co. CO.		MSc Thesis TE 100 OF SOIL Sperit V FEPRATION Sperit Sport Volse Gen	Aprilar	THE NOVE NO. SECONDS OF DE CONTRACT	THE NORTHERN HOUSING. F. MO. 3. BROWN MO. GROWN TO LOSS MY. DERED AND GROWN TO LOSS MY. A. MORTHER MICH. A. C. M. A. MORTHER MICH. A. C.	SAMPLE SAMPLE SEGMENT TO TOMORY	THE NORTHERN HOUSING COMMITTEE 1851 HOLE NO. SWEEN, 2 (CLAY) 1-VARVED, BROAM MO TAKEY, SWITTER, 2 (CLAY) 1-VARVED, BROAM MO TAKEY, SWITTER, 2 (CLAY) 1-VARVED, BROAM MO TAKEY, SWITTER, 2 (CLAY) 1-VARVED, W. D. MO TAKEY, W. D. C. AST (KON, PESTICE)	CCLAY) OF CCLAY) OF TRACES OF GW	GAYELUAN DO 10	PROJECT SLEAT MARIAN THE NORTHERN HOUSING COMMITTEE JUB NO. MS. THESTS TEST HOLE NO. SWORLD OF SCHOOL OF THE SECOND HOUSING SECOND OF THE LOSS SERVED SECOND OF THE SECOND	Pert
Quantity of Dispersing Agent, m) . 125		,	61.40650	2007407407	HYDROMETER		DIAMETER	TEMPERATURE		PERCENT FINER THAN	FINER
DATE OF THE PARTY	ž	<u>.</u>	1106	D °	# 100 SE		ı	CORRECTION T	œ	SIEVED	ORIGINAL SAMPLE
(Use Appropriate Method)	18/07/83 12:55	55:21									
METHOD NO 1 - N BASED ON AIR-DRY WEIGHT	=	12: 55.5	0.5 Mm.	29.0	1.0311	1.0312	0.058	2.03	29.13	82.0	
NY SAIL + MARKET + TARE ON	Ξ	12:56	1 Min.	29.0	1.0311	1.0312	0.042	2.03	29.13	82.0	
Wt. Soil + Tare, 98	ຄ	12:57	2 Mins.	29.0	1.0311	1.0312	0.029	2.03	29. 13	82.0	
Tare No. Tare Weight, gm	Ξ	12:59	4 Mins	29.0	1.0311	1.0312	0.020	2.03	29.13	82.0	
Wt. Soil, 98	=	13:03	8 M.45.	0.67	1.6311	1.0312	0.0144	2.03	29.13	82.0	
Percent Moisture, wit	Ξ	13:10	15 M.WS.	29.0	1.0309	1.0310	0.0104	2.03	28.93	81.5	
MEIGHT OF SAMPLE USED	12	13: 25	30 Mms.	29.0	1.0304	1.0304 1.0305	0.0075	2.03	28.43	80.1	
Tare No. Tare Weight, gm	=	13:55	1 Ha	58.9	1.0296	1.0296 1.0297	0.0056	2.00	27.60	7.7.7	
Nt. Atr-Dry Sample, M _A gm Mt. Dry Sample, M = M.	11	14:55	2 HRS	29.0	1.0290	1.0291	0.00379	2.03	27.03	76.1	
37 A 30	=	55:91	4 HRS.	29.0	1.0280	1.0281	0.00261	2.03	26.03	73.3	
WETHOD NO.2 - N BASED ON OVEN-DRY WEIGHT	11	20:55	8 HRS.	28.6	1.02.13	1.0274	0.00192	1.93	25.23	77.1	
Tare No. 11 Tare Metchit, on 249.15	19/03/83	12:55	24 HRS.	27.8	1.0251	1.0252	1.0251 1.0252 0.00110	1.73	22.83	64.3	
Dry Sample, W gm	20/07/83 12:55	12:55	48 Nas	28.7	1.0233		1.02340.00078	1.95	21.25	59.9	
RESULTS OF SIEVE TEST Percent Passing Steve No. 200 96. 4 %	* FORMULA USED	ORMULA USED R X Finer Than .	h + mt - C _d x 100X	× 100%		5 ,	Diameter From Nomograph M _L , c _{m,cd} , From Charts	Nomograph om Charts			
SPECIFIC CRAVITY From Test [2] Assumed [] a 2.81	TESTED:COMPUTED:	() () () () () () () () () ()	25	TAG	DATE: 18-22/01/82 DATE: 13/09/82 DATE: 04/01/03	हुबा दुबा हुबा	SOIL N DEPART UNIV	SOIL MECHANICS DEPARTMENT OF CIVIL UNIVERSITY OF FORT GARRY	CS LABORA CIVIL ENGINEER OF MANITOR	LABORATORY ENGINERING MANITOBA MANITOBA	
* Formula for bouyoucos hydrometer only.									:	į	

Table B-VI (Continued)

The state of the s											
HYDROPETER DATA 576.39	PROJECT S JOB NO. IN DESCRIPTI SAMPLE, PRI REMARKS	ASc. THE ON OF SOIL EPARATION	PROJECT CLEAT - MARTAR THE MO. 1909 NO. MASTER HOLE NO. DESCRIPTION OF SOIL SANTA, VANAGE, BROWNER SAMPLE, PREPARATION SAMPLE, PREPARATION SAMPLE, MASTER CROWNED FOR A M. P. C. CROWNED FOR A M. C.	THE HOLE NO. SEE, BROWN OVEN DR. LIM A. M.	PROJECT CLEAY - MARRAR THE NOMITHERA HOUSENESS COMMANTTEE JOHN MAS THESTS, 1551 HALE NO. SKRIFT NO. & CLEAN OFFH TO 10 FEET SKRIFT NO SOIL SALL MANEE BROWN THE SKRIFT STATE CLEAN THERE S OF CHANKEL BROKHES AND TRACES OF CHANKEL BROKHES AND EASTER TO 10 STATE OFFH THE SKRIFT SHOWN SALL MAS GROWNED IN A MARRAR MITH A CAST : 1804 PESTLE.	SAMPLE NO.	10. B 10. B 10. B 10. B 10. Tech	CONNOUTTEE (CLAY) 0 IN TRACES OF BY COUNTY NO 10	10 Siese	To 10 Rapples Au	FEET
Quantity of Dispersing Agent, ml . 125. Dispersing Agent Correction, cd . 0,0041	DATE	TIME	ELAPSED	TEMPERATURE	HYDROMETER READING	R. * K. + C.	DIMETER	TEMPERATURE	۵	PERCENT FINER THAN	NT FINER THAN
DRY WEIGHT OF HYDROMETER SAMPLE			TIME	္ပ္ရ	ř		ŧ	ı,	4	SIEVED	ORIGINAL SAMPLE
(Use Appropriate Method)	21/07/83 12:55	12:55	72 HRS.	29.4	1.0222	1. 0223	1.0222 1.02230.00063	2.15	20.35	57.3	
돌	22/09/83	12:55	96 HRS	29.9	1.0217	1.0218	1.02 17 1.02 18 0.00055	2.30	20.00	56.3	
1											
Wt. Soil + Tare, on											
Tare No. Tare Weight, gm "											
Mt. Hater, gm											
Nt. Soil, 9s											
WEIGHT OF SAMPLE USED											
Mt. Alc-Dry Sample + Tare, on			-								
Tare No. Tare Weight, gm *											
Nt. Air-Dry Sample, Mg gar											
N T WATER											
METHOD NO.2 - W BASED ON OVEN-DRY WEIGHT											
Oven-Dry Sample + Tere, gm 304.23											
Dry Sumple, M gm											
•	* FORMULA USED) ED	COBMULA USED R. + Mr Cd x 100% .	× 1001 ×		Ē	Diameter From Nomograph	Nomograph			
Percent Passing Steve No. 200 . 96.4 %			×			ָרֶּי װ	mt. cm.cd. From Charts	om Charts			
SPECIFIC GANITY From Test [2] Assumed [] 2.81	TESTED: COMPUTED:		222	DAT	DATE: 1 <u>8-22/01/83</u> DATE: <u>13</u> /0,9(83 DATE: <u>94</u> (19 <i>/83</i>	(83 (83 (83	SOIL N DEPART UNIV	SOIL MECHANICS LABORATO DEPARMENT OF CUM. ENGNEERING UNIVERSITY OF MANITOBA FORT GARRY MANITOBA	ICS LABORA CIVIL ENGNEER OF MANITORA	LABORATORY ENGNEERING MANITORA MANITOBA	
						-					



Equivalent Grain Size Distribution Curve for Hydrometer 1 of Clay No. 2 Figure B-3: I Analysis No. 1



Equivalent Grain Size Distribution Curve for Hydrometer 2 of Clay No. 2 Figure B-4: Analysis No.

Table B-VII Liquid Limit Test Data for Clay No. 1

ATTERBERG LIMITS PROJECT CLAY MORTAR - THE NORTHERN HOUSING SAMPLE 1 (CLAY) DEPTH 1 To 9 FEET TEST HOLE NO. _ SAMPLE DESCRIPTION GREYISH - BROWN, SILTY CLAY. GROUND WITH MORTAR AND PESTLE 100% PASSING No. 40 SIEVE LIQUID LIMIT 3 TARE NO. U35 71 U5 **U34** 61 K65 NO. BLOWS 35 20 17 14 8 WT. WET SOIL + TARE 33.66 40.06 36.43 42.94 36.50 36.71 WT. DRY SOIL + TARE 27.92 27.50 26.74 29.83 27.68 WT. WATER 92 9.03 10.23 WT. TARE 18.70 18.52 24.82 18.23 18.56 18.17 WT. DRY SOIL 8. 04 9.69 11.27 9.51 8.98 WATER CONTENT, % 86.1 88.5 90.8 95.0 99.4 102.7 WATER CONTENT PLASTIC LIMIT TARE NO. WT.WET SOIL + TARE WT. DRY SOIL + TARE WT. WATER WT. TARE WT. DRY SOIL WATER CONTENT, % FLOW CURVE AVERAGE VALUES LIQUID LIMIT, WE - 88% 100 PLASTIC LIMIT, W. = 36% 98 PLASTICITY Ip = 52% INDEX, FLOW INDEX, Ig = TOUGHNESS 92 IT = INDEX, WATER 90 CONTENT, DATE 15/07/83 SOIL MECHANICS LABORATORY DEPARTMENT OF CIVIL ENGINEERING UNIVERSITY OF MANITOBA TESTED. CHECKED R.L.Z. DATE 22/07/83 COMPUTED DATE 04/08/83

FORT GARRY

MANITOBA

Table B-VIII Plastic Limit Test Data for Clay No. 1

ATTERBERG LIMITS PROJECT CLAY MORTAR - THE NORTHERN HOUSING COMMITTEE SAMPLE 1 (CLAY) DEPTH 1 TO 9 FEET TEST HOLE NO. _ SAMPLE DESCRIPTION GREYISH - BROWN, SILTY CLAY, GROUND WITH MORTAR AND PESTLE TILL 100 % PASSING No. 40 SIEVE. LIQUID LIMIT TARE NO. NO. BLOWS WT. WET SOIL + TARE WT. DRY SOIL + TARE WT. WATER WT. TARE WT. DRY SOIL WATER CONTENT, % WATER CONTENT PLASTIC LIMIT TARE NO. Z24 WT.WET SOIL + TARE 28,050 28.171 33.298 WT. DRY SOIL + TARE 25, 432 25.718 30.999 WT. WATER 2.618 2.453 2.299 WT. TARE 24.451 18.646 18.778 WT. DRY SOIL 6.786 6.940 WATER CONTENT, % 38.58 FLOW CURVE AVERAGE VALUES LIQUID LIMIT, WE = 88 % PLASTIC LIMIT, Wy = 36 % PLASTICITY Ip = 52% INDEX, FLOW INDEX, TOUGHNESS INDEX, WATER CONTENT, DATE 20/07/83 SOIL MECHANICS LABORATORY DEPARTMENT OF CIVIL ENGINEERING UNIVERSITY OF MANITOBA DATE 22/07/83 COMPUTED DATE 04/08/83

FORT GARRY

MANITOBA

CHECKED .

Table B-IX
Liquid Limit Test Data for Clay No. 2

ATTERBERG LIMITS PROJECT CLAY MORTAR -THE NORTHERN HOUSING TEST HOLE NO. SAMPLE _2 DEPTH 1 TO 10 FEET SAMPLE DESCRIPTION BROWN AND GREY SILTY CLAY WITH TRACES OF PERBLES. GROWND WITH MORTAR AND PESTLE TILL 100 % PASSING NO. 40 SIEVE. LIQUID LIMIT TARE NO. 83 244 T20 U16 86 89 NO. BLOWS 35 27 23 11 8 6 WT. WET SOIL + TARE 38.56 35.85 34.80 35.51 35.17 40.45 27.94 WT. DRY SOIL + TARE 28.29 27.61 27.50 33.43 WT. WATER 7.19 7.57 7.67 7.02 7.56 8.48 WT. TARE 18.62 18.63 18.61 18.68 25.70 21.13 WT. DRY SOIL 9.00 9.32 7.73 8.95 9.66 8.82 WATER CONTENT, % 90.8 81.2 94.7 78.3 79.9 0.78 PLASTIC LIMIT WATER CONTENT TARE NO. WT. WET SOIL + TARE WT. DRY SOIL + TARE WT. WATER WT. TARE WT. DRY SOIL WATER CONTENT, % FLOW CURVE AVERAGE VALUES LIQUID LIMIT, WE = 81 % 72 PLASTIC LIMIT, Wp = 32% 90 PLASTICITY Ip = 49 % INDEX, 88 FLOW INDEX, Is = 86 TOUGHNESS IT -INDEX, 82 WATER CONTENT, SOIL MECHANICS LABORATORY DEPARTMENT OF CIVIL ENGINEERING UNIVERSITY OF MANITOBA DATE 15/07/83 DATE 22/07/83 COMPUTED DATE 04/08/83 CHECKED _ FORT GARRY MANITOBA

Table B-X
Plastic Limit Test Data for Clay No. 2

ATTERBERG LIMITS PROJECT CLAY MORTAR - THE NORTHERN HOUSING COMMITTEE SAMPLE 2 (CLAY) DEPTH 1 TO 10 FEET TEST HOLE NO. ___ SAMPLE DESCRIPTION BROWN AND GREY SILTY CLAY WITH TRACES OF REBLES. GROWND WITH MORTAR AND PESTLE TILL 100% PASSING No. 40 SIEVE. LIQUID LIMIT 5 TARE NO. NO. BLOWS WT. WET SOIL + TARE WT. DRY SOIL + TARE WT. WATER WT. TARE WT, DRY SOIL WATER CONTENT, % PLASTIC LIMIT WATER CONTENT 3 TARE NO. A3 A 15 A 2 4 WT.WET SOIL + TARE 23. 141 23.191 25.888 WT. DRY SOIL + TARE 20. 195 19.968 22.118 2.946 WT. WATER 3.223 3,770 WT. TARE 11.021 10.289 10.285 WT. DRY SOIL 9.174 9.679 11.833 WATER CONTENT, % 32.11 AVERAGE VALUES LIQUID LIMIT, WE = 81 % PLASTIC LIMIT, Wp = 32% PLASTICITY IP = 49% INDEX, FLOW INDEX, If = TOUGHNESS ITE INDEX, WATER CONTENT, NUMBER OF SLOWS SOIL MECHANICS LABORATORY DEPARTMENT OF CIVIL ENGINEERING UNIVERSITY OF MANITOBA FORT GARRY MANITOBA TESTED R. 12. COMPUTED R. 12. CHECKED R. 12. DATE 21/07/83 DATE 22107183 __ DATE 02 108 183

Table B-XI

Specific Gravity Test Data for Clay No. 1

SPECIFIC GRAVITY TESTS

5M _____

				
	Y- MORTAR - THE			
TEST HOLE NO.	A·5 SAMPL	E NO. 1 (CLAY)	DEPTH _ 1 To	9 FEET
DESCRIPTION	OF SAMPLE: FIRM.	VARNED, GE	REVISH - BROW	n SILTY
CLAY WITH	TRACES OF GYPSUM	AND ORGANI	C MATTER.	
REMARKS: 5	AMPLE WAS OVEN !	DRIED AND GE	ROUNDED IN A	MORTAR
WITH A CAST.	IRON PESTLE, CARE	WAS TAKEN	So As NOT	TO BREAK
אבעפועוסא!	PARTICLES. GROV	uno True 100	0% Passing N	0. 10 SIEVE.
FLASK NO.		ВВ	0	
THERMOMETE	n no.		14-985B	
	WT. FLASK + DRY SOIL	-		
COHESIONLESS	WT. FLASK	_	-	
SOILS ONLY	WT. DRY SOIL, We	-	-	
TIME UNDER	VACUUM	30 Mins.	30 Mins.	
WT. FLASK + W	ATER + SOIL, Wows		697,609	
TEMP. OF SU	SPENSION, T°C.	23.5	23.9	
WT. FLASK +	WATER, WhW	659.74 g	661.939.	
	EVAP. DISH NO.	L-VIII	H XVII	
COHESIVE	WT. DRY SOIL + TARE	272.99 9.	412.67 9.	
SOILS ONLY	WT. TARE	204.58 9	357.72 9.	
	WT. DRY SOIL, Wa	68.419	54.95 g.	
SPECIFIC GR	AVITY, G.	2.84	2.85	
AVERAGE SPE	CIFIC GRAVITY		35	
FORMULA	(We+ Whw		~ /	
WHERE	04 = SPEGIFIC	GRAVITY OF	SOLIDS (bas	ed at 20°C)
	Ws = WT. OF	RY SOIL		
	Ware WT. OF F	LASK + WATE	R AT T°C.	
	(FROM (CALIBRATION (CURVE FOR FL	.ask)
		LASK + WATE		
	G _T = Relativ G ₂₀ = Relativ	e Density of e Density of	Water at T Water at 20	oc Oc
TESTED: R.L.		DEPARTM	CHANICS LA ENT OF CIVIL EN RSITY OF M	BORATORY IGNEERING ANITOBA
CHECKED: R.J	. 2. DATE: 25/02/8			ABOTE

Table B-XII

Specific Gravity Test Data for Clay No. 2

SPECIFIC GRAVITY TESTS SM

PROJECT CLAS	MORTAR - THE NO			
TEST HOLE NO.		E NO. 2 (CLAY)		
	OF SAMPLE: SOFT.			
SILTY CLA	Y WITH TRACES (DF GYPSUM	, URGANIC	MATTER
AND PEB	BLES.			
REMARKS: S	AMPLE WAS OVEN D	RIED AND GRO	UNDED IN A	MORTAR
WITH A CAS	T- IRON PESTLE. CA	RE WAS TAK	en So As N	OT TO BREAK
MOLYIDUAL	PARTICLES. GROUN	6 TILL 100%	PASSING No.	10 SIEVE.
FLASK NO.		BC	Н	
THERMOMETE	R NO.	240397	2 40397	
	WT. FLASK + DRY SOIL			
COMESIONLESS	WT. FLASK			
30123 01121	WT. DRY SOIL, Ws			
TIME UNDER	VACUUM, MINUTES	30	30	
WT. FLASK + W	ATER + SOIL, Wows, &.	678.60	683.31	
TEMP. OF SU	SPENSION, T°C.	35.0	31.0	
WT. FLASK +	WATER, WOW . 9.	647.52	652.05	
	EVAP. DISH NO.	AL	HXIV	
COHESIVE	WT. DRY SOIL + TARE, 9.	353.05	398.85	
SOILS ONLY	WT. TARE, 9.	304.98	350.18	
	WT. DRY SOIL, We, 9.	48.07	48.67	
SPECIFIC GR	AVITY, 6.	2.82	2.79	
AVERAGE SPE	CIFIC GRAVITY	2.	81	
FORMULA WHERE	(We+Wbw Ba = SPECIFIC We = WT. OF I Wbw = WT. OF I (FROM (Wbw = WT. OF I GT = Relative G20 = Relative	GRAVITY OF	SOLIDS (base R AT T C. CURVE FOR FI R + SOIL AT	.ash)
TESTED: R.L. COMPUTED: R.L. CHECKED: R.J.	2 DATE: 14/07/8 1.2 DATE: 26/07/8 2 DATE: 28/07/8	DEPARTM UNIVE	-	

Appendix C

TESTING DATA AND PROPERTIES OF SAND

Throughout all of the tests, sand was used in every mortar mix. The source of the sand was kept constant, thereby keeping the properties of the sand constant. Visually, the sand was described as a light brown, dry, loose, homogeneous, poorly graded, clean sand consisting of sub-angular particles.

Table C-I shows the moisture content test results of the sand. The moisture content, as suspected, proved to be negligible at 0.075 percent. The sand was always in this dry state whenever used, and was assumed to have a zero

Table C-I	
Moisture Content of Sand	
Weight of Tare No. L-V111 and Wet Sand (g.) Weight of Tare No. L-V111 and Dried Sand (g.) Weight of Water in Sand (g.) Tare Weight of Tare No. L-V111 (g.) Weight of Dried Sand (g.) Moisture Content of Sand (%)	808.69 808.24 0.45 204.60 603.64 0.075

moisture content.

To determine the properties of the sand, a sieve analysis and specific gravity tests—were performed following the procedures used by the Soil Mechanics Laboratory of the University of Manitoba. These procedures follow closely the following ASTM standards: ASTM D 421-58, Standard Method for Dry Preparation of Soil Samples for Particle-Size Analysis and Determination of Soil Constants [1]; ASTM D 422-63, Standard Method for Particle-Size Analysis of Soils [2]; and ASTM D 854-58, Standard Test—for Specific Gravity of Soils [5].

Results of the sieve analysis is shown in Table C-II. From this analysis, the grain distribution curve (mechanical analysis) is shown in Figure C-1; this curve is identical to the one shown with Table C-II but is in more detail for further analysis.

To help describe the particle size distribution of the mortar sand, three parameters were used — effective diameter D_{10} , coefficient of uniformity C_U , and coefficient of curvature C_C . Effective diameter, also known as the effective size, is defined as the maximum particle size at 10 percent passing of the sieve analysis. The uniformity and curvature coefficients are defined by the following mathematical equations:

$$C_{II} = D_{60}/D_{10}$$

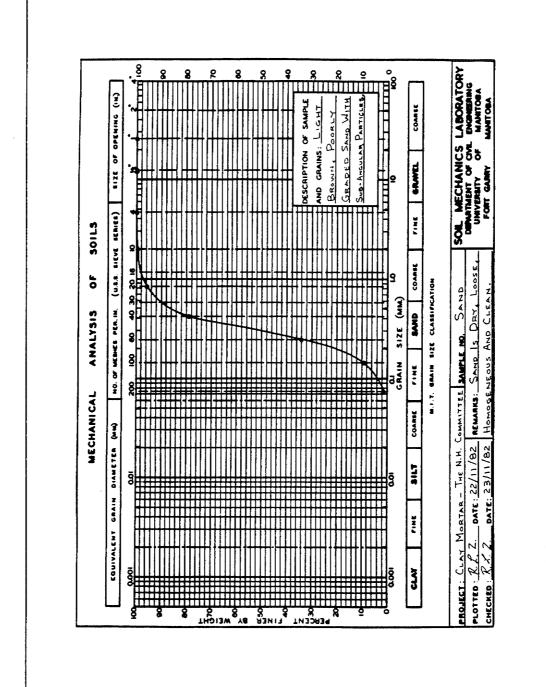
$$C_C = (D_{30})^2/(D_{60} \times D_{10}).$$

Table C-II
Sieve Analysis of Sand

SIEVE ANALYSIS

SM

REMARK	GRADED, CLI			,,,,,			
	AMPLE + TARE			EVAP	ORATING DI	SH NO	
WT. OF T		<u> </u>	_			STONE =	MN
	WT. OF SAME				NG OVEN:	IN On.	
SIEVE NO (U.S.S.)	TOTAL WT. RETAINED + TARE (GM.)	TARE (GM.)	TOTAL	WT.	I	PERCENT PASSING	SIEVE OPENING (MM)
ı	522.65	522.65	0	>	797.45	100.0	26.67
1/2	554.73	554.73	0	>	797.45	100.0	12.7
4	520.69	520.69)	797. 45	100.0	4.76
10	451.09	448.47	2	.62	794, 83	99.7	2.00
20	479, 82	450.13	29	.69	765. 14	95.9	0.84
40	522.74	387.95	134	. 79	630.35	79.0	0.42
60	729.59	370.47	359	. 12	271.23	34.0	0.25
100	555.65	356.87	198	. 78	72.45	9.1	0.149
200	413.64	354.46	59	. 18	13.27	1.7	0.074
PAN	359.62	346.35	13	. 27	$>\!\!<$	$>\!\!<$	$\geq \leq$
DIST	IN SIZE RIBUTION URVE	T FINER BY WEIGHT	60	I GRA	IN SIZE IN	MILLIMETE	3. 4. 10 84 46 47 100 R3
		•		GRA SA	ND	MILLIMETE GRAVEL CLASSIFICA	RS



'igure C-1: Grain Size Distribution Curve of Sand

 D_{60} and D_{30} are respectively the maximum particle size at 60 and 30 percent passing of the sieve analysis. From Figure C-1, page 322, D_{10} , D_{30} and D_{60} were found to have the following values:

 $D_{10} = 0.16 \text{ mm}.$

 $D_{30} = 0.24 \text{ mm}.$

 $D_{60} = 0.34 \text{ mm}.$

Hence: $C_{II} = 0.34/0.16 = 2.1$

 $C_C = (0.24)^2/(0.34 \times 0.16) = 1.1.$

Using the soil testing results of the sand examined, and the Unified Soil Classification table in Reference 6 [p. 16], the sand is classified as poorly graded sand with small amount of fines (SP). This confirms the initial visual description of being poorly graded. It is important to note at this point that the term "poorly graded" as used above is defined as used in soil testing — soil material predominantly one size or a range of sizes with some intermediate sizes missing. For a geologist, the above definition would instead be termed "well graded". This type of sand, as recorded in the Engineering Use Chart of Reference 6 [p. 17], is listed as being fair in terms of its workability as a construction material.

The results of the specific gravity tests for the sand is shown in Table C-III. From this table, the specific gravity of the sand was calculated to be 2.71.

To determine the weight of sand to be used in the volumetric proportioned lime-sand mortar mixes and to be able to convert the weight of sand used in the clay mortar mixes to volumetric proportions, the apparent density of the sand used is needed. To determine this, two density measurements were taken of the sand. One measurement involved rough shaking of the volume measuring container while filling it up with sand. For the second measurement, there was no shaking involved. Table C-IV shows the results of these two respective measurements to be 109 and 97 pcf. The average of these two values is 103 pcf; this value will be assumed to represent a condition of gentle shaking of the container.

With reference to Lea [45, p. 361], dry sand poured into a container with gentle shaking is listed as having an apparent density of 95 to 105 pcf. The above value of 103 pcf. is within this range of values. Midway in this range is the value of 100 pcf. — this is the apparent density value used for the above sand.

Table C-III

Specific Gravity Test Data for Sand

SPECIFIC GRAVITY TESTS SM

PROJECT CLAS	MORTAR THE	NORTHERN	Housing Com	MATTEE
TEST HOLE NO.		E NO. SAND		
DESCRIPTION	OF SAMPLE: LIGHT	BROWN, DRY	LOOSE, HOM	OGENEOUS
POORLY GR	ADED CLEAN SAND	CONSISTING	OF Sub- An	GULAR
PARTICLES				
REMARKS: A	LL WEIGHTS ARE	IN GRAMS. 9		
FLASH NO.		L	BC	
THERMOMETER	R NO.	Z 40290	7 40290	
COMESIONI FSS	WT. FLASK + DRY SOIL	250.79	231.65	
COMESIONLESS SOILS ONLY		166.37	151.00	L
	WT. DRY SOIL, We	84.42	80.65	
TIME UNDER		30 Mins.	30 Mins.	
	ATER + SOIL, White	717.97	700.38	
	SPENSION, T°C.	22.0	21.9	
WT. FLASK +		664.63	649.43	
	EVAP, DISH NO.	L-XIV	HXVIII	
	WT. DRY SOIL + TARE	275.61	329.83	
SOILS ONLY		191.16	249.12	
	WT. DRY SOIL, We	84.45	80.71	
SPECIFIC GR		2.71	2.71	
AVERAGE SPE	CIFIC GRAVITY	2.	71	
FORMULA	(Wg+ Wbw			20 ⁰ 0\
WHERE	,	GRAVITY OF	SOLIDS (Das	sed at 20°C)
	Wg = WT. OF (
		FLASK + WATE		
	,	CALIBRATION		•
	G ₂₀ Relativ	VLASK + WATE Ve Density of Ve Density of	F Water at 1 Water at 2	r°c.
TESTED: R.J	. Z. DATE: 03-04/03		ECHANICS L	
	1.2. DATE: 05/03/	DEPARTM	ENT OF CIVIL E	NGINEERING FANITORA
	P.Z. DATE: 23/11/8			NITOBA

	Tab	le C-IV	
	Measured Apparen	nt Density of Sand	
Degree of Container Shaking	Volume of Container/ Sand (ft.3)	Weight of Sand Alone (g.) [(lbs.)]	Apparent Density (pcf.)
Rough	0.125	6,207 [13.68]	109
None	0.125	5,515 [12.16]	97
Average Appare	nt Density		103

Appendix D

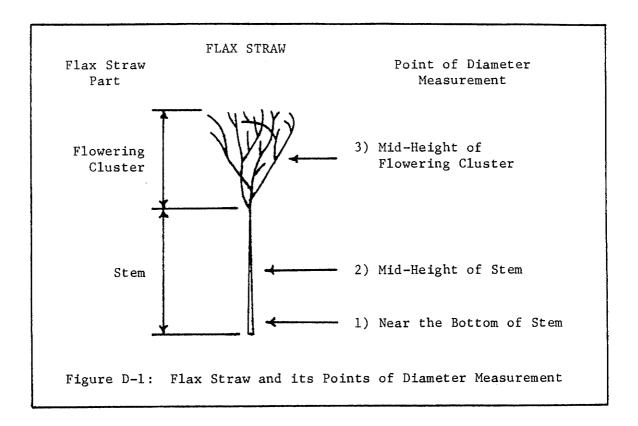
INFORMATION ON FLAX STRAW (FIBRES)

Flax straw was used as the source of fibres for the clay mortar mixes. For the description of a flax plant, see Definitions -- "flax". Flax straw can become readily available wherever grain farming takes place.

Obtained for the clay mortar mixes was one bale of flax straw. The approximate dimensions of this bale was 14 inches high by 18 inches wide by 40 inches in length. In its dry state, the bale weighed 28 pounds giving it a bale density of 4.8 pcf. It is realized however, that this bale density is only indicative and can change depending upon the degree of packing when the bale is made.

Figure D-1 shows the two basic parts of flax straw, the stem and the flowering cluster. Both of these parts consist of a straw like core material with threadlike fibres ("linen" -- see Definitions: "flax") wrapped around.

To determine what approximate length to cut the flax straw, an initial aspect ratio (length to diameter -- 1/d) of 30 was used. This aspect ratio was found to be favourable for steel fibre reinforced concrete so as to prevent the balling of the fibres when incorporated into the



mix (see Subsection 3.1.1, Preliminary Literature Search).

Before the aspect ratio could be determined, the diameter of
the flax straw was first measured.

The diameter of flax straw is non-uniform. To get an average diameter, on 10 samples of flax straw, three points of measurements were taken — one near the bottom of the stem, one at the mid-height of the stem, and one at the mid-height of the flowering cluster. These three points of measurements are shown in Figure D-1. The results of these measurements are in Table D-I. From these measurements and a study of the aspect ratio with Table D-I, it was decided to use the flax straw in one-inch lengths. The average aspect ratio of flax straw cut to one-inch lengths was 18.

Table D-I
Flax Straw Diameter Measurements

	Diame	ter of Flax Stra	w Partl
	Ste	m	Flowering Cluster
Measurement No.	Near Bottom (inch)	Mid-Height (inch)	Mid-Height (inch)
1	0.065	0.055	0.035
2	0.069	0.059	0.033
3	0.092	0.059	0.029
4	0.091	0.060	0.027
5	0.078	0.056	0.041
6	0.071	0.076	0.030
7	0.065	0.060	0.030
8	0.075	0.052	0.034
9	0.071	0.060	0.034
10	0.080	0.059	0.033
Average	0.076	0.060	0.033
Overall Average		0.056	

Notes: 1) The length of flax straw required for an aspect ratio (1/d) of 30, using the overall average diameter, is:

 $l = 30 \times d = 30(0.056) = 1.68$ inches Use l = one inch;

2) The average aspect ratio with flax straw cut to one inch lengths is:

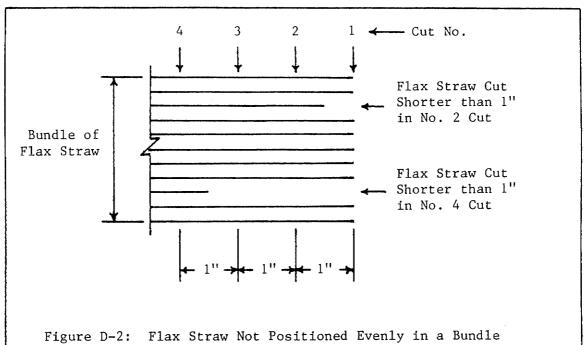
Average aspect ratio = 1/d = 1.0/0.056 = 18.

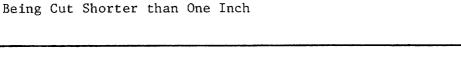
¹See Figure D-1, page 328.

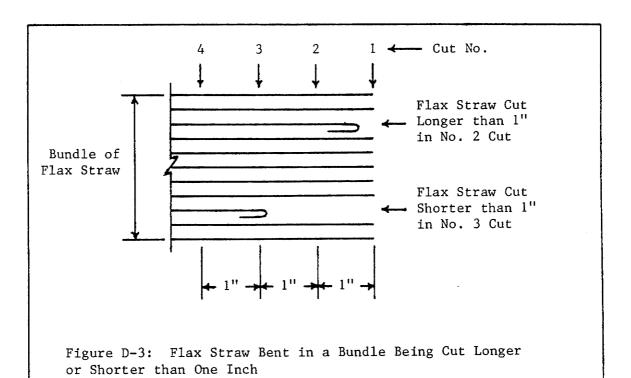
To cut the flax straw into one-inch lengths, four different methods were tried: 1) knife, 2) tin shears, 3) tin shear press, and 4) household scissors. For each method, the cutting edge was sharp and a bundle/group of straw (Photograph 2, page 18) of about one-half inch in diameter was cut at a time. The method of using a knife (with an eightinch blade) on a cutting board proved to be labourious and difficult at times. Cutting with the tin shears involved less effort in accomplishing the cut but the short length of the cutting edge (two and one-half inches) and the long handle (seven inches) made it an awkward job. The tin shear press also accomplished the cut with ease but the setup of the press made it difficult to see the cut length without some form of scale setup on the table. Another problem with the tin shear press was that it was a relatively high-cost piece of equipment, thereby making it not as readily available in practice. The fourth method of using an ordinary pair of household scissors, with a cutting edge length of three and one-half inches, proved to be excellent. The scissors required very little effort in making the cut and were easy to handle.

The rate at which the straw was cut into one-inch lengths was 0.86 pounds per man-hour. This rate was calculated from the straw cut using all of the above methods but with the majority of the cutting performed with the household scissors.

To be more precise, it should be noted that the flax straw was cut to one-inch average lengths; lengths shorter and longer than one inch were included. Figure D-2 illustrates how a straw not positioned evenly in a bundle can be cut shorter than one inch. Straw that is bent in a bundle can be cut into a length that is longer or shorter than one inch; this phenomenon is illustrated in Figure D-3. Bent flax straw is more prone to occur with the flowering part due to its smaller diameter.







Appendix E

INFORMATION ON LIME

For this investigation, two different brand names of lime were used. The brand names were designated as "Brand A" and "Brand B". Information on the bag of lime Brand A classified it as a high calcium, normal hydrated lime suited for both chemical and agriculture use. The manufacturer of lime Brand A was Steel Brothers, Canada, Limited, Lime Division Kananaskis, Alberta. Lime Brand B was also classified as a high calcium, normal hydrated lime. Labelled "SLW Spredwel", lime Brand B was manufactured in Canada by Summit Lime Works Limited of Lethbridge, Alberta at the Crows Nest Plant in British Columbia.

Lea [45, p. 361] lists the apparent density of hydrated lime to be 30 to 40 pcf. This range of values is to be taken for hydrated lime placed in a container with gentle shaking. When required, the apparent density of hydrated lime was taken at the midpoint of the above range, 35 pcf.

For the clay mortar mixes, Mix Nos. 2 to 5 contained lime which came from an unmarked plastic bag stored in the laboratory under dry conditions. It was assumed that the lime in this plastic bag was lime Brand A. For Mix Nos. 6 to 11, lime from a second bag labelled lime Brand A was

used. This second bag came from the Northern Housing Committee's [51] outdoor storage shed and showed evidence of being previously wetted.

For the lime-sand mortar mixes, Mix Nos. 12 to 17 contained lime Brand A. For Mix Nos. 18 to 23, lime Brand B was used. All of the lime used for the lime-sand mortars were obtained from the laboratory, stored under dry conditions.

The basic chemical reactions of limestone to quicklime to hydrated lime and back to a form of limestone (as hardened mortar) are as follows:

The above reactions are strictly for a theoretical pure high-calcium lime, 100 percent calcium carbonate. In reality, a small amount of magnesium carbonate usually exists.

For a high-magnesium lime, the percentage of magnesium oxide present increases markedly but calcium oxide is still present as a significant proportion (see Definitions on the different types of limes). Simultaneously with the above reactions, the following additional reactions occur for the magnesium part of the lime:

Looking at the normal hydration reaction, the magnesium oxide remains inert and does not chemically combine with the water. However, under pressure hydration, the magnesium oxide will combine with the water as shown in the following reaction:

Pressure MgO +
$$H_2O \longrightarrow Mg(OH)_2$$
 + Heat Hydration magnesium water magnesium hydroxide

The resultant magnesium hydroxide from the pressure hydration should then have the following carbonization reaction:

Carbonization $Mg(OH)_2 + CO_2 \longrightarrow MgCO_3 + H_2O$ of Pressure

Hydrated magnesium carbon magnesium water

Magnesium hydroxide dioxide carbonate

Oxide

E.1 AUTOGENOUS HEALING CAPABILITY [38, 48, 68]

For the description of the property of autogenous healing, see Appendix A.

Hydrated lime, which is very slightly soluble in pure water at low temperatures, will dissolve in rain water containing carbon dioxide even when it is already carbonated to calcium carbonate. Dissolved, the lime then becomes recarbonated into a more readily soluble carbonate, calcium bicarbonate which in turn can revert to the stable carbonate of limestone (calcium carbonate) upon drying out. While in the soluble calcium bicarbonate form, this solution can migrate into the small voids or cracks of the mortar. Then after drying out, calcium carbonate is precipitated in the void or crack. After many cycles of this solution-drying, the carbonate build-up plugs the void or crack.

The above reaction of autogenous healing is expressed chemically as follows:

Autogenous $CaCO_3$ + H_2O + CO_2 \longrightarrow $Ca(HCO_3)_2$ Healing calcium water carbon calcium carbonate

The double arrow indicates that the reaction is reversible. This reaction is similar to the development of stalactites and stalagmites in limestone caves, although the latter occurs at an infinitely slower rate.

Appendix F

SHRINKAGE DATA FOR CLAY MORTAR MIXES

Tabulated in this appendix is the shrinkage data for the clay mortar mixes. Following are notes pertaining to Tables F-I to F-XII:

- Vol. indicates volume/volumetric;
- 2. Disp. indicates displacement;
- n.d. indicates not done;
- 4. original moulded volume of cube specimens = 8.0 in. 3;
- 5. adjustment factor = Vol. shrinkage by water Disp.;

 Vol. shrinkage by calipers
- 6. adjusted measured volume = (Vol. shrinkage by calipers) x (adjustment factor);
- listed Vol. shrinkage by calipers are the average of three cube specimens.

Carlot of the ca		Table F-I			
		Shrinkage Data Mix No. 1	B		
Measurement No.	Vol. Shrinkage by Calipers (%)	Vol. Shrinkage by Water Disp. (%)	Adjustment Factor	Age (days)	Adjusted Vol. Shrinkage (%)
Н	0.0	n.d.	-	0.0	0.0
7	29.95	n.d.	(4.75	32.18
က	37.23	n.d.		9.54	40.01
4	37.27	n.d.	•	16.42	40.05
Ŋ	37.46	n.d.		23.84	40.25
9	37.06	n.d.		30.42	39.82
n.d.	n.d.	n.d.	1.07461		
Note: See page	338	for notes pertaining to this table.	able.		
Average adjustment	tment factor based on Mix Nos.	2, 3,	4, and 5 ^A (air dry).	dry).	

		Table F-II			
		Shrinkage Data Mix No. 2	ta		
Measurement No.	Vol. Shrinkage by Calipers (%)	Vol. Shrinkage by Water Disp. (%)	Adjustment Factor	Age (days)	Adjusted Vol. Shrinkage (%)
-	0.0	n.d.		0.0	0.0
81	30.73	n.d.	•	4.25	32.84
n	48.93	n.d.		8.97	52.29
4	49.31	n.d.		15.84	52.70
လ	49.52	n.d.		23.27	52.92
Ó	49.32	n.d.		30.27	52.71
7	49.32	52.71	1.0687	33.38	
Note: See page	338	for notes pertaining to this table.	able.		

To day on the state of the stat		Table F-III		Action to the state of the stat	
		Shrinkage Data Mix No. 3	ta		
Measurement No.	Vol. Shrinkage by Calipers (%)	Vol. Shrinkage by Water Disp. (%)	Adjustment Factor	Age (days)	Adjusted Vol. Shrinkage (%)
1	0.0	n.d.		0.0	0.0
ম	24.90	n.d.		3.75	26.54
က	45.39	n.d.		7.95	48.37
4	45.93	n.d.		14.81	48.95
ഹ	45.88	n.d.		22.25	48.89
တ	46.11	n.d.		30.27	49.14
	->-				
L	46.11	49.14	1.0657	31.19	
Note: See page	338	for notes pertaining to this table.	ıble.		

		Table F-IV			
	The state of the s	Shrinkage Data Mix No. 4	ta		
Measurement No.	Vol. Shrinkage by Calipers (%)	Vol. Shrinkage by Water Disp. (%)	Adjustment Factor	Age (days)	Adjusted Vol. Shrinkage (%)
T	0.0	n.d.		0.0	0.0
N	19.46	n.d.		3.63	21.09
ဢ	44.01	n.d.		7.65	47.69
4	45.02	n.d.		14.51	48.78
ស	45.13	n.d.		21.94	48.90
9	44.88	n.d.		29.96	48.63
L	44.88	48.63	1.0836	32.63	
Note: See page	338	for notes pertaining to this table.	able.		

		Table F-V			
		Shrinkage Data Mix No. 5A (Air Dry)	ta Dry)		
Measurement No.	Vol. Shrinkage by Calipers (%)	Vol. Shrinkage by Water Disp. (%)	Adjustment Factor	Age (days)	Adjusted Vol. Shrinkage (%)
1	0.0	n.d.		0.0	0.0
73	42.21	n.d.		7.88	45.60
က	42.57	n.d.		14.42	45.98
4	42.81	n.d.		23.92	46.24
5	42.91	n.d.		30.83	46.35
ဗ	→ 42.91	46.35	1.0802	31.08	
Note: See page	338	for notes pertaining to this table.			

		Table R-VI Shrinkage Data Mix No. 5 ^B (Moist Cured)	ta Cured)		
Measurement No.	Vol. Shrinkage by Calipers (%)	Vol. Shrinkage by Water Disp. (%)	Adjustment Factor	Age (days)	Adjusted Vol. Shrinkage (%)
- 2	0.0	n.d. n.d.		0.0	0.0
ო	42.14	n.d.		30.88	47.62
4	42.14	47.62	1.1300	31.08	
Note: See page 338	1	for notes pertaining to this table.	able.		

		Table F-VII Shrinkage Data	ta		
The second of th		Mix No. 6			
Measurement No.	Vol. Shrinkage by Calipers (%)	Vol. Shrinkage by Water Disp. (%)	Adjustment Factor	Age (days)	Adjusted Vol. Shrinkage (%)
1	0.0	n.d.		0.0	0.0
23	38.01	n.d.	-	7.31	43.77
က	38.63	n.d.		16.79	44.48
4	38.99	n.d.		23.79	44.90
Ŋ	39.15	n.d.		30.92	45.08
	•				
9	39.15	45.08	1.1515	34.85	
Note: See page	338	for notes pertaining to this table.	able.		

		Table R-VIII		radio pro esta e proprio de la constanta de la	
		Mix No. 7			
Measurement No.	Vol. Shrinkage by Calipers (%)	Vol. Shrinkage by Water Disp. (%)	Adjustment Factor	Age (days)	Adjusted Vol. Shrinkage (%)
	0.0	n.d.		0.0	0.0
83	35.05	n.d.	•	14.04	39.34
က	35.12	n.d.		20.90	39.42
4	35.41	n.d.		32.81	39.74
ιO	↑ 35.41	39.74	1.1223	34.02	
Note: See page		338 for notes pertaining to this table.	able.		

		Table F-IX			
		Shrinkage Data Mix No. 8	ta		
Measurement No.	Vol. Shrinkage by Calipers (%)	Vol. Shrinkage by Water Disp. (%)	Adjustment Factor	Age (days)	Adjusted Vol. Shrinkage (%)
1	0.0	n.d.		0.0	0.0
83	34.20	n.d.		13.65	37.50
8	34.39	n.d.		20.48	37.71
4	34.62	n.d.		32.40	37.96
Ç	34.62	37.96	1.0965	33.65	
Note: See page	338	for notes pertaining to this table.	able.		

		Table F-X	a.		
		Mix No. 9			The state of the s
Measurement No.	Vol. Shrinkage by Calipers (%)	Vol. Shrinkage by Water Disp. (%)	Adjustment Factor	Age (days)	Adjusted Vol. Shrinkage (%)
1	0.0	n.d.		0.0	0.0
87	38.82	n.d.		8.33	43.43
ဗ	39.11	n.d.		16.66	43.76
4	39.14	n.d.		23.74	43.79
ഗ	39.38	n.d.		29.50	44.06
છ	7 39.38	44.06	1.1188	29.69	
Note: See page	338	for notes pertaining to this table.	lb]e.		

		Table F-XI			
		Shrinkage Data Mix No. 10	ta)		
Measurement No.	Vol. Shrinkage by Calipers (%)	Vol. Shrinkage by Water Disp. (%)	Adjustment Factor	Age (days)	Adjusted Vol. Shrinkage (%)
П	0.0	n.d.		0.0	0.0
8	34.35	n.d.	•	8.13	41.79
ო	34.83	n.d.		16.08	42.37
4	34.84	n.d.		23.18	42.38
S	34.97	n.d.		28.96	42.54
9	34.97	42.54	1.2165	29.90	
Note: See page	9	38 for notes pertaining to this table.	ıble.		

		Table F-XII	I		
		Shrinkage Data Mix No. 11	ta 1		
Measurement No.	Vol. Shrinkage by Calipers (%)	Vol. Shrinkage by Water Disp. (%)	Adjustment Factor	Age (days)	Adjusted Vol. Shrinkage (%)
T	0.0	n.d.		0.0	0.0
7	30.62	n.d.	-	5.69	37.61
ກ	31.89	n.d.		12.80	39.17
4	31.86	n.d.		19.90	39.14
ĸ	32.00	n.d.		31.81	39.31
9	32.35	n.d.		39.88	39.74
7	32.35	39.74	1.2284	40.63	
Note: See page	338	for notes pertaining to this table.	uble.		

Appendix G

COMPUTER PROGRAMS

Listed in this appendix are the computer programs written and used for this investigation. These programs are presented as they were last used.

G.1 COMPUTER PROGRAM NO. 1 [25, 27]

Computer Program No. 1 was used to plot out the shrinkage behaviour curve for the clay mortar mixes -- Figure 3, page 93. Details of this program are included in the program itself.

```
SHRINKPLOT "Computer Program No. 1"
    10. //SHRINK JOB ',,,T=1M,L=5,I=10,C=0','RANDY ZAPOTOTSKY',CLASS=F,
20. // MSGLEVEL=(1,1)
    30. /*ROUTE PRINT SELF
    40. /*D800 VPLOT
    50. // EXEC FORTHCLG, USERLIB= 'SYS3. VPLOTLIB', SIZE=256K
    60. //FORT.SYSIN DD *
    70. C
    80. C
    90. C
   100. C
                                  --- SHRINKPLOT ---
   110. C
              --- THIS IS THE PROGRAM FOR PREDETERMINED PLOTTING ---
   120. C
   130. C
                                --- SHRINKAGE PLOT ---
   140. C
   150. C
   160. C
   170. C IN THIS PROGRAM THE FIRST THING THAT IS READ IN IS THE NUMBER 180. C OF PLOTS TO BE DRAWN AND THE NUMBER OF SETS OF DATA PER PLOT.
   190. C THE CHARACTERISTICS, NAMELY THE ORGIN AND AXES, ARE THEN DEFINED
   200. C AND PLOTTED OUT. FOR AESTHETICS PURPOSES ONLY, A FRAME IS DRAWN
   210. C AROUND THIS SET OF AXES.
   220. C
               FOLLOWING THE ABOVE, THE DATA POINTS ARE THEN READ IN
   230. C
   240. C PLOTTED OUT WITHIN THE LIMITS OF THE CHARACTERISTICS OF THE
   250. C PLOT. A PREDETERMINED BEST FIT CURVE IS THEN DRAWN IN.
   260. C
   270. C
               IN THE END, A LEGEND IS INSERTED IN THE INNER, UPPER
   280. C RIGHT HAND CORNER OF THE PLOT. IF NO LEGEND IS DESIRED, THIS PART
   290. C CAN BE SKIPPED.
   300. C
               WHEN SUBMITTING A JOB, THE ORDER OF SUBMISSION IS:
   310. C
   320. C
   330. C
                        SHRINKPLOT
   340. C
                    2)
                        NOPLOT
                         "FIRST DATA FILE"
   350. C
                         "SECOND DATA FILE"
   360. C
                    4)
                         "THIRD DATA FILE"
   370. C
                    5)
   380. C
                     )
   390. C
                     1)
   400. C
                         "N-2TH DATA FILE (LAST ONE)"
   410. C
   420. C
               WHERE:
                       SHRINKPLOT: IS THE NAME OF THIS PLOTTING PROGRAM.
   430. C
   440. C
   450. C
                            NOPLOT: CONTAINS THE FIRST JCL STATEMENT AND
   460. C
                                      SPECIFIES THE NUMBER OF PLOTS TO BE
                                      PLOTTED AND THE NUMBER OF SETS OF DATA
   470. C
                                      PER PLOT. THE FORM OF THIS FILE IS:
   480. C
   490. C
                                      1. //GO.SYSIN.DD *
   500. C
                                      2. "NUMBER OF PLOTS"
3. "NUMBER OF SETS OF DATA PER PLOT"
   510. C
   520. C
   530. C
   540. C
                                     THE FIRST OR ANY OTHER DATA FILE
                         DATA FILE:
                                      CONTAINS SOME BASIC INFORMATION ABOUT
   550. C
                                      THE PLOT AND ITS DATA POINTS. THE
   560. C
                                      FORM OF A DATA FILE IS:
   570. C
   580. C
                                      1. MIXNO N REMIX
   590. C
   600. C
                                      2. X1
                                                  Y1
   610. C
                                      3. X2
                                                  Y2
   620. C
   630. C
```

```
SHRINKPLOT "Computer Program No. 1"
   640. C
                                     N. X(N-1) Y(N-1)
   650. C
                                     WHERE: MIXNO = THE MIX NUMBER
   660. C
   670. C
                                                  N = THE TOTAL NUMBER OF
   680. C
                                                      DATA POINTS FOR THE
   690. C
                                                      MIX.
   700. C
                                              REMIX = "0" WHEN THE MIX WAS
   710. C
                                                          NOT REMIXED.
                                                       "1" WHEN THE MIX WAS
   720. C
   730. C
                                                          REMIXED.
                                              X&Y'S = THE DATA POINTS.
   740. C
   750. C
   760. C
              AFTER ALL OF THE DATA FOR A SINGLE PLOT HAS BEEN READ IN
   770. C THE NECESSARY DATA INFORMATION FOR THE PREDETERMINED PLOT MUST
   780. C THEN BE READ IN BEFORE THE NEXT PLOT'S INFORMATION.
   790. C
   800. C
              ALSO, WHEN SUBMITTING A JOB, ONE MUST MAKE SURE THAT THE
   810. C JCL ENDING THE DATA INFORMATION MUST BE PLACED AT THE CORRECT
   820. C POSITION. IF ONLY ONE PLOT IS TO BE PLOTTED, IT GOES AFTER
   830. C THE PREDETERMINED PLOT DATA INFORMATION WHICH IS PLACED AT THE
   840. C END OF THE SET OF DATA FILES. IN THE CASE WHERE MORE THAN TWO
   850. C PLOTS ARE TO BE DRAWN, THE JCL MUST BE PLACED AFTER THE
   860. C PREDETERMINED PLOT DATA INFORMATION FOR THE LAST PLOT WHICH IS
   870. C PLACED AT THE END OF THE LAST SET OF DATA FILES.
   880. C
   890. C
              DEPENDING ON THE NUMBER AND TYPE OF PLOTS TO BE DONE, THE
   900. C "DEVELOP A LEGEND" PART OF THE PROGRAM MUST BE MODIFIED
   910. C ACCORDINGLY, IF USED.
   920. C
              LIMITATIONS OF THE DIMENSION STATEMENTS ARE AS FOLLOWS:
   930. C
   940. C
   950. C
                             _),Y(
   960. C
                        MAXIMUM ALLOWABLE NUMBER OF DATA POINTS PER MIX
   970. C
                        READ IN IS 102 - 2 = 100
   980. C
   990. C
                        XPLOT(___), YPLOT(
                        THE MAXIMUM NUMBER OF ALLOWABLE OF PLOTTING POINTS
  1000. C
                        FOR THE BEST FIT CURVE IS 12 - 2 = 10
  1010. C
  1020. C
  1030. C
  1040. C
  1050.
              DIMENSION IBUF (4000), X(102), Y(102), XPLOT(12), YPLOT(12)
  1060.
              INTEGER REMIX
  1070. C
  1080. C
              READ AND WRITE OUT THE NUMBER OF PLOTS TO BE DRAWN
  1090. C
  1100.
              READ (5,*) NOPLOT, NODATA
           WRITE (6,10) NOPLOT
10 FORMAT ('1',/////,4X,'THE NUMBER OF PLOTS THAT ',
  1110.
  1120.
  1130.
             &'ARE TO BE DRAWN IS',3X,13)
           WRITE (6,20) NODATA
20 FORMAT (/////,4x,'THE NUMBER OF SETS OF DATA TO BE ',
  1140.
  1150.
             &'PLOTTED PER PLOT IS',3X,I3)
  1160.
  1170.
              DO 140 NP=1,NOPLOT
              CALL PLOTS (IBUF, 4000)
  1180.
  1190. C
  1200. C
               DEFINE SOME CHARACTERISTICS OF THE PLOT.
  1210. C
  1220.
              CALL PLOT (0.0,-11.0,-3)
              CALL PLOT (0.0,2.50,-3)
  1230.
  1240.
              CALL FACTOR (1.0)
              CALL AXIS (0.0,0.0,'AGE - DAYS',-10,7.0,0.0,0.0,8.0)
CALL AXIS (0.0,0.0,'% OF ORIGINAL VOLUME',20,4.0,90.0,0.0,25.0)
  1250.
 1260.
```

```
SHRINKPLOT "Computer Program No. 1"
  1270. C
  1280. C
                  ---- DRAW A RECTANGULAR FRAME AROUND THE PLOT -----
  1290. C
  1300.
                 CALL NEWPEN (4)
                 CALL RECT (-1.0,-1.25,6.0,9.0,0.0,3)
  1310.
  1320.
                 CALL NEWPEN (1)
  1330. C
  1340.
                DO 120 ND=1,NODATA
  1350. C
  1360. C
  1370. C
                  ----- READ AND WRITE OUT SOME BASIC INFORMATION -----
  1380. C
  1390.
                READ (5,*) MIXNO,N,REMIX
             WRITE (6,30) MIXNO
30 FORMAT ('1',/////,4X,'THIS IS THE PLOT ',
  1400.
  1410.
               &'PROGRAM INFORMATION FOR MIX NUMBER', 15)
  1420.
             WRITE (6,40) MIXNO,N
40 FORMAT (/////,4X,
  1430.
  1440.
               & THE TOTAL NUMBER OF DATA POINTS READ IN FOR MIX NUMBER',
  1450.
               &16,4x,'IS',17)
IF (REMIX.EQ.1) GO TO 60
  1460.
  1470.
             WRITE (6,50)
50 FORMAT (/////,4x,'THE FOLLOWING DATA IS FOR THE MIX '
  1480.
  1490.
  1500.
               &'WHEN ITS COMPONENTS WERE COMBINED FOR THE FIRST TIME')
  1510.
                GO TO 80
             60 WRITE (6,70)
  1520.
             70 FORMAT (//////,4x,'THE FOLLOWING DATA IS FOR WHEN THE ',
  1530.
  1540.
               &'HARDENED ORIGINAL MIXTURE WAS CRUSHED AND REMIXED')
  1550. C
  1560. C
                  READ AND WRITE OUT THE DATA POINTS FOR THE MIX.
  1570. C
  1580.
             80 READ (5,*) (X(I),Y(I),I=1,N)
             WRITE (6,90) MIXNO
90 FORMAT ('1',/////,33X,'DATA POINTS',//,31X, &'MIX NUMBER',1X,14)
  1590.
  1600.
           %'MIX NUMBER',1X,14)
    WRITE(6,100)

100 FORMAT(//,4X,'DATA NUMBER',10X,'X-VALUES (DAYS)',10X,
    &'Y-VALUES (% OF ORIGINAL VOLUME)',/)
    WRITE (6,110) (I,X(I),Y(I),I=1,N)

110 FORMAT (' ',7X,I3,18X,F7.3,25X,F8.3)
  1610.
  1620.
  1630.
  1640.
  1650.
  1660.
  1670. C
 1680. C
                PLOT OUT THE DATA POINTS
  1690. C
  1700.
                X (N+1) =
                             0.0
                Y (N+1) =
 1710.
                             0.0
  1720.
                X (N+2) = 8.0
  1730.
                Y (N+2) = 25.0
  1740. C
  1750.
                CALL LINE (X,Y,N,1,-1,0)
 1760. C
  1770.
           120 CONTINUE
  1780. C
 1790. C
                READ AND WRITE OUT THE PLOTTING POINTS
  1800. C
 1810.
                READ (5,*) (XPLOT(J), YPLOT(J), J=1,3)
           WRITE (6,130) NP

130 FORMAT ('1',/////,29x,'PLOTTING DATA POINTS',//, &34x,'PLOT NO.',1x,12)
 1820.
 1830.
  1840.
 1850.
                WRITE (6,100)
 1860.
                WRITE (6,110) (J,XPLOT(J),YPLOT(J),J=1,3)
 1870. C
 1880. C
                PLOT OUT THE BEST FIT CURVE
 1890. C
```

```
SHRINKPLOT "Computer Program No. 1"
                     XPLOT (4) = 0.0
YPLOT (4) = 0.0
XPLOT (5) = 8.0
YPLOT (5) = 25.0
   1900.
  1910.
  1920.
  1930.
1940. C
                     CALL NEWPEN (8)
CALL LINE (XPLOT, YPLOT, 3, 1, 0, 0)
CALL NEWPEN (1)
  1950.
  1960.
1970.
  1980. C
   1990.
                     CALL PLOT (12.0,0.0,999)
               140 CONTINUE
CALL PLOT (0.0,0.0,9999)
STOP
   2000.
  2010.
   2020.
   2030.
                     END
```

G.2 COMPUTER PROGRAM NO. 2 [27, 39 -- PP. 309-312]

Computer Program No. 2 was used to determine the constants of the best-fit polynomial curves that were used to describe the compressive strength and failure characteristics of all the mixes. The title of this program, Least-Squares Fit of a Polynomial, is self-explanatory of the method used to obtain these constants. Details of this program are included in the program itself.

```
BESTFIT "Computer Program No. 2"
    10. //ZAP JOB '0726,,,C=0,R=256K',NOTIFY=LANSDWN
    20. // EXEC WATFIV, SIZE=220K
    30. GO.SISIN DD *
    40. $JOB WATFIV RANDY ZAPOTOTSKY, NOEXT, NOCHECK
    50. C
    60. C
    70. C
    80. C **************
    90. C *
   100. C *
                 THIS IS THE MAIN PROGRAM OF "BESTFIT"
   110. C *
   120. C *
   130. C *
   140. C ************************
  150. C
  160. C
  170. C
   180. C
               THIS PROGRAM HAS THE CAPACITY OF DETERMINING FROM TWO (2)
   190. C TO A MAXIMUM OF TEN (10) CONSTANTS (C'S), FOR A LEAST-SQUARES,
   200. C BEST FIT POLYNOMIAL. FOR EXAMPLE: AN EQUATION WITH
   210. C WITH THREE (3) CONSTANTS CAN BE IN THE FORM SUCH AS:
  220. C
   230. C
                         Y = C1 + C2*X + C3*X*X
  240. C
   250. C
                                    OR
   260. C
  270. C
                         Y = C1*X + C2*X*X + C3*X*X*X
   280. C
  290. C THE SECOND EXAMPLE WOULD MAKE "Y" TOTALLY DEPENDANT
  300. C UPON "X". THEREFORE AT X=0.0, "Y" WOULD ALSO EQUAL 0.0. 310. C THIS WOULD MAKE THE BEST FIT CURVE PASS THROUGH THE
   320. C ORIGIN (0.0,0.0).
   330. C
   340. C
               THE MAXIMUM NUMBER OF DATA POINTS THAT CAN BE READ IN
   350. C IS TWO HUNDRED (200).
   360. C
   370. C
               THE FUNCTIONS CAN BE ADJUSTED TO FIT ONE'S NEED.
   380. C THIS, THREE (3) MAJOR ADJUSTMENTS ARE REQUIRED AT THE
   390. C FOLLOWING AREAS:
   400. C
                  1) "DEFINE THE FUNCTIONS"
  410. C
  420. C
                       IN THE MAIN PROGRAM
  430. C
                      "GENERATE THE F MATRIX"
   440. C
   450. C
                       IN THE MAIN PROGRAM
  460. C
                  3) THE NUMBER "M" (NUMBER OF CONSTANTS, C'S)
   470. C
                      IN THE DATA FILE. THIS NUMBER "M" MUST
   480. C
  490. C
                      EQUAL THE NUMBER OF FUNCTIONS.
  500. C
  510. C
               THE DATA FILE FOR THIS PROGRAM SHOULD HAVE RECORDS IN
   520. C THE ORDER AS SHOWN BELOW:
   530. C
               1.$ENTRY
  540. C
   550. C
               2.
                  MIXNO M N N1 N2 N3 DASH
               З.
   560. C
                    X1
                       ¥1
                       Y2
   570. C
                    Х2
   580. C
                    X3 Y3
  590. C
  600. C
  610. C
   620. C
               N+2. XN
   630. C
```

```
BESTFIT "Computer Program No. 2"
   640. C
                WHERE MIXNO = THE MIX NUMBER
   650. C
                           M = THE NUMBER OF CONSTANTS (C'S)
   660. C
                           N = THE TOTAL NUMBER OF DATA POINTS
                          N1 = THE NUMBER OF DATA POINTS FOR CUBE NUMBER 1
   670. C
                          N2 = "
N3 = "
   680. C
                                      11
                                           **
                                                Ħ
                                                       11
   690. C
                                                              11
                                                                  11
                                                                         .
                        DASH = "0" IF A PEAK LOAD OCCURRED FOR ALL OF THE
   700. C
   710. C
                                    CUBES DURING THE COMPRESSION TEST
                             = "1" IF PEAK LOADS DID NOT OCCUR FOR ALL OF
   720. C
   730. C
                                    THE CUBES DURING THE COMPRESSION TEST
   740. C
                               NOTE: THE USE OF DASH COMES IN USE WHEN
   750. C
                                       PLOTTING OUT THE BESTFIT CURVE IN
   760. C
                                       THE PLOT PROGRAM.
   770. C
   780. C
   790. C
   800. C ----- LEAST SQUARES CURVE FITTING -----
   810. C
   820.
              DIMENSION X(200),Y(200,10),F(200,10),FT(10,200)
   830.
              &,A(10,11),B(10,11),C(10)
   840.
              INTEGER DASH
   850. C
          ----- "DEFINE THE FUNCTIONS" -----
   860. C
   870. C
   880.
               F1(X)=X
   890.
               F2(X)=X*X
   900.
               F3(X)=X*X*X
   910.
               F4(X)=X*X*X*X
   920. C
   930. C READ IN THE MIX NUMBER, THE NUMBER OF C'S, THE TOTAL NUMBER
   940. C OF DATA POINTS, THE NUMBER OF DATA POINTS FOR EACH CUBE AND
   950. C THE VALUE OF DASH.
   960. C (IN FREE FORMAT)
   970. C
   980.
               READ(5,*) MIXNO,M,N,N1,N2,N3,DASH
   990. C
  1000. C WRITE OUT SOME GENERAL INFORMATION ABOUT THIS PROGRAM
  1010. C
             WRITE (6,1) MIXNO
1 FORMAT ('1',/////,4X,
  1020.
  1030.
              &'THIS IS THE BESTFIT PROGRAM FOR MIX NUMBER', 16)
  1040.
             WRITE (6,2) M
2 FORMAT (/////,4x,
  1050.
  1060.
              &'THE NUMBER OF CONSTANTS "M" READ IN FOR THIS PROGRAM IS',
  1070.
  1080.
              £15)
             WRITE (6,3) MIXNO,N
3 FORMAT (/////,4X,
  1090.
  1100.
             &'THE TOTAL NUMBER OF DATA POINTS READ IN FOR MIX NUMBER', &16,4X,'IS',17)
WRITE (6,4) N1,N2,N3
4 FORMAT (/////,4X,
  1110.
  1120.
  1130.
  1140.
              &'THE NUMBER OF DATA POINTS READ IN FOR CUBE NUMBER 1 =',
  1150.
              &1X,I3,//,42X,'CUBE NUMBER 2 =',1X,I3,//,42X,
&'CUBE NUMBER 3 =',1X,I3)
  1160.
  1170.
               IF (DASH.EQ.0) GO TO 6
  1180.
             WRITE (6,5)
5 FORMAT (/////,4x,'DURING THE COMPRESSION TEST,'
  1190.
  1200.
              &' THIS MIX DID NOT HAVE PEAK LOADS FOR ALL OF THE CUBES.')
  1210.
  1220.
               GO TO 8
             6 WRITE (6,7)
7 FORMAT (/////,4x,'DURING THE COMPRESSION TEST,',
  1230.
  1240.
              &' THIS MIX HAD PEAK LOADS FOR ALL OF THE CUBES.')
  1250.
  1260. C
```

```
BESTFIT "Computer Program No. 2"
  1270. C READ AND WRITE OUT THE X-Y VALUES OF DATA POINTS.
  1280. C (READING DONE IN FREE FORMAT)
  1290. C
             8 READ(5,*) (X(I),Y(I,1),I=1,N)
  1300.
             WRITE(6,9) MIXNO
9 FORMAT('1',/////,32x,'DATA POINTS',//,30x,
  1310.
  1320.
              &'MIX NUMBER',15)
  1330.
            WRITE(6,10)

10 FORMAT(//,4X,'DATA NUMBER',10X,'X-VALUES (STRAIN-%)',10X,
&'Y-VALUES (STRESS-PSI)',/)
WRITE(6,11) (I,X(I),Y(I,1),I=1,N)

11 FORMAT (' ',7X,I3,17X,F10.3,19X,F10.1)
  1340.
  1350.
  1360.
  1370.
  1380.
  1390. C
  1400. C ----- "GENERATE THE F MATRIX" -----
  1410. C
               DO 12 I=1,N
  1420.
               F(I,1)=F1(X(I))
  1430.
            F(I,2)=F2(X(I))
F(I,3)=F3(X(I))
12 F(I,4)=F4(X(I))
  1440.
  1450.
  1460.
  1470. C
  1480. C GENERATE THE TRANSPOSE OF THE F MATRIX
  1490. C
  1500.
                DO 13 I=1,N
  1510.
                DO 13 J=1,M
  1520.
            13 FT(J,I)=F(I,J)
  1530. C
  1540. C DETERMINE COEFFICIENT MATRIX A OF SIMULTANEOUS EQUATION
  1550. C SYSTEM
  1560. C
  1570.
                CALL MATMPY(FT,F,A,M,N,M)
  1580. C
  1590. C DETERMINE THE COLUMN OF CONSTANTS FOR SIMULTANEOUS EQUATION
  1600. C SYSTEM
  1610. C
                CALL MATMPY(FT,Y,B,M,N,1)
  1620.
  1630.
                DO 14 I=1,M
            14 A(I,M+1)=\dot{B}(I,1)
  1640.
  1650. C
  1660. C DETERMINE C VALUES BY SOLVING SIMULTANEOUS EQUATIONS USING
  1670. C CHOLESKY METHOD
  1680. C
  1690.
                MP1 = M + 1
  1700.
                CALL CHLSKY(A,M,MP1,C)
  1710. C
  1720. C WRITE OUT THE C VALUES
  1730. C
            WRITE(6,15) MIXNO
15 FORMAT('1',/////,4X,'C(01) THROUGH C(M) FOR MIX NUMBER',
  1740.
  1750.
  1760.
               &I5,//)
            1770.
  1780.
  1790.
  1800.
  1810.
                STOP
  1820.
                END
  1830. C
  1840. C
  1850. C
  1860. C *1
  1870. C *
  1880. C *
                   THE SUBROUTINE SUBPROGRAM MATMPY FOR
  1890. C *
```

```
BESTFIT "Computer Program No. 2"
  1900. C *
  1910. C *
                  THE REQUIRED MATRIX MULTIPLICATION
  1920. C *
  1930. C *
  1940. C
  1950. C
  1960. C
  1970. C
              SUBROUTINE MATMPY(A,B,C,M,N,L)
  1980.
  1990. C
  2000. C THIS SUBROUTINE DETERMINES MATRIX C AS THE PRODUCT
  2010. C OF A AND B MATRICES.
  2020. C
              DIMENSION A(10,200), B(200,10), C(10,11)
  2030.
              DO 1 I=1,M
DO 1 J=1,L
  2040.
  2050.
              C(I,J)=0.0
DO 1 K=1,N
  2060.
  2070.
            1 C(I,J)=C(I,J)+A(I,K)*B(K,J)
  2080.
  2090.
              RETURN
  2100.
              END
  2110. C
  2120. C
  2130. C
  2140. C ******
  2150. C *
  2160. C *
                     THE SUBROUTINE SUBPROGRAM UTILIZING
  2170. C *
  2180. C *
                    CHOLESKY'S METHOD FOR THE SOLUTION OF
  2190. C
  2200. C
                 THE SIMULTANEOUS LINEAR ALGEBRAIC EQUATIONS
  2210. C *
  2220. C *
  2230. C *
  2240. C *********************************
  2250. C
  2260. C
  2270. C
  2280.
              SUBROUTINE CHLSKY (A,N,M,X)
              DIMENSION A(10,11),X(10)
  2290.
  2300. C
  2310. C CALCULATE FIRST ROW OF UPPER UNIT TRIANGULAR MATRIX
  2320. C
  2330.
              DO 1 J=2,M
            1 A(1,J)=A(1,J)/A(1,1)
  2340.
  2350. C
  2360. C CALCULATE OTHER ELEMENTS OF U AND L MATRICES
  2370. C
  2380.
              DO 6 I=2,N
  2390.
              J = I
  2400.
              DO 3 II=J,N
  2410.
              SUM=0.0
  2420.
              JM1=J-1
              DO 2 K=1,JM1
  2430.
  2440.
            2 SUM=SUM+A(II,K)*A(K,J)
            3 A(II,J)=A(II,J)-SUM
  2450.
  2460.
              IP1=I+1
  2470.
              DO 5 JJ=IP1,M
              SUM=0.0
  2480.
  2490.
              IM1=I-1
              DO 4 K=1,IM1
  2500.
            4 SUM=SUM+A(I,K)*A(K,JJ)
  2510.
            5 A(I,JJ)=(A(I,JJ)-SUM)/A(I,I)
  2520.
```

```
BESTFIT "Computer Program No. 2"

2530. 6 CONTINUE
2540. C
2550. C SOLVE FOR X(I) BY BACK SUBSTITUTION
2560. C
2570. X(N)=A(N,N+1)
2580. L=N-1
2590. DO 8 NN=1,L
2600. SUM=0.0
2610. I=N-NN
2620. IP1=I+1
2630. DO 7 J=IP1,N
2640. 7 SUM=SUM+A(I,J)*X(J)
2650. 8 X(I)=A(I,M)-SUM
2660. RETURN
2670. END
```

G.3 COMPUTER PROGRAM NO. 3 [25, 27, 29 -- PP. 479-480]

Using the constants of the best-fit polynomial determined in Computer Program No. 2, this program plots out the best-fit curve along with its associated data points. To give an indication of how well a best-fit polynomial described the behaviour of the data points for a given mix, this program also calculates the value of the adjusted coefficient of multiple determination -- R_A^2 . More details of this program are included in the program itself.

```
CPLOT "Computer Program No. 3"
    10. //NOLINEC JOB ',,,T=1M,L=10,I=10,C=0','RANDY ZAPOTOTSKY',CLASS=F, 20. // MSGLEVEL=(1,1)
    30. /*ROUTE PRINT SELF
    40. /*D800 VPLOT
    50. // EXEC FORTHCLG, USERLIB= 'SYS3. VPLOTLIB', SIZE=256K
    60. //FORT.SYSIN DD *
    70. C
    80. C
    90. C
                 --- THIS IS THE PROGRAM FOR BEST FIT PLOTTING ---
   100. C
                              --- CLAY MORTAR MIXES ---
   110. C
   120. C
   130. C
   140. C
               WHEN RUNNING THIS PROGRAM, THE FILES AND ITS ORDER OF
   150. C
   160. C SUBMISSION IS AS FOLLOWS:
   170. C
                   CPLOT
   180. C
                   NOFIT
   190. C
               2.
                    "DATA FILES"
   200. C
               З.
   210. C
   220. C
               WHERE:
   230. C
   240. C
                       CPLOT - IS THE NAME OF THIS PROGRAM
   250. C
   260. C
                       NOFIT - HAS THREE RECORDS IN THE FORM AS FOLLOWS:
   270. C
                                1.//GO.SYSIN DD *
   280. C
                                2. "NUMBER OF SETS OF DATA"
3. "VALUE OF M"
   290. C
   300. C
   310. C
                                    WHERE:
   320. C
   330. C
                                         M = THE NUMBER OF CONSTANTS (C'S)
   340. C
                                              THAT WILL BE USED IN PLOTTING
   350. C
                                              EACH OF THE BEST FIT CURVES.
   360. C
   370. C
               "DATA FILES" - HAS THE FORM AS FOLLOWS:
   380. C
   390. C
   400. C
                   1. MIXNO N N1 N2 N3 DAY REMIX XSTART MAX10 YMAX DASH
                  2. X1
   410. C
                                V 1
   420. C
                  3. X2
                                ¥2
   430. C
                  4.
   440. C
                  5.
                N+1. \dot{X}(N-1)
                                Ý(N-1)
   450. C
                N+2. Ç1
   460. C
                N+_.
   470. C
   480. C
   490. C
             N+1+CN CN
   500. C
               WHERE:
   510. C
   520. C
   530. C
              MIXNO = THE MIX NUMBER
                  N = THE TOTAL NUMBER OF DATA POINTS POINTS
   540. C
                 N1 = THE NUMBER OF DATA POINTS FOR SPECIMEN NO. 1
   550. C
                                                                  NO.
   560. C
                 N2 =
                 N3 = "
                                   11
                                       11
                                              H
   570. C
              DAY = THE AGE OF THE MIX, IN DAYS
REMIX = "0" IF THE MIX WAS MIXED TOGETHER FOR THE FIRST TIME
   580. C
   590. C
                     = "1" IF THE HARDENED ORIGINAL MIX WAS CRUSHED AND REMIXED
   600. C
             XSTART = THE EXPERIMENTAL CORRECTION FACTOR TO THE X-VALUES;
   610. C
                       XSTART IS POSITIVE IF MOVING THE X-VALUES TO THE LEFT
   620. C
              MAX10 = (SEE DESCRIPTION BELOW)
    630. C
```

```
CPLOT "Computer Program No. 3"
   640. C
                YMAX = THE MAXIMUM Y-VALUE OBTAINED IN A SET OF TESTS
   650. C
                DASH = (SEE DESCRIPTION BELOW)
   660. C
               X&Y'S = THE DATA POINTS
   670. C
                 C_ = THE CONSTANTS OF THE BEST FIT EQUATION
   680. C
   690. C
   700. C TO SATISFY THE "DO" STATEMENT RULE OF ONLY USING INTEGERS 710. C GREATER THAN ZERO AND TO OBTAIN AN INCREMENT OF 0.1% STRAIN
   720. C (X-VALUES) WHEN PLOTTING THE BEST FIT CURVE, MAX10 IS
   730. C DEFINED AS FOLLOWS:
   740. C
   750. C
                        MAX10 = (MAX STRAIN(%) - XSTART + 0.1) * 10
   760. C
   770. C FROM THIS MODIFICATION TO THE MAXIMUM STRAIN VALUE, ONLY
   780. C THE INTEGER PART OF THE NUMBER IS PUT INTO THE DATA FILE.
   790. C WHEN PLOTTING IT WILL BECOME CLOSE ENOUGH TO THE MAXIMUM
   800. C STRAIN VALUE OBTAINED IN A MIX. THIS WILL SATISFY THE
   810. C INTEGER RULE OF A DO LOOP.
   820. C
                 FROM THE PROGRAM THIS MODIFICATION COMES FROM:
   830. C
   840. C
                        X(I) = ((RI/10.0) - 0.1)
   850. C
   860. C
   870. C
                 THE "-0.1" IS NEEDED SO THAT X IS EQUAL TO ZERO FOR THE
   880. C FIRST VALUE. THIS WILL MAKE THE BEST FIT CURVE PASS THROUGH
   890. C THE ORIGIN.
   900. C
   910. C
                 MAX10 MUST BE DEFINED FOR EACH INDEPENDANT MIX.
   920. C IN ADDITION, IT MUST BE PUT INTO A DATA FILE AS AN 930. C INTEGER, NOT A REAL NUMBER, TO SATISFY THE INTEGER 940. C RULES OF A DO LOOP.
   950. C
   960. C
                 A CHECK WILL BE DONE NEAR THE DEFINED FUNCTION SO AS TO
   970. C PREVENT THE BEST FIT CURVE HAVING A NEGATIVE SLOPE AND A
   980. C Y VALUE GREATER THAN THAT OBTAINED IN A SET OF TESTS.
   990. C A NEGATIVE SLOPE IS UNFAVORABLE SINCE IT DOES NOT REPRESENT
  1000. C WHAT HAPPENED IN THE ACTUAL TESTS.
  1010. C
  1020. C
                 IF THE MIX DID NOT HAVE PEAK LOADS FOR ALL OF THE CUBES,
  1030. C A STRAIGHT DASHED LINE WILL BE DRAWN HORIZONTALLY FROM THE
  1040. C END OF THE BEST FIT CURVE TO THE FAR RIGHT OF THE PLOT.
  1050. C DASHED LINE WILL REPRESENT THAT LOADING WAS CONTINUED AFTER 1060. C THIS CUT-OFF POINT, BUT NO PEAK LOAD OCCURRED. IT SHOULD BE 1070. C NOTED THOUGH THAT THE PATH OF THIS DASHED LINE DOES NOT
  1080. C NECESSARILY REPRESENT THE ACTUAL PATH TAKEN DURING THE TEST OR
  1090. C OF THE BEST FIT CURVE.
  1100. C THIS DASHED LINE WILL NOT BE DRAWN WHEN THE VALUE OF 1110. C "DASH" IS EQUAL TO "0" (ZERO). WHEN "DASH" IS EQUAL TO
  1120. C "1" (ONE), A DASHED LINE WILL BE DRAWN.
  1130. C
                AT THE END OF THE DATA FILE(S), THE PROPER JCL MUST BE
  1140. C
  1150. C DEFINED IN ORDER FOR THE PROGRAM TO RUN.
  1160. C
  1170. C
                 DUE TO THE LIMITS ON THE DIMENSION STATEMENTS THE
  1180. C FOLLOWING LIMITS ARE DEFINED:
  1190. C
  1200. C
                        1) XRAY_(_
                                     __), YRAY_(_
  1210. C
                             MAXIMUM ALLOWABLE NUMBER OF DATA POINTS PER
  1220. C
                             SPECIMEN READ IN IS 77 - 2 = 75
  1230. C
  1240. C
                            MAXIMUM ALLOWABLE NUMBER OF CONSTANTS
  1250. C
  1260. C
                            READ IN IS 10
```

```
CPLOT "Computer Program No. 3"
  1270. C
                               __), Y(_
  1280. C
                       3) X(
  1290. C
                           MAXIMUM ALLOWABLE STRAIN IN THE TESTS
  1300. C
                           IS (502 - 2)/10 = 50\%
  1310. C
  1320. C
1330. C
                      4) XNEW_(
                           AS FOR XRAY_( )
  1340. C
  1350. C
                                     __), MYDATA(
                       5) MXDATA(_
                           MAXIMUM ALLOWABLE NUMBER OF DATA POINTS
  1360. C
  1370. C
                           POINTS PER MIX PER MIXED X AND Y
  1380. C
                           DATA ARRAYS = 225
  1390. C
  1400. C
  1410. C
               IN ORDER FOR THIS PROGRAM TO RUN SATISFACTORY FOR DIFFERENT
  1420. C RUNS, ONE MUST ENSURE THAT THE FOLLOWING IS DONE:
  1430. C
               A. CHECK TO SEE THAT THE BEST FIT EQUATION AT THE FOLLOWING
  1440. C
                   TWO (2) LOCATIONS IS THE ONE THAT IS WANTED AND THAT THEY
  1450. C
  1460. C
                   ARE BOTH THE SAME:
  1470. C
  1480. C
                   1. IN THE PLOTTING SECTION AND
  1490. C
 1500. C
                       IN THE ADJUSTED COEFFICIENT OF MULTIPLE DETERMINATION
  1510. C
                        CALCULATION PART.
  1520. C
  1530. C
               B. ADJUST THE DEVELOP A LEGEND ACCORDINGLY TO THE DATA OR SKIP
  1540. C
                   OVER THIS PART OF THE PROGRAM BY A SIMPLE GO TO STATEMENT.
  1550. C
  1560. C
  1570. C
  1580.
              DIMENSION IBUF (4000),
  1590.
              &XRAY1(77), YRAY1(77), XRAY2(77), YRAY2(77), XRAY3(77), YRAY3(77),
              &C(10),X(502),Y(502),XNEW1(77),XNEW2(77),XNEW3(77)
  1600.
  1610.
               REAL MXDATA(225), MYDATA(225)
  1620.
               INTEGER DAY, DASH, P1, P2, P3, P4, P5, P6, DP
 1630. C
  1640. C
               READ AND WRITE OUT THE NUMBER OF PLOTS TO BE DRAWN AND THE
  1650. C NUMBER OF CONSTANTS (C'S) THAT ARE TO BE USED.
  1660. C
  1670.
               READ (5,*) NOFIT,M
           WRITE (6,70) NOFIT
70 FORMAT ('1',/////,4x,'THE NUMBER OF PLOT(S) THAT ', &'ARE TO BE DRAWN IS',3x,13)
  1680.
 1690.
  1700.
           WRITE (6,80) M
80 FORMAT (////,4x,
  1710.
  1720.
              & THE NUMBER OF CONSTANTS "M" READ IN FOR THIS PROGRAM IS', 15)
  1730.
  1740. C
  1750.
               DO 780 NF=1,NOFIT
  1760.
               CALL PLOTS (IBUF, 4000)
  1770. C
  1780. C
               DEFINE SOME CHARACTERISTICS OF THE PLOT.
  1790. C
  1800.
               CALL PLOT (0.0,-11.0,-3)
               CALL PLOT (0.0,2.0625,-3)
  1810.
 1820.
               CALL FACTOR (1.0)
              CALL AXIS (0.0,0.0,'STRAIN - %',-10,4.0,0.0,0.0,5.0)
CALL AXIS (0.0,0.0,'STRESS - PSI',12,7.0,90.0,0.0,160.0)
  1830.
 1840.
  1850. C
  1860. C
               DRAW A RECTANGULAR FRAME AROUND THE PLOT
  1870. C
 1880.
               CALL NEWPEN (4)
  1890.
               CALL RECT (-0.75,-1.25,9.0,5.5,0.0,3)
```

```
CPLOT "Computer Program No. 3"
                  CALL NEWPEN (1)
  1900.
  1910. C
                   READ AND WRITE OUT SOME BASIC INFORMATION ABOUT THE MIX.
  1920. C
  1930. C
  1940.
                  READ (5,*) MIXNO,N,N1,N2,N3,DAY,REMIX,XSTART,MAX10,YMAX,DASH
              WRITE (6,90) MIXNO,DAY
90 FORMAT ('1',////,4X,
  1950.
  1960.
                &'THIS IS THE PLOT PROGRAM FOR MIX NUMBER', 3X,
  1970.
                &I3,3X,'AT THE',3X,I2,3X,'DAY STRENGTH')
IF (REMIX.EQ.1) GO TO 110
  1980.
  1990.
            WRITE (6,100)
100 FORMAT (////,4x,'THE FOLLOWING DATA IS FOR THE MIX '
  2000.
  2010.
                &'WHEN ITS COMPONENTS WERE COMBINED FOR THE FIRST TIME')
  2020.
  2030.
                  GO TO 130
            110 WRITE (6,120)
  2040.
  2050.
             120 FORMAT (////,4x,'THE FOLLOWING DATA IS FOR WHEN THE ',
                & 'HARDENED ORIGINAL MIXTURE WAS CRUSHED AND REMIXED')
  2060.
            130 WRITE (6,140) XSTART
140 FORMAT (////,4X,'THE VALUE OF XSTART READ IN IS',
  2070.
  2080.
  2090.
                &2X,F6.3)
            WRITE (6,150) MIXNO, MAX10
150 FORMAT (////,4X,
  2100.
  2110.
                &'THE VALUE OF MAX10 THAT WAS READ IN FOR MIX NUMBER', 15,
  2120.
                &3X,'IS',3X,I4)
WRITE (6,160) YMAX
  2130.
  2140.
             160 FORMAT (////,4X,'THE HIGHEST STRESS THAT WAS REACHED ',
  2150.
                &'DURING THE TEST WAS',3X,F6.1,3X,'PSI')
IF (DASH.EQ.0) GO TO 180
  2160.
  2170.
            WRITE (6,170)
170 FORMAT (////,4x,'DURING THE TESTING,'
  2180.
  2190.
                   THIS MIX DID NOT HAVE PEAK LOADS FOR ALL OF THE SPECIMENS.')
  2200.
            GO TO 200
180 WRITE (6,190)
190 FORMAT (////,4x,'DURING THE TESTING,'
  2210.
  2220.
  2230.
  2240.
                &' THIS MIX HAD PEAK LOADS FOR ALL OF THE SPECIMENS.')
            200 WRITE (6,210) MIXNO,N
210 FORMAT (////,4X,
  2250.
  2260.
                & THE TOTAL NUMBER OF DATA POINTS READ IN FOR MIX NUMBER',
  2270.
                &16,4X,'IS',17)
WRITE (6,220) N1,N2,N3
  2280.
  2290.
            220 FORMAT (////,4x,
  2300.
                &'THE NUMBER OF DATA POINTS READ IN FOR SPECIMEN NUMBER 1 =',
  2310.
  2320.
                £1X,I3,//,42X,'SPECIMEN NUMBER 2 = 1,1X,I3,//,42X,
                &'SPECIMEN NUMBER 3 =',1X,13)
  2330.
  2340. C
  2350. C
                   READ AND WRITE OUT THE DATA POINTS FOR THE MIX.
  2360. C
                 READ (5,*) (XRAY1(I),YRAY1(I),I=1,N1)
READ (5,*) (XRAY2(J),YRAY2(J),J=1,N2)
READ (5,*) (XRAY3(K),YRAY3(K),K=1,N3)
  2370.
  2380.
  2390.
  2400. C
            WRITE (6,230) MIXNO,DAY

230 FORMAT ('1',/////,32x,'DATA POINTS',//,30x,
&'MIX NUMBER',15,//,29x,12,3x,'DAY STRENGTH')
IF (REMIX.EQ.0) GO TO 250
  2410.
  2420.
  2430.
  2440.
            WRITE (6,240)
240 FORMAT (/,35x,'REMIX')
  2450.
  2460.
  2470.
             250 WRITE(6,260)
            260 FORMAT(//,4X,'DATA NUMBER',10X,'X-VALUES (STRAIN-%)',10X, &'Y-VALUES (STRESS-PSI)',/)
  2480.
  2490.
            WRITE (6,270)
270 FORMAT (/,4X,'SPECIMEN NUMBER 1',/)
WRITE (6,300) (I,XRAY1(I),YRAY1(I),I=1,N1)
  2500.
  2510.
  2520.
```

```
CPLOT "Computer Program No. 3"
             WRITE (6,280)
280 FORMAT (//,4x,'SPECIMEN NUMBER 2',/)
WRITE (6,300) (J,XRAY2(J),YRAY2(J),J=1,N2)
   2530.
  2540.
  2550.
             WRITE (6,290)

290 FORMAT (//,4x,'SPECIMEN NUMBER 3',/)
WRITE (6,300) (K,XRAY3(K),YRAY3(K),K=1,N3)

300 FORMAT ('',7x,I3,17x,F10.3,19x,F10.1)
  2560.
  2570.
  2580.
  2590.
  2600. C
  2610. C
                    ADJUST THE X-VALUES WITH XSTART TO CORRECT FOR
  2620. C EXPERIMENTAL ERROR.
  2630. C
   2640.
                  DO 310 I=1,N1
                  XNEW1(I) = XRAY1(I) - XSTART
  2650.
  2660.
             310 CONTINUE
  2670.
                  DO 320 J=1,N2
                  XNEW2(J) = XRAY2(J) - XSTART
  2680.
  2690.
             320 CONTINUE
  2700.
                  DO 330 K=1,N3
                  XNEW3(K) = XRAY3(K) - XSTART
  2710.
  2720.
             330 CONTINUE
  2730. C
  2740. C
                   WRITE OUT THE NEW ADJUSTED X-VALUES AND ITS CORRESPONDING
  2750. C Y-VALUES.
  2760. C
             WRITE (6,340) MIXNO,DAY

340 FORMAT ('1',/////,27X,'ADJUSTED DATA POINTS',//,30X,
&'MIX NUMBER',15,//,29X,12,3X,'DAY STRENGTH')
  2770.
  2780.
  2790.
  2800.
                  IF (REMIX.EQ.0) GO TO 360
             WRITE (6,350)
350 FORMAT (/,35x,'REMIX')
  2810.
  2820.
             360 WRITE(6,370)
370 FORMAT(//,4x,'DATA NUMBER',10x,'x-VALUES (STRAIN-%)',10x,
  2830.
  2840.
  2850.
                 &'Y-VALUES (STRESS-PSI)',/)
             WRITE (6,380)
380 FORMAT (/,4x,'SPECIMEN NUMBER 1',/)
  2860.
  2870.
                  WRITE (6,410) (1,XNEW1(1),YRAY1(1),I=1,N1)
  2880.
             WRITE (6,390)
390 FORMAT (//,4x,'SPECIMEN NUMBER 2',/)
WRITE (6,410) (J,XNEW2(J),YRAY2(J),J=1,N2)
  2890.
  2900.
  2910.
             WRITE (6,400)

400 FORMAT (//,4x,'SPECIMEN NUMBER 3',/)
WRITE (6,410) (K,XNEW3(K),YRAY3(K),K=1,N3)

410 FORMAT ('',7x,I3,17x,F10.3,19x,F10.1)
  2920.
  2930.
  2940.
  2950.
  2960. C
  2970. C
                   PLOT OUT THE ADJUSTED DATA POINTS.
  2980. C
  2990.
                  XNEW1 (N1+1) =
                                         0.0
                  YRAY1 (N1+1)=
  3000.
                                         0.0
  3010.
                  XNEW1 (N1+2) =
                                         5.0
  3020.
                  YRAY1 (N1+2)=
                                      160.0
  3030. C
  3040.
                  XNEW2 (N2+1) =
  3050.
                  YRAY2 (N2+1)=
                                         0.0
                  XNEW2 (N2+2) =
  3060.
                                         5.0
  3070.
                  YRAY2 (N2+2)=
                                      160.0
  3080. C
  3090.
                  XNEW3 (N3+1) =
                                         0.0
                                         0.0
  3100.
                  YRAY3 (N3+1)=
  3110.
                  XNEW3 (N3+2) =
                                         5.0
  3120.
                  YRAY3 (N3+2)=
                                      160.0
  3130. C
  3140.
                  CALL LINE (XNEW1, YRAY1, N1, 1, -1, 0)
  3150.
                  CALL LINE (XNEW2, YRAY2, N2, 1, -1, 2)
```

```
CPLOT "Computer Program No. 3"
  3160.
                 CALL LINE (XNEW3, YRAY3, N3, 1, -1, 3)
  3170. C
                  READ AND WRITE OUT THE CONSTANTS (C-VALUES).
  3180. C
  3190. C
                 READ (5,*) (C(I),I=1,M)
  3200.
            WRITE (6,420) MIXNO,DAY

420 FORMAT ('1',/////,11X,'C VALUES',//,9X,'MIX NUMBER',
&1X,12,//,8X,12,1X,'DAY STRENGTH')
IF (REMIX.EQ.0) GO TO 440
  3210.
  3220.
  3230.
  3240.
            WRITE (6,430)
430 FORMAT (/,13x,'REMIX')
  3250.
  3260.
            440 WRITE (6,450)
450 FORMAT (/,4X,'C()',15X,'VALUE',/)
WRITE (6,460) (I,C(I),I=1,M)
  3270.
  3280.
  3290.
  3300.
            460 FORMAT('0',4x,12,12x,f12.7)
  3310. C
  3320. C
                  CALCULATE THE PLOTTING POINTS FOR THE BEST FIT CURVE.
  3330. C
  3340.
                 NSUM = 0
  3350.
                 DO 480 I=1,MAX10,1
  3360.
                 RI = I
  3370.
                 X(I) = ((RI/10.0) - 0.1)
  3380.
                 XTEMP = X(I) + XSTART
  3390. C
  3400. C
                 THE USER OF THIS PROGRAM SHOULD TAKE NOTE OF THE
  3410. C FOLLOWING:
  3420. C
  3430. C
                           1) THE FUNCTION DEFINED ON THE NEXT RECORD OF THE
  3440. C
                                PROGRAM. THIS IS THE FUNCTION OF THE BEST FIT
  3450. C
                                CURVE THAT WILL BE DRAWN THROUGH THE DATA
                                POINTS.
  3460. C
  3470. C
  3480. C
                                THE NUMBER OF CONSTANT'S (C'S) READ INTO THE
  3490. C
                                PROGRAM MUST BE EQUAL TO AMOUNT DEFINED IN
  3500. C
                                THIS FUNCTION.
  3510. C
  3520. C
                           3) ONE MUST MAKE SURE THAT THE CONSTANTS ARE READ
  3530. C
                                IN THE PROPER ORDER TO THE CORRESPONDING ONES
  3540. C
                                DEFINED BY THE FUNCTION.
  3550. C
  3560.
                 Y(I) = (C(1)*XTEMP) + (C(2)*(XTEMP**2))
  3570. C
  3580.
                 IF (I.EQ.1) GO TO 470
                 IF (Y(I).LT.Y(I-1)) GO TO 490
IF (Y(I).GT.YMAX) GO TO 490
  3590.
  3600.
  3610.
            470 \text{ NSUM} = \text{NSUM} + 1
  3620.
            480 CONTINUE
  3630. C
  3640. C
                  LIST THE BEST FIT CURVE PLOTTING VALUES.
  3650. C
            490 WRITE (6,500) MIXNO, DAY 500 FORMAT ('1',/////,24X,
  3660.
  3670.
                &'BEST FIT CURVE PLOTTING VALUES',//,31X,'MIX NUMBER',15,
  3680.
                £//,29X,12,3X,'DAY STRENGTH')
IF (REMIX.EQ.0) GO TO 520
  3690.
  3700.
            WRITE (6,510)
510 FORMAT (/,35x,'REMIX')
520 WRITE (6,530)
530 FORMAT (//,4x,'PLOTTING NUMBER',10x,'x-VALUES (STRAIN-%)',
  3710.
  3720.
  3730.
  3740.
            &10X,'Y-VALUES (STRESS-PSI)',/)
WRITE (6,540) (I,X(I),Y(I),I=1,NSUM)
540 FORMAT ('',9X,I3,21X,F8.3,22X,F7.1)
  3750.
  3760.
                             ',9x,13,21x,F8.3,22x,F7.1)
  3770.
  3780. C
```

```
CPLOT "Computer Program No. 3"
                                     PLOT OUT THE BEST FIT CURVE.
     3790. C
     3800. C
                                                                         0.0
     3810.
                                   X (NSUM+1) =
     3820.
                                   Y (NSUM+1) =
                                                                         0.0
     3830.
                                   X (NSUM+2) =
                                                                         5.0
                                   Y (NSUM+2) =
                                                                   160.0
     3840.
     3850. C
                                   CALL NEWPEN (8)
     3860.
                                   CALL FLINE (X,Y,-NSUM,1,0,0)
      3870.
                                   IF (DASH.EQ.0) GO TO 550
     3880.
                                   XDASH = (X(NSUM)/5.0) + 0.12
     3890.
                                   YDASH = Y(NSUM)/160.0
      3900.
                                   XEND = 4.0 - XDASH
     3910.
                                    CALL PLOT (XDASH, YDASH, -3)
      3920.
                                   CALL DASHP (XEND, 0.0, 0.12)
      3930.
                                    CALL PLOT (-XDASH,-YDASH,-3)
     3940.
     3950.
                         550 CALL NEWPEN (1)
      3960. C
                                      ----- DEVELOP A LEGEND -----
      3970. C
      3980. C
     3990. C
                                     PUT MAJOR AND MINOR INFORMATION INTO THE LEGEND.
      4000. C
                                    IF (NF.NE.1) GO TO 551
      4010.
                                   IF (NF.NE.1) GO TO 551

CALL SYMBOL (2.74,6.86,0.14,'MIX NO. 1',0.0,9)

CALL SYMBOL (2.88,6.58,0.14,'0% LIME',0.0,7)

CALL SYMBOL (2.845,6.37,0.07,'ONE UNIT CLAY',0.0,13)

CALL SYMBOL (3.055,6.23,0.07,'33.3% SAND',0.0,10)

CALL SYMBOL (3.055,6.09,0.07,'1.75% FIBRES',0.0,12)

CALL SYMBOL (3.055,5.95,0.07,' 83% M.C.',0.0,10)

CALL SYMBOL (2.845,5.74,0.07,'28-DAY STRENGTH',0.0,15)

CALL SYMBOL (3.16,5.53,0.07,'= CUBE 1',0.0,8)
      4020.
      4030.
      4040.
      4050.
      4060.
      4070.
      4080.
                                   CALL SYMBOL (3.16,5.53,0.07, = CUBE 1',0.0,8)
CALL SYMBOL (3.16,5.39,0.07, = CUBE 2',0.0,8)
CALL SYMBOL (3.16,5.25,0.07, = CUBE 3',0.0,8)
GO TO 600
      4090.
      4100.
      4110.
                         GO TO 600
551 IF (NF.NE.2) GO TO 552
      4120.
                                   IF (NF.NE.2) GO TO 552

CALL SYMBOL (2.74,6.86,0.14,'MIX NO. 2',0.0,9)

CALL SYMBOL (2.88,6.58,0.14,'3% LIME',0.0,7)

CALL SYMBOL (2.845,6.37,0.07,'ONE UNIT CLAY',0.0,13)

CALL SYMBOL (3.055,6.23,0.07,'33.3% SAND',0.0,10)

CALL SYMBOL (3.055,6.09,0.07,'1.75% FIBRES',0.0,12)

CALL SYMBOL (3.055,5.95,0.07,' 140% M.C.',0.0,10)

CALL SYMBOL (2.845,5.74,0.07,'28-DAY STRENGTH',0.0,15)

CALL SYMBOL (3.16,5.53,0.07,'= CUBE 1',0.0,8)

CALL SYMBOL (3.16,5.39,0.07,'= CUBE 2',0.0,8)

CALL SYMBOL (3.16,5.25,0.07,'= CUBE 3',0.0,8)
      4130.
      4140.
      4150.
      4160.
      4170.
      4180.
      4190.
      4200.
      4210.
      4220.
      4230.
                         CALL SYMBOL (3.16,5.25,0.07,'= CUBE 3',0.0,8)
GO TO 600

552 IF (NF.NE.3) GO TO 553
CALL SYMBOL (2.74,6.86,0.14,'MIX NO. 3',0.0,9)
CALL SYMBOL (2.74,6.58,0.14,'4.5% LIME',0.0,9)
CALL SYMBOL (2.845,6.37,0.07,'ONE UNIT CLAY',0.0,13)
CALL SYMBOL (3.055,6.23,0.07,'33.3% SAND',0.0,10)
CALL SYMBOL (3.055,6.09,0.07,'1.75% FIBRES',0.0,12)
CALL SYMBOL (3.055,5.95,0.07,' 142% M.C.',0.0,10)
CALL SYMBOL (2.845,5.74,0.07,'28-DAY STRENGTH',0.0,15)
CALL SYMBOL (3.16,5.33,0.07,'= CUBE 1',0.0,8)
CALL SYMBOL (3.16,5.39,0.07,'= CUBE 2',0.0,8)
CALL SYMBOL (3.16,5.25,0.07,'= CUBE 3',0.0,8)
GO TO 600
      4240.
      4250.
      4260.
       4270.
      4280.
       4290.
       4300.
       4310.
       4320.
       4330.
       4340.
       4350.
                                    GO TO 600
       4360.
                           553 IF (NF.NE.4) GO TO 554
       4370.
                                    CALL SYMBOL (2.74,6.86,0.14,'MIX NO. 4',0.0,9)
CALL SYMBOL (2.88,6.58,0.14,'6% LIME',0.0,7)
CALL SYMBOL (2.845,6.37,0.07,'ONE UNIT CLAY',0.0,13)
CALL SYMBOL (3.055,6.23,0.07,'33.3% SAND',0.0,10)
       4380.
       4390.
       4400.
       4410.
```

```
CPLOT "Computer Program No. 3"
                                                         CALL SYMBOL (3.055,6.09,0.07,'1.75% FIBRES',0.0,12)
CALL SYMBOL (3.055,5.95,0.07,' 144% M.C.',0.0,10)
CALL SYMBOL (2.845,5.74,0.07,'28-DAY STRENGTH',0.0,15)
CALL SYMBOL (3.16,5.53,0.07,'= CUBE 1',0.0,8)
CALL SYMBOL (3.16,5.39,0.07,'= CUBE 2',0.0,8)
CALL SYMBOL (3.16,5.25,0.07,'= CUBE 3',0.0,8)
        4420.
        4430.
         4440.
        4450.
        4460.
        4470.
        4480.
                                                          GO TO 600
        4490.
                                          554 IF (NF.NE.5) GO TO 555
                                                        IF (NF.NE.5) GO TO 555

CALL SYMBOL (4.00,6.95,0.14,'A',0.0,1)

CALL SYMBOL (2.74,6.86,0.14,'MIX NO. 5',0.0,9)

CALL SYMBOL (2.88,6.58,0.14,'8% LIME',0.0,7)

CALL SYMBOL (2.845,6.37,0.07,'ONE UNIT CLAY',0.0,13)

CALL SYMBOL (3.055,6.23,0.07,'33.3% SAND',0.0,10)

CALL SYMBOL (3.055,6.09,0.07,'1.75% FIBRES',0.0,12)

CALL SYMBOL (3.055,5.95,0.07,'1.47% M.C.',0.0,10)

CALL SYMBOL (2.845,5.74,0.07,'28-DAY STRENGTH',0.0,15)

CALL SYMBOL (3.16,5.53,0.07,'20 CUBE 1',0.0,8)

CALL SYMBOL (3.16,5.39,0.07,'20 CUBE 2',0.0,8)

CALL SYMBOL (3.16,5.25,0.07,'20 CUBE 3',0.0,8)

GO TO 600
        4500.
        4510.
        4520.
        4530.
        4540.
        4550.
        4560.
        4570.
        4580.
        4590.
        4600.
        4610.
                                                          GO TO 600
        4620.
                                         555 IF (NF.NE.6) GO TO 556
                                                        IF (NF.NE.6) GO TO 556

CALL SYMBOL (4.00,6.95,0.14,'B',0.0,1)

CALL SYMBOL (2.74,6.86,0.14,'MIX NO. 5',0.0,9)

CALL SYMBOL (2.88,6.58,0.14,'8% LIME',0.0,7)

CALL SYMBOL (2.845,6.37,0.07,'ONE UNIT CLAY',0.0,13)

CALL SYMBOL (3.055,6.23,0.07,'33.3% SAND',0.0,10)

CALL SYMBOL (3.055,6.09,0.07,'1.75% FIBRES',0.0,12)

CALL SYMBOL (3.055,5.95,0.07,'1.75% FIBRES',0.0,12)

CALL SYMBOL (3.16,5.53,0.07,'28-DAY STRENGTH',0.0,15)

CALL SYMBOL (3.16,5.53,0.07,'20BE 1',0.0,8)

CALL SYMBOL (3.16,5.39,0.07,'20BE 2',0.0,8)

CALL SYMBOL (3.16,5.25,0.07,'20BE 3',0.0,8)

GO TO 600
        4630.
        4640.
        4650.
        4660.
        4670.
        4680.
        4690.
        4700.
        4710.
        4720.
        4730.
        4740.
                                                          GO TO 600
        4750.
                                         556 IF (NF.NE.7) GO TO 557
                                                        IF (NF.NE.7) GO TO 557

CALL SYMBOL (2.74,6.86,0.14,'MIX NO. 6',0.0,9)

CALL SYMBOL (2.81,6.58,0.14,'20% SAND',0.0,8)

CALL SYMBOL (2.845,6.37,0.07,'ONE UNIT CLAY',0.0,13)

CALL SYMBOL (3.055,6.23,0.07,'1.75% FIBRES',0.0,12)

CALL SYMBOL (3.055,6.09,0.07,' 4.5% LIME',0.0,10)

CALL SYMBOL (3.055,5.95,0.07,' 130% M.C.',0.0,10)

CALL SYMBOL (2.845,5.74,0.07,'28-DAY STRENGTH',0.0,15)

CALL SYMBOL (3.16,5.53,0.07,'= CUBE 1',0.0,8)

CALL SYMBOL (3.16,5.39,0.07,'= CUBE 2',0.0,8)

CALL SYMBOL (3.16,5.25,0.07,'= CUBE 3',0.0,8)

GO TO 600
        4760.
        4770.
        4780.
        4790.
        4800.
        4810.
        4820.
        4830.
        4840.
                                      CALL SYMBOL (3.10, GO TO 600

557 IF (NF.NE.8) GO TO 558

CALL SYMBOL (2.74,6.86,0.14,'MIX NO. 7',0.0,9)

CALL SYMBOL (2.81,6.58,0.14,'45% SAND',0.0,8)

CALL SYMBOL (2.845,6.37,0.07,'ONE UNIT CLAY',0.0,13)

CALL SYMBOL (3.055,6.23,0.07,'1.75% FIBRES',0.0,12)

CALL SYMBOL (3.055,6.09,0.07,'4.5% LIME',0.0,10)

CALL SYMBOL (3.055,5.95,0.07,'141% M.C.',0.0,10)

CALL SYMBOL (3.055,5.95,0.07,'141% M.C.',0.0,10)

CALL SYMBOL (3.055,5.95,0.07,'28-DAY STRENGTH',0.0,1
        4850.
        4860.
        4870.
        4880.
        4890.
        4900.
        4910.
        4920.
                                                        CALL SYMBOL (3.055,5.95,0.07,' 141% M.C.',0.0,10)
CALL SYMBOL (2.845,5.74,0.07,'28-DAY STRENGTH',0.0,15)
CALL SYMBOL (3.16,5.53,0.07,'= CUBE 1',0.0,8)
CALL SYMBOL (3.16,5.39,0.07,'= CUBE 2',0.0,8)
CALL SYMBOL (3.16,5.25,0.07,'= CUBE 3',0.0,8)
GO TO 600
        4930.
        4940.
        4950.
        4960.
        4970.
        4980.
                                        558 IF (NF.NE.9) GO TO 559

CALL SYMBOL (2.74,6.86,0.14,'MIX NO. 8',0.0,9)

CALL SYMBOL (2.81,6.58,0.14,'60% SAND',0.0,8)

CALL SYMBOL (2.845,6.37,0.07,'ONE UNIT CLAY',0.0,13)

CALL SYMBOL (3.055,6.23,0.07,'1.75% FIBRES',0.0,12)

CALL SYMBOL (3.055,6.09,0.07,' 4.5% LIME',0.0,10)
        4990.
        5000.
        5010.
        5020.
        5030.
        5040.
```

```
CPLOT "Computer Program No. 3"
                                            CALL SYMBOL (3.055,5.95,0.07,' 136% M.C.',0.0,10)
                                           CALL SYMBOL (3.055,5.95,0.07, 136% M.C.,0.0,10)
CALL SYMBOL (2.845,5.74,0.07,'28-DAY STRENGTH',0.0,15)
CALL SYMBOL (3.16,5.53,0.07,'= CUBE 1',0.0,8)
CALL SYMBOL (3.16,5.39,0.07,'= CUBE 2',0.0,8)
CALL SYMBOL (3.16,5.25,0.07,'= CUBE 3',0.0,8)
      5060.
      5070.
      5080.
      5090.
                             CALL SYMBOL (3.16,5.25,0.07,'= CUBE 3',0.0,8)
GO TO 600

559 IF (NF.NE.10) GO TO 560
CALL SYMBOL (2.74,6.86,0.14,'MIX NO. 9',0.0,9)
CALL SYMBOL (2.60,6.58,0.14,'1.0% FIBRES',0.0,11)
CALL SYMBOL (2.92,6.37,0.07,'ONE UNIT CLAY',0.0,13)
CALL SYMBOL (3.13,6.23,0.07,'33.3% SAND',0.0,10)
CALL SYMBOL (3.20,6.09,0.07,'4.5% LIME',0.0,9)
CALL SYMBOL (3.20,5.95,0.07,'124% M.C.',0.0,9)
CALL SYMBOL (2.845,5.74,0.07,'28-DAY STRENGTH',0.0,15)
CALL SYMBOL (3.16,5.53,0.07,'= CUBE 1',0.0,8)
CALL SYMBOL (3.16,5.39,0.07,'= CUBE 2',0.0,8)
CALL SYMBOL (3.16,5.25,0.07,'= CUBE 3',0.0,8)
GO TO 600
      5100.
      5110.
      5120.
      5130.
      5140.
      5150.
      5160.
      5170.
     5180.
     5190.
     5200.
     5210.
     5220.
                                           GO TO 600
                              560 IF (NF.NE.11) GO TO 561
     5230.
                                         IF (NF.NE.11) GO TO 561

CALL SYMBOL (2.67,6.86,0.14,'MIX NO. 10',0.0,10)

CALL SYMBOL (2.60,6.58,0.14,'2.5% FIBRES',0.0,11)

CALL SYMBOL (2.92,6.37,0.07,'ONE UNIT CLAY',0.0,13)

CALL SYMBOL (3.13,6.23,0.07,'33.3% SAND',0.0,10)

CALL SYMBOL (3.20,6.09,0.07,'4.5% LIME',0.0,9)

CALL SYMBOL (3.20,5.95,0.07,'138% M.C.',0.0,9)

CALL SYMBOL (2.845,5.74,0.07,'28-DAY STRENGTH',0.0,15)

CALL SYMBOL (3.16,5.53,0.07,'= CUBE 1',0.0,8)

CALL SYMBOL (3.16,5.39,0.07,'= CUBE 2',0.0,8)

CALL SYMBOL (3.16,5.25,0.07,'= CUBE 3',0.0,8)

GO TO 600
     5240.
     5250.
     5260.
     5270.
     5280.
     5290.
     5300.
     5310.
     5320.
     5330.
     5340.
                                          GO TO 600
     5350.
                              561 IF (NF.NE.12) GO TO 562
                                         IF (NF.NE.12) GO TO 562

CALL SYMBOL (2.67,6.86,0.14,'MIX NO. 11',0.0,10)

CALL SYMBOL (2.60,6.58,0.14,'5.0% FIBRES',0.0,11)

CALL SYMBOL (2.92,6.37,0.07,'ONE UNIT CLAY',0.0,13)

CALL SYMBOL (3.13,6.23,0.07,'33.3% SAND',0.0,10)

CALL SYMBOL (3.20,6.09,0.07,'4.5% LIME',0.0,9)

CALL SYMBOL (3.20,5.95,0.07,'148% M.C.',0.0,9)

CALL SYMBOL (2.845,5.74,0.07,'28-DAY STRENGTH',0.0,15)

CALL SYMBOL (3.16,5.53,0.07,'= CUBE 1',0.0,8)

CALL SYMBOL (3.16,5.39,0.07,'= CUBE 2',0.0,8)

CALL SYMBOL (3.16,5.25,0.07,'= CUBE 3',0.0,8)

GO TO 600
     5360.
     5370.
     5380.
     5390.
     5400.
     5410.
     5420.
     5430.
     5440.
     5450.
                             GO TO 600
562 IF (NF.NE.13) GO TO 600
     5460.
     5470.
                                        IF (NF.NE.13) GO TO 600

CALL SYMBOL (2.74,6.86,0.14,'MIX NO. 1',0.0,9)

CALL SYMBOL (2.88,6.58,0.14,'0% LIME',0.0,7)

CALL SYMBOL (2.845,6.37,0.07,'ONE UNIT CLAY',0.0,13)

CALL SYMBOL (3.055,6.23,0.07,'33.3% SAND',0.0,10)

CALL SYMBOL (3.055,6.09,0.07,'1.75% FIBRES',0.0,12)

CALL SYMBOL (3.055,5.95,0.07,' 83% M.C.',0.0,10)

CALL SYMBOL (2.845,5.74,0.07,'28-DAY STRENGTH',0.0,15)

CALL SYMBOL (3.16,5.53,0.07,'= CUBE 1',0.0,8)

CALL SYMBOL (3.16,5.39,0.07,'= CUBE 2',0.0,8)

CALL SYMBOL (3.16,5.25,0.07,'= CUBE 3',0.0,8)

GO TO 600
     5480.
     5490.
     5500.
     5510.
     5520.
     5530.
     5540.
     5550.
     5560.
     5570.
     5580.
                                          GO TO 600
     5590. C
     5600. C
                                             THE FOLLOWING RECORDS WILL PLACE THE SYMBOLS USED FOR
     5610. C PLOTTING THE DATA POINTS INTO THE LEGEND. ONE SYMBOL WILL BE
     5620. C USED FOR EACH DIFFERENT CUBE.
     5630. C
     5640.
                              600 IF (REMIX.EQ.1) GO TO 610
                                          CALL SYMBOL (3.055,5.565,0.07,0,0.0,-1)
CALL SYMBOL (3.055,5.41333,0.07,2,0.0,-1)
     5650.
     5660.
                                          CALL SYMBOL (3.055,5.285,0.07,3,0.0,-1)
    5670.
```

```
CPLOT "Computer Program No. 3"
  5680.
              GO TO 620
          610 CALL SYMBOL (3.055,5.285,0.07,0,0.0,-1)
CALL SYMBOL (3.055,5.13333,0.07,2,0.0,-1)
  5690.
  5700.
  5710.
              CALL SYMBOL (3.055,5.005,0.07,3.0.0,-1)
  5720. C
  5730.
          620 CALL PLOT (12.0,0.0,999)
  5740. C
  5750. C
               ---- END OF PLOTTING -----
  5760. C
  5770. C
  5780. C
  5790. C
  5800. C
  5810. C *
                 ADJUSTED COEFFICIENT OF MULTIPLE DETERMINATION
  5820. C *
  5830. C *
  5840. C *
  5850. C **********************
  5860. C
  5870. C
  5880. C
  5890. C NOTES: 1) THIS PROGRAM FOR CALCULATING THE ADJUSTED COEFFICIENT
                       OF MULTIPLE DETERMINATION WILL TAKE INTO ACCOUNT ALL
  5900. C
  5910. C
                       THE DATA POINTS READ IN, UP TO AND INCLUDING BOTH THE
                       MAXIMUM X AND Y VALUES. IT IS REMINDED THOUGH, THAT THE BEST FIT CURVE IS PLOTTED JUST TO THE POINT BEFORE
  5920. C
  5930. C
  5940. C
                       A NEGATIVE SLOPE STARTS OR AFTER YMAX IS REACHED.
                       THEREFORE THE BEST FIT CURVE MAY OR MAY NOT OF BEEN
  5950. C
  5960. C
                       DRAWN TO THE MAXIMUM X-VALUE DATA POINT.
  5970. C
                   2) FOR THE ADJUSTED COEFFICIENT OF MULTIPLE DETERMINATION
  5980. C
  5990. C
                       TO BE CORRECTLY CALCULATED, THE BEST FIT EQUATION USED
  6000. C
                       IN THIS PART MUST MATCH WITH THE ONE USED ABOVE
                       (SEE "THE BEST FIT EQUATION").
  6010. C
  6020. C
  6030. C
  6040. C
               TRANSFER THE ARRAYS XRAY1,2,3 AND YRAY1,2,3 TO ARRAYS
  6050. C MXDATA AND MYDATA RESPECTIVELY. 6060. C
  6070. C
  6080.
              P1 = 1
              P2 = P1 + (N1-1)
  6090.
  6100.
              DO 630 DP=P1.P2
               I = DP
  6110.
  6120.
              MXDATA(DP) = XRAY1(I)
  6130.
              MYDATA(DP) = YRAY1(I)
          630 CONTINUE
  6140.
  6150.
               P3 = P2 + 1
               P4 = P3 + (N2-1)
  6160.
  6170.
               DO 640 DP=P3,P4
  6180.
               J = DP - N1
               MXDATA(DP) = XRAY2(J)
  6190.
  6200.
               MYDATA(DP) = YRAY2(J)
          640 CONTINUE
  6210.
  6220.
               P5 = P4 +
  6230.
               P6 = P5 + (N3-1)
               DO 650 DP=P5,P6
  6240.
  6250.
               K = DP - N2 - N1
               MXDATA(DP) = XRAY3(K)
  6260.
  6270.
               MYDATA(DP) = YRAY3(K)
  6280.
          650 CONTINUE
  6290. C
                CHECK TO SEE IF THE TRANSFER OF THE ARRAYS WAS
  6300. C
```

```
CPLOT "Computer Program No. 3"
  6310. C SUCCESSFULLY DONE BY WRITING OUT THE ARRAYS MXDATA AND MYDATA.
  6320. C
           WRITE (6,660) MIXNO,DAY
660 FORMAT ('1',/////,32X,'DATA POINTS',//,30X,
&'MIX NUMBER',I5,//,29X,I2,3X,'DAY STRENGTH')
  6330.
  6340.
  6350.
               IF (REMIX.EQ.0) GO TO 680
  6360.
           WRITE (6,670)
670 FORMAT (/,35x,'REMIX')
  6370.
  6380.
           680 WRITE (6,690)
690 FORMAT (//,26x,'"ARRAY TRANSFER CHECK"')
  6390.
  6400.
           WRITE (6,700)
700 FORMAT(//,4x,'DATA NUMBER',10x,'x-VALUES (STRAIN-%)',10x,
  6410.
  6420.
           &'Y-VALUES (STRESS-PSI)',/)
WRITE (6,710) (L,MXDATA(L),MYDATA(L),L=1,N)
710 FORMAT ('',7X,I3,17X,F10.3,19X,F10.1)
  6430.
  6440.
  6450.
  6460. C
  6470. C
                DETERMINE THE ERROR SUM OF SQUARES
  6480. C WITH RESPECT TO Y - (SSEY).
  6490. C
  6500. C
                ---- "THE BEST FIT EQUATION" -----
  6510. C
  6520.
               SSEY = 0.0
               DO 720 NR=1,N
  6530.
  6540.
               XR2 = MXDATA(NR)
  6550.
               YBF = (C(1)*XR2) + (C(2)*(XR2**2))
               DIFFE = MYDATA(NR) - YBF
  6560.
  6570.
               ADIFFE = ABS(DIFFE)
               SSEY = SSEY + ((ADIFFE)**2)
  6580.
  6590.
           720 CONTINUE
  6600. C
  6610. C
                DETERMINE THE TOTAL SUM OF SQUARES
  6620. C WITH RESPECT TO Y - (SSTY).
  6630. C
  6640.
               SSTY = 0.0
               SUMY = 0.0
  6650.
               DO 730 NR=1,N
  6660.
               SUMY = SUMY + MYDATA(NR)
  6670.
  6680.
           730 CONTINUE
               RN = N
AVGY = SUMY/RN
  6690.
  6700.
  6710.
               DO 740 NR=1,N
  6720.
               DIFFY = (MYDATA(NR) - AVGY)
               ADIFFY = ABS(DIFFY)
  6730.
  6740.
               SSTY = SSTY + ((ADIFFY)**2)
  6750.
           740 CONTINUE
  6760. C
  6770. C
                DEFINE THE R-SQUARED ADJUSTMENT FACTOR.
  6780. C
  6790. C
                 THE PURPOSE OF THE R-SQUARED ADJUSTMENT FACTOR IS TO
  6800. C BALANCE THE COST OF USING MORE PARAMETERS (A HIGHER DEGREE
  6810. C POLYNOMIAL) AGAINST THE GAIN IN R-SQUARED. SUCH THAT, AS
  6820. C ONE USES A HIGHER DEGREE POLYNOMINAL AS A BEST FIT CURVE,
           THE R-SQUARED WILL ALSO RISE.
  6830. C
  6840. C
  6850.
               RN = N
  6860.
               RM = M
  6870.
               ADJFAC = (RN - 1.0)/(RN - (RM + 1.0))
  6880. C
  6890. C
                CALCULATE AND WRITE OUT THE ADJUSTED COEFFICIENT OF
  6900. C MULTIPLE DETERMINATION (R-SQUARED).
  6910. C
               R2 = 1.0 - (ADJFAC * (SSEY/SSTY))
  6920.
  6930.
               IF (REMIX.EQ.0) GO TO 760
```

```
CPLOT "Computer Program No. 3"
                         WRITE (6,750) MIXNO,DAY,R2

750 FORMAT ('1',//////////,62x,'2',/,9x,
&'THE ADJUSTED COEFFICIENT OF MULTIPLE DETERMINATION (R )',
&' FOR MIX NUMBER',3X,12,',',/,4X,'REMIX AT THE',3X,12,3X,
&'DAY STRENGTH, RELATIVE TO THE BEST FIT EQUATION',//,4X,
&'WHICH WAS USED, IS:',3X,F10.7)
GO TO 780
     6940.
     6950.
     6960.
     6970.
     6980.
     6990.
                         &'WHICH WAS USED, IS: ,3x,Fiv./,
GO TO 780

760 WRITE (6,770) MIXNO,DAY,R2

770 FORMAT ('1',//////////,62x,'2',/,9x,
&'THE ADJUSTED COEFFICIENT OF MULTIPLE DETERMINATION (R )',
&' FOR MIX NUMBER',3X,I2,',',/,4x,'AT THE',3X,I2,3X,
&'DAY STRENGTH, RELATIVE TO THE BEST FIT EQUATION',//,4X,
&'WHICH WAS USED, IS:',3X,F10.7)
     7000.
    7010.
     7020.
    7030.
    7040.
    7050.
    7060.
    7070. C
    7080.
                         780 CONTINUE
    7090.
                                    CALL PLOT (0.0,0.0,9999)
    7100.
                                    STOP
    7110.
                                    END
```

G.4 COMPUTER PROGRAM NO. 4 [25, 27]

Computer Program No. 4 performs simple plotting. Three sets of data points are plotted within specified axes and then for each set, a separate smooth curve is drawn from data point to data point. More details of this program are included in the program itself.

```
CSIMPLOT "Computer Program No. 4"
    10. //NOFAILC JOB ',,,T=1M,L=5,I=10,C=0','RANDY ZAPOTOTSKY',
20. // MSGLEVEL=(1,1)
    30. /*ROUTE PRINT SELF
    40. /*D800 VPLOT
    50. // EXEC FORTHCLG, USERLIB='SYS3. VPLOTLIB', SIZE=256K
    60. //FORT.SYSIN DD *
    70. C
    80. C
    90. C
                                --- CSIMPLOT ---
   100. C
   110. C
               --- THIS IS THE PROGRAM FOR SIMPLE PLOTTING ---
   120. C
                           --- CLAY MORTAR MIXES ---
   130. C
   140. C
   150. C
   160. C
               IN THIS PROGRAM THE FIRST THING THAT IS READ IN IS THE
   170. C
   180. C NUMBER OF PLOTS TO BE DRAWN. THE CHARACTERISTICS, NAMELY
   190. C THE ORGIN AND AXES, ARE THEN DEFINED AND PLOTTED OUT.
   200. C FOR AESTHETICS PURPOSES ONLY, A FRAME IS THEN DRAWN AROUND 210. C THIS SET OF AXES.
   220. C
   230. C
               FOLLOWING THE ABOVE, THE DATA POINTS ARE THEN READ IN,
   240. C PLOTTED OUT WITHIN THE LIMITS OF THE CHARACTERISTICS OF THE
   250. C PLOT AND THEN A SMOOTH LINE JOINS EACH SET OF POINTS.
   260. C FOR EACH PLOT THREE SETS OF CURVES ARE SET OUT TO BE PLOTTED.
   270. C
               IN THE END, A LEGEND IS INSERTED IN THE INNER, UPPER
   280. C
   290. C RIGHT HAND CORNER OF THE PLOT. IF NO LEGEND IS DESIRED, THIS
   300. C PART CAN BE SKIPPED.
   310. C
   320. C
               WHEN SUBMITTING A JOB, THE ORDER OF SUBMISSION IS:
   330. C
                         CSIMPLOT
   340. C
   350. C
                    2)
                         NOPLOT
                         "FIRST DATA FILE"
   360. C
                     3)
                         "SECOND DATA FILE"
   370. C
                     4)
   380. C
                         "THIRD DATA FILE"
                     5)
                     Ĭ
   390. C
   400. C
                         "N-2TH DATA FILE (LAST ONE)"
   410. C
   420. C
   430. C
               WHERE:
                                      IS THE NAME OF THIS SIMPLE PLOTTING
   440. C
                          CSIMPLOT:
                                      PROGRAM.
   450. C
   460. C
                                      CONTAINS THE FIRST JCL STATEMENT AND
                            NOPLOT:
   470. C
                                      SPECIFIES THE NUMBER OF PLOTS TO BE
   480. C
                                      PLOTTED. THE FORM OF THIS FILE IS:
   490. C
   500. C
                                      1. //GO.SYSIN.DD *
2. "NUMBER OF PLOTS"
   510. C
   520. C
   530. C
                                      THE FIRST OR ANY OTHER DATA FILE
   540. C
                                      CONTAINS SOME BASIC INFORMATION ABOUT THE PLOT AND ITS DATA POINTS. THE
   550. C
   560. C
                                      FORM OF A DATA FILE IS:
   570. C
   580. C
                                      1. MIXNO N N1 N2 N3 DAY REMIX
   590. C
                                      2. X1
                                                  Y1
   600. C
                                      3. X2
                                                  Y2
   610. C
   620. C
   630. C
```

```
CSIMPLOT "Computer Program No. 4"
   640. C
                                      N. X(N-1) Y(N-1)
   650. C
   660. C
                                      WHERE: MIXNO = THE MIX NUMBER
   670. C
                                                  N = THE TOTAL NUMBER OF
   680. C
                                                       DATA POINTS FOR THE
   690. C
                                                       MIX.
   700. C
                                                 N1 = THE TOTAL NUMBER OF
   710. C
                                                       DATA POINTS FOR CUBE
   720. C
                                                       NUMBER 1.
   730. C
                                                 N2 = THE TOTAL NUMBER OF
   740. C
                                                       DATA POINTS FOR CUBE
   750. C
                                                       NUMBER 2.
   760. C
                                                 N3 = THE TOTAL NUMBER OF
   770. C
                                                       DATA POINTS FOR CUBE
   780. C
                                                       NUMBER 3.
   790. C
                                                DAY = THE AGE (IN DAYS) OF
   800. C
                                                       THE MIX AT THE TIME
   810. C
                                                       OF TESTING.
                                              REMIX = "0" WHEN THE MIX WAS
   820. C
   830. C
                                                           NOT REMIXED.
                                                       "1" WHEN THE MIX WAS
   840. C
   850. C
                                                           REMIXED.
   860. C
                                              X&Y'S = THE DATA POINTS.
   870. C
   880. C
   890. C
               ALSO, WHEN SUBMITTING A JOB, ONE MUST MAKE SURE THAT THE
   900. C JCL ENDING THE DATA INFORMATION MUST BE PLACED AT THE CORRECT
   910. C POSITION. IF ONLY ONE PLOT IS TO BE PLOTTED, IT GOES AT THE
  920. C END OF THE FIRST DATA FILE. IN THE CASE WHERE TWO OR MORE
   930. C PLOTS WILL BE DRAWN, THE JCL MUST BE PUT AT THE END OF THE
   940. C LAST DATA FILE.
   950. C
              DEPENDING ON THE NUMBER AND TYPE OF PLOTS TO BE DONE, THE
  960. C
   970. C "DEVELOP A LEGEND" PART OF THE PROGRAM MUST BE MODIFIED
   980. C
          ACCORDINGLY, IF USED.
   990. C
  1000. C
              LIMITATIONS OF THE DIMENSION STATEMENTS ARE AS FOLLOWS:
 1010. C
 1020. C
                        STRAN_(__),STRES_(
  1030. C
                        MAXIMUM ALLOWABLE NUMBER OF DATA POINTS PER CUBE
 1040. C
                        READ IN IS 102 - 2 = 100
  1050. C
  1060. C
 1070. C
  1080.
              DIMENSION IBUF (4000), STRAN1 (102), STRES1 (102), STRAN2 (102),
             &STRES2(102),STRAN3(102),STRES3(102)
  1090.
  1100.
              INTEGER DAY, REMIX
  1110. C
 1120. C
              READ AND WRITE OUT THE NUMBER OF PLOTS TO BE DRAWN
  1130. C
 1140.
              READ (5,*) NOPLOT
            WRITE (6,5) NOPLOT

5 FORMAT ('1',/////,4x,'THE NUMBER OF PLOTS THAT ', &'ARE TO BE DRAWN IS',3X,13)
  1150.
  1160.
 1170.
              DO 100 NP=1,NOPLOT
CALL PLOTS (IBUF,4000)
  1180.
 1190.
  1200. C
 1210. C
               DEFINE SOME CHARACTERISTICS OF THE PLOT.
 1220. C
              CALL PLOT (0.0,-11.0,-3)
CALL PLOT (0.0,2.0625,-3)
  1230.
 1240.
 1250.
              CALL FACTOR (1.0)
 1260.
              CALL AXIS (0.0,0.0,'STRAIN - \%',-10,4.0,0.0,0.0,16.0)
```

```
CSIMPLOT "Computer Program No. 4"
  1270.
                  CALL AXIS (0.0,0.0, 'STRESS - PSI', 12,7.0,90.0,0.0,160.0)
  1280. C
  1290. C
                   ----- DRAW A RECTANGULAR FRAME AROUND THE PLOT -----
  1300. C
  1310.
                 CALL NEWPEN (4)
                 CALL RECT (-0.75,-1.25,9.0,5.5,0.0,3)
  1320.
  1330.
                  CALL NEWPEN (1)
  1340. C
  1350. C
                   ----- READ AND WRITE OUT SOME BASIC INFORMATION -----
  1360. C
                 READ (5,*) MIXNO,N,N1,N2,N3,DAY,REMIX
  1370.
               WRITE (6,6) MIXNO, DAY
6 FORMAT ('1',/////,4x,'THIS IS THE SIMPLE PLOT', &'PROGRAM FOR MIX NUMBER',15,3x,'AT THE',3x,12,3x,
  1380.
  1390.
  1400.
                &'DAY STRENGTH')
  1410.
               WRITE (6,7) MIXNO,N
7 FORMAT (//////,4x,
  1420.
  1430.
                &'THE TOTAL NUMBER OF DATA POINTS READ IN FOR MIX NUMBER',
  1440.
              &16,4X,'IS',I7)
WRITE (6,8) N1,N2,N3
8 FORMAT (//////,4X,
  1450.
  1460.
  1470.
  1480.
                &'THE NUMBER OF DATA POINTS READ IN FOR CUBE NUMBER 1 =',
                &1X,13,//,42X,'CUBE NUMBER 2 =',1X,13,//,42X,
&'CUBE NUMBER 3 =',1X,13)

IF (REMIX.EQ.1) GO TO 10
  1490.
  1500.
  1510.
               WRITE (6,9)
9 FORMAT (/////,4X,'THE FOLLOWING DATA IS FOR THE MIX
  1520.
  1530.
  1540.
                &'WHEN ITS COMPONENTS WERE COMBINED FOR THE FIRST TIME')
  1550.
                 GO TO 12
             10 WRITE (6,11)
11 FORMAT (/////,4x,'THE FOLLOWING DATA IS FOR WHEN THE ',
  1560.
  1570.
 1580.
                & 'HARDENED ORIGINAL MIXTURE WAS CRUSHED AND REMIXED')
  1590. C
  1600. C
                  READ AND WRITE OUT THE DATA POINTS FOR THE MIX.
  1610. C
  1620.
              12 READ (5,*) (STRAN1(I), STRES1(I), I=1,N1)
  1630.
                 READ (5,*) (STRAN2(J), STRES2(J), J=1,N2)
             READ (5,*) (STRAN3(K),STRES3(K),K=1,N3)
WRITE (6,13) MIXNO,DAY

13 FORMAT ('1',/////,32X,'DATA POINTS',//,30X,
&'MIX NUMBER',15,//,29X,12,3X,'DAY STRENGTH')
  1640.
  1650.
  1660.
  1670.
             WRITE(6,14)
14 FORMAT(//,4x,'DATA NUMBER',10x,'x-VALUES (STRAIN-%)',10x,
  1680.
  1690.
  1700.
             WRITE (6,15)
15 FORMAT (/,4x,'CUBE NUMBER 1',/)
  1710.
  1720.
                 WRITE (6,18) (I,STRAN1(I),STRES1(I),I=1,N1)
  1730.
             WRITE (6,16)
16 FORMAT (//,4x,'CUBE NUMBER 2',/)
  1740.
  1750.
                 WRITE (6,18) (J,STRAN2(J),STRES2(J),J=1,N2)
  1760.
             WRITE (6,17)

17 FORMAT (//,4x,'CUBE NUMBER 3',/)
WRITE (6,18) (K,STRAN3(K),STRES3(K),K=1,N3)

18 FORMAT (' ',7x,13,17x,F10.3,19x,F10.1)
  1770.
  1780.
  1790.
  1800.
  1810. C
  1820. C
                 PLOT OUT THE DATA POINTS AND JOIN THE POINTS WITH A
  1830. C SMOOTH LINE.
  1840. C
  1850.
                 STRAN1 (N1+1)=
                                       0.0
  1860.
                 STRES1 (N1+1)=
                                      0.0
  1870.
                 STRAN1 (N1+2)=
                                     16.0
  1880.
                 STRES1 (N1+2) = 160.0
  1890. C
```

```
CSIMPLOT "Computer Program No. 4"
      1900.
                                          STRAN2 (N2+1) =
      1910.
                                         STRES2 (N2+1)=
                                                                                            0.0
      1920.
                                         STRAN2 (N2+2) = 16.0
                                         STRES2 (N2+2) = 160.0
      1930.
     1940. C
      1950.
                                         STRAN3 (N3+1)=
                                         STRES3 (N3+1)=
     1960.
                                                                                            0.0
      1970.
                                         STRAN3 (N3+2) = 16.0
     1980.
                                         STRES3 (N3+2) = 160.0
      1990. C
                                         CALL FLINE (STRAN1, STRES1, -N1, 1, 1, 0)
      2000.
                                         CALL FLINE (STRAN2, STRES2, -N2,1,1,2)
CALL FLINE (STRAN3, STRES3, -N3,1,1,3)
      2010.
     2020.
     2030. C
     2040. C
     2050. C
                                            ----- DEVELOP A LEGEND -----
     2060. C
     2070. C
                                           PUT MAJOR AND MINOR INFORMATION INTO THE LEGEND.
     2080. C
                                       IF (NP.NE.1) GO TO 21

CALL SYMBOL (2.74,6.86,0.14,'MIX NO. 7',0.0,9)

CALL SYMBOL (2.81,6.58,0.14,'45% SAND',0.0,8)

CALL SYMBOL (2.845,6.37,0.07,'ONE UNIT CLAY',0.0,13)

CALL SYMBOL (3.055,6.23,0.07,'1.75% FIBRES',0.0,12)

CALL SYMBOL (3.055,6.09,0.07,'4.5% LIME',0.0,10)

CALL SYMBOL (3.055,5.95,0.07,'4.5% LIME',0.0,10)

CALL SYMBOL (2.845,5.74,0.07,'28-DAY STRENGTH',0.0,15)

CALL SYMBOL (3.16,5.53,0.07,'= CUBE 1',0.0,8)

CALL SYMBOL (3.16,5.39,0.07,'= CUBE 2',0.0,8)

CALL SYMBOL (3.16,5.25,0.07,'= CUBE 3',0.0,8)

GO TO 97
     2090.
     2100.
     2110.
     2120.
     2130.
     2140.
     2150.
     2160.
     2170.
     2180.
     2190.
                              CALL SYMBOL (3.16,5.25,0.07,'= CUBE 3',0.0,8)
GO TO 97

21 IF (NP.NE.2) GO TO 22
CALL SYMBOL (2.74,6.86,0.14,'MIX NO. 8',0.0,9)
CALL SYMBOL (2.81,6.58,0.14,'60% SAND',0.0,8)
CALL SYMBOL (2.845,6.37,0.07,'ONE UNIT CLAY',0.0,13)
CALL SYMBOL (3.055,6.23,0.07,'1.75% FIBRES',0.0,12)
CALL SYMBOL (3.055,6.09,0.07,'4.5% LIME',0.0,10)
CALL SYMBOL (3.055,5.95,0.07,'136% M.C.',0.0,10)
CALL SYMBOL (2.845,5.74,0.07,'28-DAY STRENGTH',0.0,15)
CALL SYMBOL (3.16,5.35,0.07,'= CUBE 1',0.0,8)
CALL SYMBOL (3.16,5.39,0.07,'= CUBE 2',0.0,8)
CALL SYMBOL (3.16,5.25,0.07,'= CUBE 3',0.0,8)
GO TO 97
     2200.
     2210.
     2220.
     2230.
     2240.
     2250.
     2260.
     2270.
     2280.
     2290.
     2300.
     2310.
     2320.
                                         GO TO 97
    2330.
                               22 IF (NP.NE.3) GO TO 23
                                       IF (NP.NE.3) GO TO 23

CALL SYMBOL (2.67,6.86,0.14,'MIX NO. 10',0.0,10)

CALL SYMBOL (2.60,6.58,0.14,'2.5% FIBRES',0.0,11)

CALL SYMBOL (2.92,6.37,0.07,'ONE UNIT CLAY',0.0,13)

CALL SYMBOL (3.13,6.23,0.07,'33.3% SAND',0.0,10)

CALL SYMBOL (3.20,6.09,0.07,'4.5% LIME',0.0,9)

CALL SYMBOL (3.20,5.95,0.07,'138% M.C.',0.0,9)

CALL SYMBOL (2.845,5.74,0.07,'28-DAY STRENGTH',0.0,15)

CALL SYMBOL (3.16,5.53,0.07,'= CUBE 1',0.0,8)

CALL SYMBOL (3.16,5.39,0.07,'= CUBE 2',0.0,8)

CALL SYMBOL (3.16,5.25,0.07,'= CUBE 3',0.0,8)

GO TO 97
     2340.
     2350.
     2360.
     2370.
     2380.
     2390.
     2400.
     2410.
     2420.
     2430.
     2440.
                                         GO TO 97
                               23 IF (NP.NE.4) GO TO 24
     2450.
                                       TF (NP.NE.4) GO TO 24

CALL SYMBOL (2.67,6.86,0.14,'MIX NO. 11',0.0,10)

CALL SYMBOL (2.60,6.58,0.14,'5.0% FIBRES',0.0,11)

CALL SYMBOL (2.92,6.37,0.07,'ONE UNIT CLAY',0.0,13)

CALL SYMBOL (3.13,6.23,0.07,'33.3% SAND',0.0,10)

CALL SYMBOL (3.20,6.09,0.07,'4.5% LIME',0.0,9)

CALL SYMBOL (3.20,5.95,0.07,'148% M.C.',0.0,9)

CALL SYMBOL (2.845,5.74,0.07,'28-DAY STRENGTH',0.0,15)
    2460.
    2470.
    2480.
    2490.
    2500.
    2510.
    2520.
```

```
CSIMPLOT
                   "Computer Program No. 4"
                           CALL SYMBOL (3.16,5.53,0.07,'= CUBE 1',0.0,8)
CALL SYMBOL (3.16,5.39,0.07,'= CUBE 2',0.0,8)
CALL SYMBOL (3.16,5.25,0.07,'= CUBE 3',0.0,8)
   2530.
   2540.
   2550.
                           GO TO 97
   2560.
                     24 IF (NP.NE.5) GO TO 97
   2570.
                          IF (NP.NE.5) GO TO 97

CALL SYMBOL (2.74,6.86,0.14,'MIX NO. 7',0.0,9)

CALL SYMBOL (2.81,6.58,0.14,'45% SAND',0.0,8)

CALL SYMBOL (2.845,6.37,0.07,'ONE UNIT CLAY',0.0,13)

CALL SYMBOL (3.055,6.23,0.07,'1.75% FIBRES',0.0,12)

CALL SYMBOL (3.055,6.09,0.07,' 4.5% LIME',0.0,10)

CALL SYMBOL (3.055,5.95,0.07,' 141% M.C.',0.0,10)

CALL SYMBOL (2.845,5.74,0.07,'28-DAY STRENGTH',0.0,15)

CALL SYMBOL (3.16,5.53,0.07,'= CUBE 1',0.0,8)

CALL SYMBOL (3.16,5.39,0.07,'= CUBE 2',0.0,8)

CALL SYMBOL (3.16,5.25,0.07,'= CUBE 3',0.0,8)
   2580.
   2590.
   2600.
   2610.
   2620.
   2630.
   2640.
   2650.
   2660.
   2670.
   2680. C
2690.
                             THE FOLLOWING RECORDS WILL PLACE THE SYMBOLS USED FOR
   2700. C PLOTTING THE DATA POINTS INTO THE LEGEND. ONE SYMBOL WILL BE
   2710. C USED FOR EACH DIFFERENT CUBE.
   2720. C
   2730.
                     97 IF (REMIX.EQ.1) GO TO 98
                          CALL SYMBOL (3.055,5.565,0.07,0,0.0,-1)
CALL SYMBOL (3.055,5.41333,0.07,2,0.0,-1)
CALL SYMBOL (3.055,5.285,0.07,3,0.0,-1)
   2740.
   2750.
   2760.
   2770.
                           GO TO 99
                     98 CALL SYMBOL (3.055,5.285,0.07,0,0.0,-1)
CALL SYMBOL (3.055,5.13333,0.07,2,0.0,-1)
   2780.
   2790.
   2800.
                           CALL SYMBOL (3.055,5.005,0.07,3,0.0,-1)
   2810. C
   2820.
                     99 CALL PLOT (12.0,0.0,999)
   2830.
                   100 CONTINUE
   2840.
                           CALL PLOT (0.0,0.0,9999)
   2850.
                           STOP
   2860.
                           END
```

G.5 COMPUTER PROGRAM NO. 5 [25, 27]

Using the best-fit curves plotted out in Computer Program 3, Computer Program No. 5 can take various combinations of these curves and plot them together on one plot. As set up, the maximum number of curves that this program can put together on one plot is six. If more than one combination plot is to be plotted upon the submission of this program, the number of curves for each plot must be the same along with the nature of the defined best-fit equation for each of the curves. More details of this program are included in the program itself.

```
CLAYCOMB "Computer Program No. 5"
    10. //LIMECLAY JOB ',,,T=1M,L=5,I=10,C=0','RANDY ZAPOTOTSKY',CLASS=F, 20. //MSGLEVEL=(1,1)
    30. /*ROUTE PRINT SELF
    40. /*D800 VPLOT
    50. // EXEC FORTHCLG, USERLIB='SYS3. VPLOTLIB'.SIZE=256K
    60. //FORT.SYSIN DD *
    70. C
    80. C
    90. C
   100. C
                   --- THIS IS THE COMBINATION PLOTTING PROGRAM ---
   110. C
                                --- CLAY MORTAR MIXES ---
   120. C
   130. C
   140. C
   150. C
              WHAT THIS PROGRAM BASICALLY DOES IS THAT IT DRAWS FROM ONE
   160. C UP TO SIX CURVES ON ONE SET OF AXES. ONE SUCH PLOT IS CALLED A
   170. C COMBINATION PLOT. THE NUMBER OF COMBINATION PLOT(S) TO BE DRAWN
   180. C IS DEPENDANT UPON THE VALUE OF NOCOMB, OF WHICH IS READ IN.
   190. C
   200. C
              THE ORDER OF FILE SUBMISSION IS:
   210. C
                                                  NOCOMB
   220. C
                                                  COMBDATA - "COMBINATION DATA"
   230. C
   240. C
              WHERE: CLAYCOMB = THE NAME OF THIS PROGRAM
   250. C
   260. C
                        NOCOMB - HAS THE FORM AS FOLLOWS:
   270. C
                                  1.//GO.SYSIN DD *
   280. C
                                     "NUMBER OF COMBINATION PLOT(S) THAT ARE
   290. C
                                      TO BE DRAWN - NOCOMB"
   300. C
                                  3. "NUMBER OF CURVES TO BE DRAWN ON EACH
   310. C
                                      COMBINATION PLOT - NOCURV"
   320. C
   330. C
                      COMBDATA - HAS THE FORM AS FOLLOWS:
   340. C
   350. C
                         1. MIXNO,M,DAY,REMIX,XSTART,MAX10,XLAST,YMAX,DASH
  360. C
                        2. C1
   370. C
                        3. C2
   380. C
                         4.
  390. C
                      M+1. CM
  400. C
  410. C
              WHERE:
  420. C
  430. C
            MIXNO = THE MIX NUMBER
  440. C
               M = THE NUMBER OF CONSTANT(S) USED FOR THE BEST FIT EQUATION
            DAY = THE AGE OF THE MIX, IN DAYS
REMIX = "0" IF THE MIX WAS MIXED TOGETHER FOR THE FIRST TIME
  450. C
  460. C
  470. C
                  = "1" IF THE HARDENED ORIGINAL MIX WAS CRUSHED AND REMIXED
           XSTART = THE EXPERIMENTAL CORRECTION FACTOR TO THE X-VALUES:
  480. C
                    XSTART IS POSITIVE IF MOVING THE X-VALUES TO THE LEFT
  490. C
  500. C
            MAX10 = (SEE DESCRIPTION BELOW)
            XLAST = THE MAXIMUM X-VALUE OBTAINED DURING THE BEST FIT PLOTTING
  510. C
  520. C
             YMAX =
                                Y-VALUE
             DASH = (SEE DESCRIPTION BELOW)
  530. C
  540. C
               C_ = THE CONSTANT(S) OF THE BEST FIT EQUATION
  550. C
  560. C
              IT SHOULD BE NOTED HERE THAT LINES 1 TO M+1 ARE TO BE REPEATED
  570. C THE SAME NUMBER OF TIMES (UP TO A MAXIMUM OF SIX) AS THE NUMBER OF
  580. C CURVES THAT ARE TO BE PLOTTED ON EACH COMBINATION PLOT.
  590. C
  600. C
              ALSO, THE NUMBER AND THE CORRESPONDING CONSTANT(S) MUST MATCH
  610. C THOSE DEFINED FOR EACH CURVE DRAWN ON ANY COMBINATION PLOT.
  620. C IF MORE THAN ONE COMBINATION PLOT IS TO BE DRAWN, THEY MUST ALL BE
  630. C SIMILAR IN NATURE DUE TO THE DEFINED BEST FIT EQUATION(S) FOR
```

```
CLAYCOMB "Computer Program No. 5"
   640. C EACH OF THE CURVE(S).
   650. C
                TO SATISFY THE "DO" STATEMENT RULE OF ONLY USING INTEGERS
   660. C
   670. C GREATER THAN ZERO AND TO OBTAIN AN INCREMENT OF 0.1% STRAIN
   680. C (X-VALUES) WHEN PLOTTING THE BEST FIT CURVE, MAX10 IS
   690. C DEFINED AS FOLLOWS:
   700. C
   710. C
                       MAX10 = (MAX STRAIN(%) - XSTART + 0.1) * 10
   720. C
   730. C FROM THIS MODIFICATION TO THE MAXIMUM STRAIN VALUE, ONLY
   740. C THE INTEGER PART OF THE NUMBER IS PUT INTO THE DATA FILE,
   750. C IN ORDER TO SATISY THE INTEGER RULE OF A DO LOOP.
   760. C WHEN PLOTTING IT WILL BECOME CLOSE ENOUGH TO THE MAXIMUM
   770. C STRAIN VALUE OBTAINED IN A MIX. THE LAST DATA POINT PLOTTED
   780.\ C DURING THE BEST FIT PLOTTING WILL BE OBTAINED WITH THE USE 790.\ C OF XLAST.
   800. C
   810. C
                FROM THE PROGRAM THIS MODIFICATION COMES FROM:
   820. C
   830. C
                       X(I) = ((R/10.0) - 0.1)
   840. C
   850. C
               THE "-0.1" IS NEEDED SO THAT X IS EQUAL TO ZERO FOR THE
   860. C FIRST VALUE. THIS WILL MAKE THE BEST FIT CURVE PASS THROUGH
   870. C THE ORIGIN.
   880. C
   890. C
                MAX10 MUST BE DEFINED FOR EACH INDEPENDANT MIX.
   900. C AGAIN, IT MUST BE PUT INTO A DATA FILE AS AN
   910. C INTEGER, NOT A REAL NUMBER, TO SATISFY THE INTEGER 920. C RULE OF A DO LOOP.
   930. C
   940. C
                A CHECK WILL BE DONE NEAR THE DEFINED FUNCTION SO AS TO
   950. C PREVENT THE BEST FIT CURVE HAVING A NEGATIVE SLOPE AND A
   960. C Y VALUE GREATER THAN THAT OBTAINED DURING THE BEST FIT PLOTTING.
   970. C THIS IS DONE WITH THE USE OF YMAX AS DEFINED ABOVE.
   980. C A NEGATIVE SLOPE IS UNFAVORABLE SINCE IT DOES NOT REPRESENT
   990. C WHAT HAPPENED IN THE ACTUAL TESTS.
  1000. C
  1010. C
                IF THE MIX DID NOT HAVE PEAK LOADS FOR ALL OF THE CUBES,
  1020. C A STRAIGHT DASHED LINE WILL BE DRAWN HORIZONTALLY FROM THE
  1030. C END OF THE BEST FIT CURVE TO THE FAR RIGHT OF THE PLOT. THIS
  1040. C DASHED LINE WILL REPRESENT THAT LOADING WAS CONTINUED AFTER 1050. C THIS CUT-OFF POINT, BUT NO PEAK LOAD OCCURRED. IT SHOULD BE
  1060. C NOTED THOUGH THAT THE PATH OF THIS DASHED LINE DOES NOT
 1070. C NECESSARILY REPRESENT THE ACTUAL PATH TAKEN DURING THE TEST OR 1080. C OF THE BEST FIT CURVE.
  1090. C
                THIS DASHED LINE WILL NOT BE DRAWN WHEN THE VALUE OF
  1100. C "DASH" IS EQUAL TO "0" (ZERO). WHEN "DASH" IS EQUAL TO
  1110. C "1" (ONE), A DASHED LINE WILL BE DRAWN.
  1120. C
  1130. C
  1130. C A LEGEND MAY BE INSERTED AT THE END OF EACH COMBINATION 1140. C PLOT(S) BY INSERTING THE PROPER "CALL SYMBOL" STATEMENTS AT THE
  1150. C END OF THE OUTER DO LOOP.
  1160. C
 1170. C AT THE END OF THE DATA FILE(S), THE PROPER JCL MUST BE 1180. C DEFINED IN ORDER FOR THE PROGRAM TO RUN.
  1190. C
  1200. C
                DUE TO THE LIMITS ON THE DIMENSION STATEMENTS THE
  1210. C FOLLOWING LIMITS ARE DEFINED:
  1220. C
  1230. C
  1240. C
                           MAXIMUM ALLOWABLE NUMBER OF CONSTANT(S)
  1250. C
                           PER PLOTTED CURVE IS 10
```

1260. C

```
CLAYCOMB "Computer Program No. 5"
  1270. C
                           2) X_(__),Y_(
                                MAXIMUM ALLOWABLE NUMBER OF PLOTTING DATA POINTS
  1280. C
  1290. C
                                PER CURVE IS 502 - 2 = 500
  1300. C
  1310. C
  1320. C
  1330.
                  DIMENSION IBUF (4000)
  1340.
                \&C(10), X1(502), Y1(502), X2(502), Y2(502), X3(502), Y3(502),
  1350.
                 &X4(502),Y4(502),X5(502),Y5(502),X6(502),Y6(502)
  1360.
                  INTEGER DAY, REMIX
  1370. C
  1380. C
                   READ AND WRITE OUT THE NUMBER OF COMBINATION PLOT(S) AND THE
  1390. C
1400. C
                   NUMBER OF CURVE(S) PER PLOT THAT ARE TO BE DRAWN
  1410.
                  READ (5,*) NOCOMB, NOCURV
              WRITE (6,50) NOCOMB
50 FORMAT ('1',///,4X,'THE NUMBER OF COMBINATION PLOT(S) ',
  1420.
  1430.
                &'THAT ARE TO BE DRAWN IS',3X,13)
  1440.
              WRITE (6,60) NOCURV

60 FORMAT (///,4X,'THE NUMBER OF CURVE(S) TO BE DRAWN ON ', &'EACH PLOT IS',3X,13)
  1450.
  1460.
  1470.
  1480. C
                 DO 610 NC=1,NOCOMB
CALL PLOTS (IBUF,4000)
  1490.
  1500.
  1510. C
  1520. C
                   DEFINE SOME CHARACTERISTICS OF THE PLOT
  1530. C
  1540.
                  CALL PLOT (0.0,-11.0,-3)
                  CALL PLOT (0.0,2.0625,-3)
  1550.
  1560.
                  CALL FACTOR (1.0)
                 CALL AXIS (0.0,0.0, STRAIN - %',-10,4.0,0.0,0.0,5.0)
CALL AXIS (0.0,0.0, STRESS - PSI',12,7.0,90.0,0.0,160.0)
  1570.
  1580.
  1590. C
                 DRAW A RECTANGULAR FRAME AROUND THE PLOT
  1600. C
  1610. C
  1620.
                 CALL NEWPEN (4)
                 CALL RECT (-0.75,-1.25,9.0,5.5,0.0,3)
  1630.
  1640.
                 CALL NEWPEN (1)
  1650. C
  1660.
                 DO 590 NCURV=1,NOCURV
  1670. C
                 READ AND WRITE OUT SOME BASIC INFORMATION ABOUT THE MIX
  1680. C
  1690. C
  1700.
                 READ (5,*) MIXNO, M, DAY, REMIX, XSTART, MAX10, XLAST, YMAX, DASH
  1710. C
             WRITE (6,70) MIXNO,DAY

70 FORMAT ('1',////,4X,
&'THIS IS THE CLAYCOMB PROGRAM INFORMATION FOR MIX NUMBER',3X,
&I3,3X,'AT THE',3X,12,3X,'DAY STRENGTH')
WRITE (6,80) MIXNO,M

80 FORMAT (////,4X,'THE NUMBER OF CONSTANT(S)-M READ IN FOR ',
&'MIX NUMBER',3X,I3,3X,'IS',3X,I3,3X)
IF (REMIX.EQ.1) GO TO 100
WRITE (6,90)
  1720.
  1730.
  1740.
  1750.
  1760.
  1770.
  1780.
  1790.
  1800.
             WRITE (6,90)
90 FORMAT (////,4X,'THE FOLLOWING DATA IS FOR THE MIX '
  1810.
 1820.
                &'WHEN ITS COMPONENTS WERE COMBINED FOR THE FIRST TIME')
  1830.
                 GO TO 120
            100 WRITE (6,110)
110 FORMAT (////,4x,'THE FOLLOWING DATA IS FOR WHEN THE ',
  1840.
  1850.
                &'HARDENED ORIGINAL MIXTURE WAS CRUSHED AND REMIXED')
  1860.
  1870.
            120 WRITE (6,130) XSTART
130 FORMAT (////,4X,'THE VALUE OF XSTART READ IN IS',
  1880.
  1890.
                &2X,F6.3)
```

```
"Computer Program No. 5"
CLAYCOMB
            WRITE (6,140) MIXNO,MAX10
140 FORMAT (////,4X,
  1900.
  1910.
               &'THE VALUE OF MAX10 THAT WAS READ IN FOR MIX NUMBER', 15,
  1920.
               &3X,'IS',3X,I4)
  1930.
            WRITE (6,150) XLAST
150 FORMAT (/////,4X,'THE HIGHEST STRAIN THAT WAS REACHED ',
  1940.
  1950.
                &'DURING THE BEST FIT PLOTTING IS',3X,F7.3,3X,'%')
  1960.
            WRITE (6,160) YMAX
160 FORMAT (////,4X,'THE HIGHEST STRESS THAT WAS REACHED ',
  1970.
  1980.
               &'DURING THE BEST FIT PLOTTING IS', 3X, F6.1, 3X, 'PSI')
  1990.
  2000.
                IF (DASH.EQ.0) GO TO 180
            WRITE (6,170)
170 FORMAT (////,4x,'DURING THE TESTING,'
  2010.
  2020.
               &' THIS MIX DID NOT HAVE PEAK LOADS FOR ALL OF THE SPECIMENS.')
  2030.
  2040.
                GO TO 200
            180 WRITE (6,190)
190 FORMAT (////,4X, DURING THE TESTING,
  2050.
  2060.
  2070.
               &' THIS MIX HAD PEAK LOADS FOR ALL OF THE SPECIMENS.')
  2080. C
  2090. C
                  READ AND WRITE OUT THE CONSTANTS (C-VALUES)
  2100. C
            200 READ (5,*) (C(I),I=1,M)
  2110.
  2120. C
           WRITE (6,210) MIXNO,DAY
210 FORMAT ('1',/////,11X,'C VALUES',//,9X,'MIX NUMBER',
&1X,I2,//,8X,I2,1X,'DAY STRENGTH')
  2130.
  2140.
  2150.
                IF (REMIX.EQ.0) GO TO 230
  2160.
           WRITE (6,220)
220 FORMAT (/,13X,'REMIX')
  2170.
  2180.
           230 WRITE (6,240)
240 FORMAT (//,4x,'C( )',15x,'VALUE',/)
WRITE (6,250) (I,C(I),I=1,M)
250 FORMAT('0',4x,I2,12x,F12.7)
  2190.
  2200.
  2210.
  2220.
  2230. C
  2240. C
                CALCULATE THE BEST FIT CURVE PLOTTING POINTS - CURVE NO. 1
  2250. C
  2260.
                IF (NCURV.NE.1) GO TO 340
  2270.
                NSUM1 = 0
  2280.
                DO 260 I=1,MAX10
  2290.
                RI = I
                X1(I) = ((RI/10.0) - 0.1)
  2300.
  2310.
                IF (X1(I).GE.XLAST) GO TO 270
                XTEMP = X1(I) + XSTART

Y1(I) = (C(1)) + (C(2)*XTEMP) + (C(3)*(XTEMP**2)) +
  2320.
  2330.
               &(C(4)*(XTEMP**3))
  2340.
  2350.
                IF (Y1(I).GT.YMAX) GO TO 270
  2360.
                NSUM1 = NSUM1 + 1
  2370.
           260 CONTINUE
  2380.
            270 \times 1(NSUM1 + 1) = XLAST
  2390.
                XLTEMP = XLAST + XSTART
                Y1(NSUM1 + 1) = (C(1)) + (C(2)*XLTEMP) + (C(3)*(XLTEMP**2)) +
  2400.
  2410.
               &(C(4)*(XLTEMP**3))
  2420.
                NSUM1 = NSUM1 + 1
  2430. C
  2440. C
                 LIST THE BEST FIT CURVE PLOTTING VALUES - CURVE NO. 1
  2450. C
           WRITE (6,280) MIXNO,DAY 280 FORMAT ('1',/////,24X,
  2460.
  2470.
               &'BEST FIT CURVE PLOTTING VALUES', //, 31X, 'MIX NUMBER', 15,
  2480.
               &//,29x,12,3x,'DAY STRENGTH')
IF (REMIX.EQ.0) GO TO 300
  2490.
  2500.
           WRITE (6,290)
290 FORMAT (/,35x,'REMIX')
  2510.
  2520.
```

```
CLAYCOMB "Computer Program No. 5"
           300 WRITE (6,310)
310 FORMAT (//,4X,'PLOTTING NUMBER',10X,'X-VALUES (STRAIN-%)',
&10X,'Y-VALUES (STRESS-PSI)',/)
WRITE (6,320) (I,X1(I),Y1(I),I=1,NSUM1)
320 FORMAT ('',9X,I3,21X,F8.3,22X,F7.1)
  2530.
  2540.
  2550.
  2560.
  2570.
  2580. C
  2590. C
                PLOT OUT THE BEST FIT CURVE - CURVE NO. 1
  2600. C
                                  0.0
  2610.
                X1(NSUM1+1)=
  2620.
                Y1(NSUM1+1)=
                                  0.0
                X1(NSUM1+2) =
  2630.
                                  5.0
                Y1(NSUM1+2) = 160.0
  2640.
  2650. C
  2660.
                CALL NEWPEN(8)
  2670.
                CALL FLINE (X1,Y1,-NSUM1,1,0,0) IF (DASH.EQ.0) GO TO 330
  2680.
  2690.
                XDASH = (X1(NSUM1)/5.0) + 0.12
  2700.
                YDASH = Y1(NSUM1)/160.0
  2710.
                XEND = 4.0 - XDASH
                CALL PLOT (XDASH, YDASH, -3)
  2720.
  2730.
                CALL DASHP (XEND, 0.0, 0.12)
           CALL PLOT (-XDASH,-YDASH,-3)
330 CALL PLOT (0.0,0.0,3)
  2740.
  2750.
                CALL NEWPEN(1)
  2760.
  2770.
                GO TO 590
  2780. C
  2790. C
                CALCULATE THE BEST FIT CURVE PLOTTING POINTS - CURVE NO. 2
  2800. C
           340 IF (NCURV.NE.2) GO TO 390
  2810.
  2820.
                NSUM2 = 0
                DO 350 J=1,MAX10
  2830.
  2840.
                RJ=J
                X2(J) = ((RJ/10.0) - 0.1)
  2850.
                IF (X2(J).GE.XLAST) GO TO 360
  2860.
  2870.
                XTEMP = X2(J) + XSTART
                Y2(J) = (C(1)) + (C(2)*XTEMP) + (C(3)*(XTEMP**2)) +
  2880.
  2890.
               &(C(4)*(XTEMP**3))
  2900.
                IF (Y2(J).GT.YMAX) GO TO 360
  2910.
                NSUM2 = NSUM2 + 1
  2920.
           350 CONTINUE
  2930.
           360 \times 2(NSUM2 + 1) = XLAST
                XLTEMP = XLAST + XSTART
Y2(NSUM2 + 1) = (C(1)) + (C(2)*XLTEMP) + (C(3)*(XLTEMP**2)) +
  2940.
  2950.
  2960.
               &(C(4)*(XLTEMP**3))
                NSUM2 = NSUM2 + 1
  2970.
  2980. C
  2990. C
                LIST THE BEST FIT CURVE PLOTTING VALUES - CURVE NO. 2
  3000. C
  3010.
                WRITE (6,280) MIXNO, DAY
  3020.
                IF (REMIX.EQ.0) GO TO 370
                WRITE (6,290)
  3030.
            370 WRITE (6,310)
  3040.
  3050.
                WRITE (6,320) (J,X2(J),Y2(J),J=1,NSUM2)
  3060. C
  3070. C
                PLOT OUT THE BEST FIT CURVE - CURVE NO. 2
  3080. C
  3090.
                X2(NSUM2+1)=
  3100.
                Y2(NSUM2+1) =
                                  0.0
  3110.
                X2(NSUM2+2) =
                                  5.0
  3120.
                Y2(NSUM2+2) = 160.0
  3130. C
  3140.
                CALL NEWPEN(8)
  3150.
                CALL FLINE (X2,Y2,-NSUM2,1,0,0)
```

```
CLAYCOMB "Computer Program No. 5"
                IF (DASH.EQ.0) GO TO 380
  3160.
  3170.
               XDASH = (X2(NSUM2)/5.0) + 0.12
               YDASH = Y2(NSUM2)/160.0
  3180.
  3190.
               XEND = 4.0 - XDASH
               CALL PLOT (XDASH, YDASH, -3)
CALL DASHP (XEND, 0.0, 0.12)
  3200.
  3210.
               CALL PLOT (-XDASH, -YDASH, -3)
  3220.
           380 CALL PLOT (0.0,0.0,3)
  3230.
  3240.
               CALL NEWPEN(1)
               GO TO 590
  3250.
  3260. C
  3270. C
               CALCULATE THE BEST FIT CURVE PLOTTING POINTS - CURVE NO. 3
  3280. C
  3290.
           390 IF (NCURV.NE.3) GO TO 440
  3300.
               NSUM3 = 0
               DO 400 K=1,MAX10
  3310.
  3320.
               RK=K
               X3(K) = ((RK/10.0) - 0.1)
IF (X3(K).GE.XLAST) GO TO 410
  3330.
  3340.
  3350.
               XTEMP = X3(K) + XSTART
               Y3(K) = (C(1)) + (C(2)*XTEMP) + (C(3)*(XTEMP**2)) +
  3360.
  3370.
              &(C(4)*(XTEMP**3))
               IF (Y3(K).GT.YMAX) GO TO 410
  3380.
               NSUM3 = NSUM3 + 1
  3390.
  3400.
           400 CONTINUE
           410 \times 3(NSUM3 + 1) = XLAST
  3410.
               XLTEMP = XLAST + XSTART
  3420.
  3430.
               Y3(NSUM3 + 1) = (C(1)) + (C(2)*XLTEMP) + (C(3)*(XLTEMP**2)) +
              &(C(4)*(XLTEMP**3))
  3440.
  3450.
               NSUM3 = NSUM3 + 1
  3460. C
               LIST THE BEST FIT CURVE PLOTTING POINTS - CURVE NO. 3
  3470. C
  3480. C
  3490.
               WRITE (6,280) MIXNO, DAY
  3500.
               IF (REMIX.EQ.0) GO TO 420
  3510.
               WRITE (6,290)
           420 WRITE (6,310)
  3520.
  3530.
               WRITE (6,320) (K,X3(K),Y3(K),K=1,NSUM3)
  3540. C
               PLOT OUT THE BEST FIT CURVE - CURVE NO. 3
  3550. C
  3560. C
                                0.0
  3570.
               X3(NSUM3+1)=
  3580.
               Y3(NSUM3+1)=
                                0.0
  3590.
               X3(NSUM3+2) =
                                5.0
               Y3(NSUM3+2) = 160.0
  3600.
  3610. C
               CALL NEWPEN(8)
  3620.
               CALL FLINE (X3,Y3,-NSUM3,1,0,0) IF (DASH.EQ.0) GO TO 430
  3630.
  3640.
               XDASH = (X3(NSUM3)/5.0) + 0.12
  3650.
               YDASH = Y3(NSUM3)/160.0
  3660.
  3670.
               XEND = 4.0 - XDASH
               CALL PLOT (XDASH, YDASH, -3)
  3680.
           CALL DASHP (XEND,0.0,0.12)
CALL PLOT (-XDASH,-YDASH,-3)
430 CALL PLOT (0.0,0.0,3)
  3690.
  3700.
  3710.
  3720.
               CALL NEWPEN(1)
  3730.
               GO TO 590
  3740. C
  3750. C
               CALCULATE THE BEST FIT CURVE PLOTTING POINTS - CURVE NO. 4
  3760. C
  3770.
           440 IF (NCURV.NE.4) GO TO 490
  3780.
               NSUM4 = 0
```

```
CLAYCOMB "Computer Program No. 5"
  3790.
               DO 450 L=1,MAX10
  3800.
              RL=L
               X4(L) = ((RL/10.0) - 0.1)
  3810.
               IF (X4(L).GE.XLAST) GO TO 460
  3820.
              XTEMP = X4(L) + XSTART
  3830.
  3840.
              Y4(L) = (C(1)) + (C(2)*XTEMP) + (C(3)*(XTEMP**2)) +
  3850.
              &(C(4)*(XTEMP**3))
  3860.
              IF (Y4(L).GT.YMAX) GO TO 460
  3870.
              NSUM4 = NSUM4 + 1
  3880.
          450 CONTINUE
  3890.
          460 \times 4(NSUM4 + 1) = XLAST
  3900.
              XLTEMP = XLAST + XSTART
              Y4(NSUM4 + 1) = (C(1)) + (C(2)*XLTEMP) + (C(3)*(XLTEMP**2)) +
  3910.
  3920.
              &(C(4)*(XLTEMP**3))
  3930.
              NSUM4 = NSUM4 + 1
  3940. C
  3950. C
              LIST THE BEST FIT CURVE PLOTTING POINTS - CURVE NO. 4
  3960. C
  3970.
              WRITE (6,280) MIXNO, DAY
  3980.
              IF (REMIX.EQ.0) GO TO 470
  3990.
              WRITE (6,290)
  4000.
          470 WRITE (6,310)
  4010.
              WRITE (6,320) (L,X4(L),Y4(L),L=1,NSUM4)
  4020. C
  4030. C
              PLOT OUT THE BEST FIT CURVE - CURVE NO. 4
  4040. C
  4050.
              X4(NSUM4+1)=
                               0.0
  4060.
              Y4(NSUM4+1) =
                               0.0
  4070.
              X4(NSUM4+2) =
                               5.0
  4080.
              Y4(NSUM4+2) = 160.0
 4090. C
  4100.
              CALL NEWPEN(8)
              CALL FLINE (X4,Y4,-NSUM4,1,0,0) IF (DASH.EQ.0) GO TO 480
  4110.
  4120.
  4130.
              XDASH = (X4(NSUM4)/5.0) + 0.12
 4140.
              YDASH = Y4(NSUM4)/160.0
              XEND = 4.0 - XDASH
 4150.
              CALL PLOT (XDASH, YDASH, -3)
 4160.
              CALL DASHP (XEND, 0.0, 0.12)
 4170.
          CALL PLOT (-XDASH,-YDASH,-3)
480 CALL PLOT (0.0,0.0,3)
 4180.
  4190.
              CALL NEWPEN(1)
 4200.
 4210.
              GO TO 590
 4220. C
 4230. C
              CALCULATE THE BEST FIT CURVE PLOTTING POINTS - CURVE NO. 5
  4240. C
  4250.
          490 IF (NCURV.NE.5) GO TO 540
              NSUM5 = 0
  4260.
  4270.
              DO 500 MJ=1,MAX10
 4280.
              RMJ=MJ
  4290.
              X5(MJ) = ((RMJ/10.0) - 0.1)
              IF (X5(MJ).GE.XLAST) GO TO 510
  4300.
              XTEMP = X5(MJ) + XSTART
  4310.
  4320.
              Y5(MJ) = (C(1)) + (C(2)*XTEMP) + (C(3)*(XTEMP**2)) +
 4330.
             &(C(4)*(XTEMP**3))
              IF (Y5(MJ).GT.YMAX) GO TO 510
  4340.
              NSUM5 = NSUM5 + 1
 4350.
          500 CONTINUE
 4360.
  4370.
          510 \times 5(NSUM5 + 1) = XLAST
              XLTEMP = XLAST + XSTART
 4380.
              Y5(NSUM5 + 1) = (C(1)) + (C(2)*XLTEMP) + (C(3)*(XLTEMP**2)) +
 4390.
 4400.
             &(C(4)*(XLTEMP**3))
  4410.
              NSUM5 = NSUM5 + 1
```

```
CLAYCOMB "Computer Program No. 5"
  4420. C
  4430. C
               LIST THE BEST FIT CURVE PLOTTING POINTS - CURVE NO. 5
  4440. C
  4450.
               WRITE (6,280) MIXNO, DAY
               IF (REMIX.EQ.0) GO TO 520
  4460.
               WRITE (6,290)
  4470.
  4480.
           520 WRITE (6,310)
  4490.
               WRITE (6,320) (MJ,X5(MJ),Y5(MJ),MJ=1,NSUM5)
  4500. C
  4510. C
               PLOT OUT THE BEST FIT CURVE - CURVE NO. 5
  4520. C
  4530.
               X5(NSUM5+1)=
                                0.0
  4540.
               Y5(NSUM5+1)=
                                0.0
  4550.
               X5(NSUM5+2) =
                                5.0
  4560.
               Y5(NSUM5+2) = 160.0
  4570. C
  4580.
               CALL NEWPEN(8)
               CALL FLINE (X5,Y5,-NSUM5,1,0,0)
IF (DASH.EQ.0) GO TO 530
XDASH = (X5(NSUM5)/5.0) + 0.12
  4590.
  4600.
  4610.
               YDASH = Y5(NSUM5)/160.0
 4620.
  4630.
               XEND = 4.0 - XDASH
               CALL PLOT (XDASH, YDASH, -3)
 4640.
 4650.
               CALL DASHP (XEND, 0.0, 0.12)
          CALL PLOT (-XDASH,-YDASH,-3)
530 CALL PLOT (0.0,0.0,3)
  4660.
 4670.
               CALL NEWPEN(1)
 4680.
 4690.
               GO TO 590
 4700. C
 4710. C
               CALCULATE THE BEST FIT CURVE PLOTTING POINTS - CURVE NO. 6
 4720. C
 4730.
           540 IF (NCURV.NE.6) GO TO 590
 4740.
              NSUM6 = 0
               DO 550 NJ=1,MAX10
 4750.
 4760.
               RNJ=NJ
 4770.
               X6(NJ) = ((RNJ/10.0) - 0.1)
 4780.
               IF (X6(NJ).GE.XLAST) GO TO 560
               XTEMP = X6(NJ) + XSTART

Y6(NJ) = (C(1)) + (C(2)*XTEMP) + (C(3)*(XTEMP**2)) +
 4790.
 4800.
 4810.
              &(C(4)*(XTEMP**3))
 4820.
               IF (Y6(NJ).GT.YMAX) GO TO 560
 4830.
               NSUM6 = NSUM6 + 1
          550 CONTINUE
 4840.
 4850.
          560 \times 6(NSUM6 + 1) = XLAST
               XLTEMP = XLAST + XSTART
 4860.
 4870.
               Y6(NSUM6 + 1) = (C(1)) + (C(2)*XLTEMP) + (C(3)*(XLTEMP**2)) +
 4880.
              &(C(4)*(XLTEMP**3))
 4890.
               NSUM6 = NSUM6 + 1
 4900. C
 4910. C
               LIST THE BEST FIT CURVE PLOTTING POINTS - CURVE NO. 6
 4920. C
 4930.
               WRITE (6,280) MIXNO, DAY
 4940.
               IF (REMIX.EQ.0) GO TO 570
          WRITE (6,290)
570 WRITE (6,310)
 4950.
 4960.
 4970.
               WRITE (6,320) (NJ,X6(NJ),Y6(NJ),NJ=1.NSUM6)
 4980. C
 4990. C
               PLOT OUT THE BEST FIT CURVE - CURVE NO. 6
 5000. C
 5010.
               X6(NSUM6+1) =
                                0.0
 5020.
               Y6(NSUM6+1)=
                                0.0
 5030.
                                5.0
               X6(NSUM6+2) =
 5040.
               Y6(NSUM6+2) = 160.0
```

```
CLAYCOMB "Computer Program No. 5"
    5050. C
                             CALL NEWPEN(8)
    5060.
                             CALL FLINE (X6,Y6,-NSUM6,1,0,0) IF (DASH.EQ.0) GO TO 580
    5070.
    5080.
    5090.
                             XDASH = (X6(NSUM6)/5.0) + 0.12
                             YDASH = Y6(NSUM6)/160.0
    5100.
                             XEND = 4.0 - XDASH
    5110.
                             CALL PLOT (XDASH, YDASH, -3)
    5120.
                     CALL DASHP (XEND,0.0,0.12)
CALL PLOT (-XDASH,-YDASH,-3)
580 CALL PLOT (0.0,0.0,3)
    5130.
    5140.
    5150.
    5160.
                             CALL NEWPEN(1)
    5170. C
    5180.
                     590 CONTINUE
    5190. C
    5200. C
                             DEVELOP A LEGEND FOR COMBINATION PLOT NO. 1
    5210. C
                            IF (NC.NE.1) GO TO 591

CALL SYMBOL (2.46,6.86,0.14,'CLAY MORTAR',0.0,11)

CALL SYMBOL (2.53,6.58,0.14,'LIME STUDY',0.0,10)

CALL SYMBOL (3.615,6.37,0.07,'A',0.0,1)

CALL SYMBOL (2.775,6.32,0.07,'MIX NOS. 1-5',0.0,12)

CALL SYMBOL (2.705,6.18,0.07,'28-DAY STRENGTH',0.0,15)

CALL SYMBOL (2.705,5.97,0.07,'ONE UNIT CLAY',0.0,13)

CALL SYMBOL (2.915,5.83,0.07,'33.3% SAND',0.0,10)

CALL SYMBOL (2.915,5.69,0.07,'1.75% FIBRES',0.0,12)
    5220.
    5230.
    5240.
    5250.
    5260.
    5270.
    5280.
    5290.
    5300.
    5310.
                             GO TO 609
    5320. C
                             DEVELOP A LEGEND FOR COMBINATION PLOT NO. 2
    5330. C
    5340. C
                   591 IF (NC.NE.2) GO TO 609

CALL SYMBOL (2.46,6.86,0.14,'CLAY MORTAR',0.0,11)

CALL SYMBOL (2.53,6.58,0.14,'LIME STUDY',0.0,10)

CALL SYMBOL (3.615,6.37,0.07,'A',0.0,1)

CALL SYMBOL (2.775,6.32,0.07,'MIX NOS. 1-5',0.0,12)

CALL SYMBOL (2.705,6.18,0.07,'28-DAY STRENGTH',0.0,15)

CALL SYMBOL (2.705,5.97,0.07,'ONE UNIT CLAY',0.0,13)

CALL SYMBOL (2.915,5.83,0.07,'33.3% SAND',0.0,10)

CALL SYMBOL (2.915,5.69,0.07,'1.75% FIBRES',0.0,12)
    5350.
    5360.
    5370.
    5380.
    5390.
    5400.
    5410.
    5420.
    5430.
    5440. C
    5450.
                     609 CALL PLOT (12.0,0.0,999)
   5460.
                     610 CONTINUE
   5470.
                             CALL PLOT (0.0,0.0,9999)
    5480.
                             STOP
   5490.
                             END
```

G.6 COMPUTER PROGRAM NO. 6 [25, 27]

Computer Program No. 6 performs the same job as Computer Program No. 4 but is modified to be used for the lime-sand mortar mixes. Modifications were necessary due to the lower stress-strain values obtained with the lime-sand mortar mixes. This involved a reduction of the plot scales. More details of this program can be obtained from the description of Computer Program No. 4 and within the program itself.

```
LSIMPLOT "Computer Program No. 6"
    10. //DAY28 JOB ',,,T=1M,L=5,I=10,C=0','RANDY ZAPOTOTSKY',CLASS=F,
20. // MSGLEVEL=(1,1)
    30. /*ROUTE PRINT SELF
    40. /*D800 VPLOT
    50. // EXEC FORTHCLG, USERLIB='SYS3.VPLOTLIB', SIZE=256K
    60. //FORT.SYSIN DD *
    70. C
    80. C
    90. C
   100. C
                                --- LSIMPLOT ---
   110. C
   120. C
              --- THIS IS THE PROGRAM FOR SIMPLE PLOTTING ---
                       --- LIME-SAND MORTAR MIXES ---
   130. C
   140. C
   150. C
   160. C
   170. C
              IN THIS PROGRAM THE FIRST THING THAT IS READ IN IS THE
  180. C NUMBER OF PLOTS TO BE DRAWN. THE CHARACTERISTICS, NAMELY 190. C THE ORGIN AND AXES, ARE THEN DEFINED AND PLOTTED OUT.
   200. C FOR AESTHETICS PURPOSES ONLY, A FRAME IS THEN DRAWN AROUND
   210. C THIS SET OF AXES.
   220. C
   230. C
              FOLLOWING THE ABOVE. THE DATA POINTS ARE THEN READ IN.
   240. C PLOTTED OUT WITHIN THE LIMITS OF THE CHARACTERISTICS OF THE
   250. C PLOT AND THEN A SMOOTH LINE JOINS EACH SET OF POINTS.
   260. C FOR EACH PLOT THREE SETS OF CURVES ARE SET OUT TO BE PLOTTED.
   270. C
   280. C
              IN THE END, A LEGEND IS INSERTED IN THE INNER, UPPER
   290. C RIGHT HAND CORNER OF THE PLOT. IF NO LEGEND IS DESIRED, THIS
   300. C PART CAN BE SKIPPED.
   310. C
   320. C
              WHEN SUBMITTING A JOB, THE ORDER OF SUBMISSION IS:
   330. C
   340. C
                        LSIMPLOT
   350. C
                    2)
                        NOPLOT
   360. C
                    3)
                        "FIRST DATA FILE"
   370. C
                    4)
                        "SECOND DATA FILE"
                        "THIRD DATA FILE
   380. C
                    5)
   390. C
  400. C
                        "N-2TH DATA FILE (LAST ONE)"
   410. C
                    N)
  420. C
   430. C
              WHERE:
   440. C
                         LSIMPLOT: IS THE NAME OF THIS SIMPLE PLOTTING
   450. C
                                     PROGRAM.
   460. C
   470. C
                                     CONTAINS THE FIRST JCL STATEMENT AND
                           NOPLOT:
   480. C
                                     SPECIFIES THE NUMBER OF PLOTS TO BE
                                     PLOTTED. THE FORM OF THIS FILE IS:
   490. C
   500. C
                                     1. //GO.SYSIN.DD *
   510. C
   520. C
                                     2. "NUMBER OF PLOTS"
  530. C
   540. C
                        DATA FILE: THE FIRST OR ANY OTHER DATA FILE
   550. C
                                     CONTAINS SOME BASIC INFORMATION ABOUT
                                     THE PLOT AND ITS DATA POINTS. THE
   560. C
   570. C
                                     FORM OF A DATA FILE IS:
   580. C
   590. C
                                     1. MIXNO N N1 N2 N3 DAY REMIX
  600. C
                                     2. X1
                                                 Y 1
  610. C
                                     3. X2
                                                 ¥2
  620. C
  630. C
```

```
LSIMPLOT "Computer Program No. 6"
   640. C
                                      N. X(N-1) Y(N-1)
   650. C
   660. C
                                      WHERE: MIXNO = THE MIX NUMBER
   670. C
                                                   N = THE TOTAL NUMBER OF
   680. C
                                                        DATA POINTS FOR THE
   690. C
                                                       MIX.
   700. C
                                                  N1 = THE TOTAL NUMBER OF
   710. C
                                                        DATA POINTS FOR CUBE
   720. C
                                                        NUMBER 1.
   730. C
                                                  N2 = THE TOTAL NUMBER OF
   740. C
                                                       DATA POINTS FOR CUBE
   750. C
                                                        NUMBER 2.
   760. C
                                                  N3 = THE TOTAL NUMBER OF
   770. C
                                                        DATA POINTS FOR CUBE
   780. C
                                                        NUMBER 3.
                                                 DAY = THE AGE (IN DAYS) OF
THE MIX AT THE TIME
   790. C
   800. C
   810. C
                                                        OF TESTING.
  820. C
                                               REMIX = "0" WHEN THE MIX WAS
  830. C
                                                            NOT REMIXED.
                                                        "1" WHEN THE MIX WAS
  840. C
  850. C
                                                            REMIXED.
  860. C
                                               X&Y'S = THE DATA POINTS.
  870. C
  880. C
  890. C
  890. C ALSO, WHEN SUBMITTING A JOB, ONE MUST MAKE SURE THAT THE 900. C JCL ENDING THE DATA INFORMATION MUST BE PLACED AT THE CORRECT
  910. C POSITION. IF ONLY ONE PLOT IS TO BE PLOTTED, IT GOES AT THE
  920. C END OF THE FIRST DATA FILE. IN THE CASE WHERE TWO OR MORE
  930. C PLOTS WILL BE DRAWN, THE JCL MUST BE PUT AT THE END OF THE
  940. C LAST DATA FILE.
  950. C
              DEPENDING ON THE NUMBER AND TYPE OF PLOTS TO BE DONE, THE
  960. C
  970. C "DEVELOP A LEGEND" PART OF THE PROGRAM MUST BE MODIFIED
  980. C ACCORDINGLY, IF USED.
  990. C
  1000. C
               LIMITATIONS OF THE DIMENSION STATEMENTS ARE AS FOLLOWS:
  1010. C
  1020. C
                         STRAN_(__),STRES_(_
 1030. C
                         MAXIMUM ALLOWABLE NUMBER OF DATA POINTS PER CUBE
 1040. C
                         READ IN IS 102 - 2 = 100
 1050. C
 1060. C
 1070. C
              DIMENSION IBUF (4000), STRAN1(102), STRES1(102), STRAN2(102),
 1080.
 1090.
              &STRES2(102),STRAN3(102),STRES3(102)
 1100.
              INTEGER DAY, REMIX
 1110. C
 1120. C
              READ AND WRITE OUT THE NUMBER OF PLOTS TO BE DRAWN
 1130. C
 1140.
              READ (5,*) NOPLOT
            WRITE (6,5) NOPLOT
5 FORMAT ('1',/////,4x,'THE NUMBER OF PLOTS THAT ',
 1150.
 1160.
             &'ARE TO BE DRAWN IS',3X,13)
 1170.
              DO 100 NP=1,NOPLOT
 1180.
 1190.
              CALL PLOTS (IBUF, 4000)
 1200. C
 1210. C
               DEFINE SOME CHARACTERISTICS OF THE PLOT.
 1220. C
              CALL PLOT (0.0,-11.0,-3)
CALL PLOT (0.0,2.0625,-3)
 1230.
 1240.
 1250.
               CALL FACTOR (1.0)
 1260.
              CALL AXIS (0.0,0.0, 'STRAIN - %',-10,4.0,0.0,0.0,1.0)
```

```
LSIMPLOT "Computer Program No. 6"
  1270.
                   CALL AXIS (0.0,0.0, STRESS - PSI', 12,7.0,90.0,0.0,25.0)
  1280. C
                    ----- DRAW A RECTANGULAR FRAME AROUND THE PLOT -----
  1290. C
  1300. C
  1310.
                   CALL NEWPEN (4)
                   CALL RECT (-0.75,-1.25,9.0,5.5,0.0,3)
  1320.
  1330.
                   CALL NEWPEN (1)
  1340. C
  1350. C
                    ---- READ AND WRITE OUT SOME BASIC INFORMATION -----
  1360. C
  1370.
                   READ (5,*) MIXNO,N,N1,N2,N3,DAY,REMIX
                WRITE (6,6) MIXNO,DAY
6 FORMAT ('1',/////,4x,'THIS IS THE SIMPLE PLOT ', &'PROGRAM FOR MIX NUMBER',15,3X,'AT THE',3X,12,3X,
  1380.
  1390.
  1400.
  1410.
                 &'DAY STRENGTH')
                WRITE (6,7) MIXNO,N
7 FORMAT (/////,4X,
  1420.
  1430.
                & THE TOTAL NUMBER OF DATA POINTS READ IN FOR MIX NUMBER', &16,4X,'IS',17)
WRITE (6,8) N1,N2,N3
8 FORMAT (/////,4X,
  1440.
  1450.
  1460.
  1470.
  1480.
                 &'THE NUMBER OF DATA POINTS READ IN FOR CUBE NUMBER 1 =',
                 &1X, I3, //, 42X, 'CUBE NUMBER 2 =',1X, I3, //, 42X, &'CUBE NUMBER 3 =',1X, I3)

IF (REMIX.EQ.1) GO TO 10
  1490.
  1500.
  1510.
  1520.
                   WRITE (6,9)
                9 FORMAT (/////,4x,'THE FOLLOWING DATA IS FOR THE MIX ',
  1530.
                 &'WHEN ITS COMPONENTS WERE COMBINED FOR THE FIRST TIME') GO TO 12
  1540.
  1550.
               10 WRITE (6,11)
11 FORMAT (/////,4x,'THE FOLLOWING DATA IS FOR WHEN THE ',
  1560.
  1570.
  1580.
                 &'HARDENED ORIGINAL MIXTURE WAS CRUSHED AND REMIXED')
  1590. C
                    READ AND WRITE OUT THE DATA POINTS FOR THE MIX.
  1600. C
  1610. C
  1620.
               12 READ (5,*) (STRAN1(I), STRES1(I), I=1,N1)
              READ (5,*) (STRAN(1),STRES(1),J=1,N2)
READ (5,*) (STRAN3(K),STRES3(K),K=1,N3)
WRITE (6,13) MIXNO,DAY

13 FORMAT ('1',/////,32X,'DATA POINTS',//,30X,
&'MIX NUMBER',15,//,29X,12,3X,'DAY STRENGTH')
UDITE (6,14)
  1630.
  1640.
  1650.
  1660.
  1670.
               WRITE(6,14)

14 FORMAT(//,4x,'DATA NUMBER',10x,'X-VALUES (STRAIN-%)',10x,
  1680.
  1690.
                 &'Y-VALUES (STRESS-PSI)',/)
  1700.
              WRITE (6,15)

15 FORMAT (/,4X,'CUBE NUMBER 1',/)
WRITE (6,18) (I,STRAN1(I),STRES1(I),I=1,N1)
WRITE (6,16)

16 FORMAT (//,4X,'CUBE NUMBER 2',/)
  1710.
  1720.
  1730.
  1740.
  1750.
                   WRITE (6,18) (J,STRAN2(J),STRES2(J),J=1,N2)
  1760.
               WRITE (6,17)
17 FORMAT (//,4x,'CUBE NUMBER 3',/)
  1770.
  1780.
               WRITE (6,18) (K,STRAN3(K),STRES3(K),K=1,N3)
18 FORMAT ('',7X,13,17X,F10.3,19X,F10.1)
  1790.
  1800.
  1810. C
  1820. C
                   PLOT OUT THE DATA POINTS AND JOIN THE POINTS WITH A
  1830. C SMOOTH LINE.
  1840. C
  1850.
                   STRAN1 (N1+1) = 0.0
                  STRES1 (N1+1) = 0.0
STRAN1 (N1+2) = 1.0
  1860.
  1870.
                   STRES1 (N1+2) = 25.0
  1880.
  1890. C
```

```
LSIMPLOT "Computer Program No. 6"
     1900.
                                    STRAN2 (N2+1)=
     1910.
                                    STRES2 (N2+1) = 0.0
     1920.
                                    STRAN2 (N2+2) = 1.0
     1930.
                                    STRES2 (N2+2) = 25.0
     1940. C
                                    STRAN3 (N3+1) = 0.0
     1950.
     1960.
                                    STRES3 (N3+1)=
                                                                            0.0
     1970.
                                    STRAN3 (N3+2) =
                                                                              1.0
     1980.
                                    STRES3 (N3+2) = 25.0
     1990. C
     2000.
                                    CALL FLINE (STRAN1, STRES1, -N1, 1, 1, 0)
                                    CALL FLINE (STRAN2, STRES2, -N2, 1, 1, 2)
     2010.
     2020.
                                    CALL FLINE (STRAN3, STRES3, -N3, 1, 1, 3)
     2030. C
     2040. C
     2050. C
                                       ----- DEVELOP A LEGEND -----
     2060. C
     2070. C
                                      PUT MAJOR AND MINOR INFORMATION INTO THE LEGEND.
    2080. C
                                   IF (NP.NE.1) GO TO 36

CALL SYMBOL (2.25,6.86,0.14,'MIX NO. 12',0.0,10)

CALL SYMBOL (1.90,6.58,0.14,'LIME:SAND = 1:6',0.0,15)

CALL SYMBOL (2.53,6.37,0.07,'LIME BRAND A',0.0,12)

CALL SYMBOL (2.425,6.23,0.07,'28-DAY STRENGTH',0.0,15)

CALL SYMBOL (2.60,6.09,0.07,'20.4% M.C.',0.0,10)

CALL SYMBOL (2.74,5.88,0.07,'= CUBE 1',0.0,8)

CALL SYMBOL (2.74,5.74,0.07,'= CUBE 2',0.0,8)

CALL SYMBOL (2.74,5.60,0.07,'= CUBE 3',0.0,8)
     2090.
    2100.
    2110.
     2120.
     2130.
     2140.
     2150.
     2160.
    2170.
     2180.
                                    GO TO 97
                           GO TO 97

36 IF (NP.NE.2) GO TO 37

CALL SYMBOL (2.25,6.86,0.14,'MIX NO. 13',0.0,10)

CALL SYMBOL (1.90,6.58,0.14,'LIME:SAND = 1:5',0.0,15)

CALL SYMBOL (2.53,6.37,0.07,'LIME BRAND A',0.0,12)

CALL SYMBOL (2.425,6.23,0.07,'28-DAY STRENGTH',0.0,15)

CALL SYMBOL (2.60,6.09,0.07,'20.8% M.C.',0.0,10)

CALL SYMBOL (2.74,5.88,0.07,'= CUBE 1',0.0,8)

CALL SYMBOL (2.74,5.74,0.07,'= CUBE 2',0.0,8)

CALL SYMBOL (2.74,5.60,0.07,'= CUBE 3',0.0,8)
     2190.
     2200.
     2210.
     2220.
     2230.
     2240.
     2250.
     2260.
     2270.
                                    GO TO 97
     2280.
     2290.
                            37 IF (NP.NE.3) GO TO 38
                                   IF (NP.NE.3) GO TO 38

CALL SYMBOL (2.25,6.86,0.14,'MIX NO. 14',0.0,10)

CALL SYMBOL (1.76,6.58,0.14,'LIME:SAND = 1:4.5',0.0,17)

CALL SYMBOL (2.53,6.37,0.07,'LIME BRAND A',0.0,12)

CALL SYMBOL (2.425,6.23,0.07,'28-DAY STRENGTH',0.0,15)

CALL SYMBOL (2.60,6.09,0.07,'20.8% M.C.',0.0,10)

CALL SYMBOL (2.74,5.88,0.07,'= CUBE 1',0.0,8)

CALL SYMBOL (2.74,5.74,0.07,'= CUBE 2',0.0,8)

CALL SYMBOL (2.74,5.60,0.07,'= CUBE 3',0.0,8)
    2300.
     2310.
     2320.
    2330.
     2340.
     2350.
     2360.
     2370.
                            CALL SYMBOL (2.74,5.60,0.07,'= CUBE 3',0.0,8)
GO TO 97

38 IF (NP.NE.4) GO TO 39
CALL SYMBOL (2.25,6.86,0.14,'MIX NO. 15',0.0,10)
CALL SYMBOL (1.69,6.58,0.14,'LIME:SAND = 1:3.65',0.0,1
CALL SYMBOL (2.53,6.37,0.07,'LIME BRAND A',0.0,12)
CALL SYMBOL (2.425,6.23,0.07,'28-DAY STRENGTH',0.0,15)
CALL SYMBOL (2.60,6.09,0.07,'21.3% M.C.',0.0,10)
CALL SYMBOL (2.74,5.88,0.07,'= CUBE 1',0.0,8)
CALL SYMBOL (2.74,5.74,0.07,'= CUBE 2',0.0,8)
CALL SYMBOL (2.74,5.60,0.07,'= CUBE 3',0.0,8)
GO TO 97
    2380.
     2390.
     2400.
                                                                                                                                                                 ,0.0,18)
     2410.
     2420.
    2430.
     2440.
     2450.
     2460.
     2470.
    2480.
                                    GO TO 97
     2490.
                            39 IF (NP.NE.5) GO TO 40
                                   CALL SYMBOL (2.25,6.86,0.14,'MIX NO. 16',0.0,10)
CALL SYMBOL (1.90,6.58,0.14,'LIME:SAND = 1:3',0.0,15)
CALL SYMBOL (2.53,6.37,0.07,'LIME BRAND A',0.0,12)
     2500.
     2510.
     2520.
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LSIMPLOT
                               "Computer Program No. 6"
                                                CALL SYMBOL (2.425,6.23,0.07,'28-DAY STRENGTH',0.0,15)
CALL SYMBOL (2.60,6.09,0.07,'22.7% M.C.',0.0,10)
CALL SYMBOL (2.74,5.88,0.07,'= CUBE 1',0.0,8)
CALL SYMBOL (2.74,5.74,0.07,'= CUBE 2',0.0,8)
CALL SYMBOL (2.74,5.60,0.07,'= CUBE 3',0.0,8)
       2530.
       2540.
       2550.
       2560.
       2570.
       2580.
                                                 GO TO 97
                                      40 IF (NP.NE.6) GO TO 41
       2590.
                                               IF (NP.NE.6) GO TO 41

CALL SYMBOL (2.25,6.86,0.14,'MIX NO. 17',0.0,10)

CALL SYMBOL (1.90,6.58,0.14,'LIME:SAND = 1:2',0.0,15)

CALL SYMBOL (2.53,6.37,0.07,'LIME BRAND A',0.0,12)

CALL SYMBOL (2.425,6.23,0.07,'28-DAY STRENGTH',0.0,15)

CALL SYMBOL (2.60,6.09,0.07,'29.6% M.C.',0.0,10)

CALL SYMBOL (2.74,5.88,0.07,'= CUBE 1',0.0,8)

CALL SYMBOL (2.74,5.74,0.07,'= CUBE 2',0.0,8)

CALL SYMBOL (2.74,5.60,0.07,'= CUBE 3',0.0,8)

GO TO 97
       2600.
       2610.
       2620.
       2630.
       2640.
       2650.
       2660.
       2670.
                                     GO TO 97
41 IF (NP.NE.7) GO TO 42
CALL SYMBOL (0.725,6.86,0.14,'MIX NO. 17',0.0,10)
CALL SYMBOL (1.075,6.58,0.14,'REMIX',0.0,5)
CYMBOL (0.375,6.30,0.14,'LIME:SAND = 1:2',0.
       2680.
                                                 GO TO 97
      2690.
      2700.
       2710.
                                               CALL SYMBOL (1.075,6.58,0.14, REMIX',0.0,5)
CALL SYMBOL (0.375,6.30,0.14, LIME:SAND = 1:2',0.0,15)
CALL SYMBOL (1.005,6.09,0.07, LIME BRAND A',0.0,12)
CALL SYMBOL (0.795,5.95,0.07, REMIX AGE = 5 DAYS',0.0,18)
CALL SYMBOL (0.900,5.81,0.07, '28-DAY STRENGTH',0.0,15)
CALL SYMBOL (1.075,5.67,0.07,'26.7% M.C.',0.0,10)
CALL SYMBOL (1.215,5.46,0.07,'= CUBE 1',0.0,8)
CALL SYMBOL (1.215,5.32,0.07,'= CUBE 2',0.0,8)
CALL SYMBOL (1.215,5.18,0.07,'= CUBE 3',0.0,8)
CALL SYMBOL (1.110.5.495.0.07.0.0.0.-1)
      2720.
      2730.
      2740.
      2750.
      2760.
      2770.
      2780.
      2790.
                                               CALL SYMBOL (1.110,5.495,0.07,0,0.0,-1)
CALL SYMBOL (1.110,5.343333,0.07,2,0.0,-1)
CALL SYMBOL (1.110,5.215,0.07,3,0.0,-1)
      2800.
      2810.
      2820.
      2830.
                                                GO TO 99
                                    GO TO 99

42 IF (NP.NE.8) GO TO 43

CALL SYMBOL (2.25,6.86,0.14,'MIX NO. 18',0.0,10)

CALL SYMBOL (1.90,6.58,0.14,'LIME:SAND = 1:6',0.0,15)

CALL SYMBOL (2.53,6.37,0.07,'LIME BRAND B',0.0,12)

CALL SYMBOL (2.425,6.23,0.07,'28-DAY STRENGTH',0.0,15

CALL SYMBOL (2.60,6.09,0.07,'19.0% M.C.',0.0,10)

CALL SYMBOL (2.74,5.88,0.07,'= CUBE 1',0.0,8)

CALL SYMBOL (2.74,5.74,0.07,'= CUBE 2',0.0,8)

CALL SYMBOL (2.74,5.60,0.07,'= CUBE 3',0.0,8)
      2840.
      2850.
      2860.
      2870.
      2880.
                                                                                                                                                                                                                   ,0.0,15)
      2890.
      2900.
      2910.
      2920.
      2930.
                                                GO TO 97
                                    GO TO 97
43 IF (NP.NE.9) GO TO 44
CALL SYMBOL (2.25,6.86,0.14,'MIX NO. 19',0.0,10)
CALL SYMBOL (1.90,6.58,0.14,'LIME:SAND = 1:5',0.0,15)
CALL SYMBOL (2.53,6.37,0.07,'LIME BRAND B',0.0,12)
CALL SYMBOL (2.425,6.23,0.07,'28-DAY STRENGTH',0.0,15
CALL SYMBOL (2.60,6.09,0.07,'18.4% M.C.',0.0,10)
CALL SYMBOL (2.74,5.88,0.07,'= CUBE 1',0.0,8)
CALL SYMBOL (2.74,5.74,0.07,'= CUBE 2',0.0,8)
CALL SYMBOL (2.74,5.60,0.07,'= CUBE 3',0.0,8)
      2940.
      2950.
      2960.
      2970.
      2980.
                                                                                                                                                                                                                  ,0.0,15)
      2990.
      3000.
      3010.
      3020.
                                     GO TO 97
44 IF (NP.NE.10) GO TO 45
      3030.
      3040.
                                              IF (NP.NE.10) GO TO 45

CALL SYMBOL (2.25,6.86,0.14,'MIX NO. 20',0.0,10)

CALL SYMBOL (1.76,6.58,0.14,'LIME:SAND = 1:4.5',0.0,17)

CALL SYMBOL (2.53,6.37,0.07,'LIME BRAND B',0.0,12)

CALL SYMBOL (2.425,6.23,0.07,'18.12 STRENGTH',0.0,15)

CALL SYMBOL (2.60,6.09,0.07,'18.12 M.C.',0.0,10)

CALL SYMBOL (2.74,5.88,0.07,'= CUBE 1',0.0,8)

CALL SYMBOL (2.74,5.74,0.07,'= CUBE 2',0.0,8)

CALL SYMBOL (2.74,5.60,0.07,'= CUBE 3',0.0,8)
      3050.
      3060.
      3070.
      3080.
      3090.
      3100.
     3110.
     3120.
     3130.
                                               GO TO 97
     3140.
                                     45 IF (NP.NE.11) GO TO 46
     3150.
                                               CALL SYMBOL (2.25,6.86,0.14, 'MIX NO. 20',0.0,10)
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LSIMPLOT
                                   "Computer Program No. 6"
                                                      CALL SYMBOL (2.60,6.58,0.14,'REMIX',0.0,5)
CALL SYMBOL (1.76,6.30,0.14,'LIME:SAND = 1:4.5',0.0,17)
CALL SYMBOL (2.53,6.09,0.07,'LIME BRAND B',0.0,12)
CALL SYMBOL (2.285,5.95,0.07,'REMIX AGE = 19 DAYS',0.0,
CALL SYMBOL (2.425,5.81,0.07,'28-DAY STRENGTH',0.0,15)
CALL SYMBOL (2.60,5.67,0.07,'18.0% M.C.',0.0,10)
CALL SYMBOL (2.74,5.46,0.07,'= CUBE 1',0.0,8)
CALL SYMBOL (2.74,5.32,0.07,'= CUBE 2',0.0,8)
CALL SYMBOL (2.74,5.18,0.07,'= CUBE 3',0.0,8)
        3160.
        3170.
        3180.
        3190.
        3200.
        3210.
        3220.
        3230.
        3240.
        3250.
                                                        GO TO 97
                                            46 IF (NP.NE.12) GO TO 47
        3260.
                                                      IF (NP.NE.12) GO TO 47

CALL SYMBOL (2.25,6.86,0.14,'MIX NO. 21',0.0,10)

CALL SYMBOL (1.69,6.58,0.14,'LIME:SAND = 1:3.65',0.0,18)

CALL SYMBOL (2.53,6.37,0.07,'LIME BRAND B',0.0,12)

CALL SYMBOL (2.425,6.23,0.07,'28-DAY STRENGTH',0.0,15)

CALL SYMBOL (2.60,6.09,0.07,'17.8% M.C.',0.0,10)

CALL SYMBOL (2.74,5.88,0.07,'= CUBE 1',0.0,8)

CALL SYMBOL (2.74,5.74,0.07,'= CUBE 2',0.0,8)

CALL SYMBOL (2.74,5.60,0.07,'= CUBE 3',0.0,8)

GO TO 97
        3270.
        3280.
       3290.
       3300.
        3310.
       3320.
       3330.
       3340.
       3350.
                                                       GO TO 97
                                            47 IF (NP.NE.13) GO TO 48
       3360.
                                                      IF (NP.NE.13) GO TO 48

CALL SYMBOL (2.25,6.86,0.14,'MIX NO. 21',0.0,10)

CALL SYMBOL (2.60,6.58,0.14,'REMIX',0.0,5)

CALL SYMBOL (1.69,6.30,0.14,'LIME:SAND = 1:3.65',0.0,18)

CALL SYMBOL (2.53,6.09,0.07,'LIME BRAND B',0.0,12)

CALL SYMBOL (2.285,5.95,0.07,'REMIX AGE = 19 DAYS',0.0,19)

CALL SYMBOL (2.425,5.81,0.07,'28-DAY STRENGTH',0.0,15)

CALL SYMBOL (2.60,5.67,0.07,'17.5% M.C.',0.0,10)

CALL SYMBOL (2.74,5.46,0.07,'= CUBE 1',0.0,8)

CALL SYMBOL (2.74,5.32,0.07,'= CUBE 2',0.0,8)

CALL SYMBOL (2.74,5.18,0.07,'= CUBE 3',0.0,8)
       3370.
       3380.
        3390.
        3400.
        3410.
       3420.
        3430.
        3440.
        3450.
       3460.
                                           GO TO 97
48 IF (NP.NE.14) GO TO 49
        3470.
       3480.
                                                      IF (NP.NE.14) GO TO 49

CALL SYMBOL (2.25,6.86,0.14,'MIX NO. 22',0.0,10)

CALL SYMBOL (1.90,6.58,0.14,'LIME:SAND = 1:3',0.0,15)

CALL SYMBOL (2.53,6.37,0.07,'LIME BRAND B',0.0,12)

CALL SYMBOL (2.425,6.23,0.07,'28-DAY STRENGTH',0.0,15)

CALL SYMBOL (2.60,6.09,0.07,'17.4% M.C.',0.0,10)

CALL SYMBOL (2.74,5.88,0.07,'= CUBE 1',0.0,8)

CALL SYMBOL (2.74,5.74,0.07,'= CUBE 2',0.0,8)

CALL SYMBOL (2.74,5.60,0.07,'= CUBE 3',0.0,8)
        3490.
       3500.
        3510.
        3520.
       3530.
       3540.
       3550.
       3560.
        3570.
                                                       GO TO 97
                                                     IF (NP.NE.15) GO TO 50
       3580.
                                                      IF (NP.NE.15) GO TO 50

CALL SYMBOL (2.25,6.86,0.14,'MIX NO. 22',0.0,10)

CALL SYMBOL (2.60,6.58,0.14,'REMIX',0.0,5)

CALL SYMBOL (1.90,6.30,0.14,'LIME:SAND = 1:3',0.0,15)

CALL SYMBOL (2.53,6.09,0.07,'LIME BRAND B',0.0,12)

CALL SYMBOL (2.285,5.95,0.07,'REMIX AGE = 16 DAYS',0.

CALL SYMBOL (2.425,5.81,0.07,'28-DAY STRENGTH',0.0,15)

CALL SYMBOL (2.60,5.67,0.07,'17.3% M.C.',0.0,10)

CALL SYMBOL (2.74,5.46,0.07,'= CUBE 1',0.0,8)

CALL SYMBOL (2.74,5.32,0.07,'= CUBE 2',0.0,8)

CALL SYMBOL (2.74,5.18,0.07,'= CUBE 3',0.0,8)
        3590.
        3600.
       3610.
       3620.
        3630.
                                                                                                                                                                                                                                                ,0.0,15)
        3640.
        3650.
        3660.
       3670.
        3680.
       3690.
                                                       GO TO 97
        3700.
                                           50 IF (NP.NE.16) GO TO 51
                                                     IF (NP.NE.16) GO TO 51

CALL SYMBOL (2.25,6.86,0.14,'MIX NO. 23',0.0,10)

CALL SYMBOL (1.90,6.58,0.14,'LIME:SAND = 1:2',0.0,15)

CALL SYMBOL (2.53,6.37,0.07,'LIME BRAND B',0.0,12)

CALL SYMBOL (2.425,6.23,0.07,'28-DAY STRENGTH',0.0,15)

CALL SYMBOL (2.60,6.09,0.07,'16.2% M.C.',0.0,10)

CALL SYMBOL (2.74,5.88,0.07,'= CUBE 1',0.0,8)

CALL SYMBOL (2.74,5.74,0.07,'= CUBE 2',0.0,8)

CALL SYMBOL (2.74,5.60,0.07,'= CUBE 3',0.0,8)
       3710.
       3720.
       3730.
       3740.
       3750.
       3760.
       3770.
       3780.
```

```
LSIMPLOT "Computer Program No. 6"
    3790.
                          GO TO 97
                     51 IF (NP.NE.17) GO TO 97
   3800.
                         IF (NP.NE.17) GO TO 97

CALL SYMBOL (2.25,6.86,0.14,'MIX NO. 23',0.0,10)

CALL SYMBOL (2.60,6.58,0.14,'REMIX',0.0,5)

CALL SYMBOL (1.90,6.30,0.14,'LIME:SAND = 1:2',0.0,15)

CALL SYMBOL (2.53,6.09,0.07,'LIME BRAND B',0.0,12)

CALL SYMBOL (2.285,5.95,0.07,'REMIX AGE = 17 DAYS',0.0,19)

CALL SYMBOL (2.425,5.81,0.07,'28-DAY STRENGTH',0.0,15)

CALL SYMBOL (2.60,5.67,0.07,'15.8% M.C.',0.0,10)

CALL SYMBOL (2.74,5.46,0.07,'= CUBE 1',0.0,8)

CALL SYMBOL (2.74,5.32,0.07,'= CUBE 2',0.0,8)

CALL SYMBOL (2.74,5.18,0.07,'= CUBE 3',0.0,8)
   3810.
   3820.
   3830.
   3840.
   3850.
   3860.
   3870.
   3880.
   3890.
   3900.
   3910. C
   3920. C
                            THE FOLLOWING RECORDS WILL PLACE THE SYMBOLS USED FOR
   3930. C PLOTTING THE DATA POINTS INTO THE LEGEND. ONE SYMBOL WILL BE
   3940. C
                  USED FOR EACH DIFFERENT CUBE.
   3950. C
   3960.
                    97 IF (REMIX.EQ.1) GO TO 98
                         CALL SYMBOL (2.635,5.915,0.07,0,0.0,-1)
CALL SYMBOL (2.635,5.763333,0.07,2,0.0,-1)
CALL SYMBOL (2.635,5.635,0.07,3,0.0,-1)
   3970.
   3980.
   3990.
   4000.
                          GO TO 99
                    98 CALL SYMBOL (2.635,5.495,0.07,0,0.0,-1)
CALL SYMBOL (2.635,5.343333,0.07,2,0.0,-1)
   4010.
   4020.
   4030.
                          CALL SYMBOL (2.635, 5.215, 0.07, 3, 0.0, -1)
   4040. C
   4050.
                    99 CALL PLOT (12.0,0.0,999)
   4060.
                  100 CONTINUE
   4070.
                         CALL PLOT (0.0,0.0,9999)
   4080.
                         STOP
   4090.
                         END
```

G.7 COMPUTER PROGRAM NO. 7 [25, 27, 29 -- PP. 479-480]

Computer Program No. 7 performs the same job as Computer Program No. 3 but is modified to be used for the lime-sand mortar mixes. Modifications were necessary primarily due to the lower stress-strain values obtained with the lime-sand mortar mixes. This meant a reduction of the plot scales and a reduction in the increment of calculating and plotting of the best-fit curve. The defined best-fit curve is also different but can be easily changed as in Computer Program No. 3. More details of this program can be obtained from the description of Computer Program No. 3 and within the program itself.

```
LPLOT "Computer Program No. 7"
    10. //DAY7P2DB JOB ',,,T=1M,L=10,I=10,C=0','RANDY ZAPOTOTSKY',CLASS=F, 20. // MSGLEVEL=(1,1)
    30. /*ROUTE PRINT SELF
    40. /*D800 VPLOT
    50. // EXEC FORTHCLG, USERLIB='SYS3. VPLOTLIB', SIZE=256K
    60. //FORT.SYSIN DD *
    70. C
    80. C
    90. C
   100. C
                 --- THIS IS THE PROGRAM FOR BEST FIT PLOTTING ---
   110. C
                                 --- LIME-SAND MIXES ---
   120. C
   130. C
   140. C
   150. C
               WHEN RUNNING THIS PROGRAM, THE FILES AND ITS ORDER OF
   160. C SUBMISSION IS AS FOLLOWS:
   170. C
   180. C
                1. LPLOT
   190. C
               2. NOFIT
   200. C
                    "DATA FILES"
   210. C
               WHERE:
   220. C
   230. C
   240, C
                       LPLOT - IS THE NAME OF THIS PROGRAM
   250. C
   260. C
                       NOFIT - HAS THREE RECORDS IN THE FORM AS FOLLOWS:
   270. C
   280. C
                                 1.//GO.SYSIN DD *
                                2. "NUMBER OF SETS OF DATA"
3. "VALUE OF M"
   290. C
   300. C
   310. C
   320. C
                                     WHERE:
   330. C
   340. C
                                           M = THE NUMBER OF CONSTANTS (C'S)
   350. C
                                               THAT WILL BE USED IN PLOTTING
   360. C
                                               EACH OF THE BEST FIT CURVES.
   370. C
               "DATA FILES" - HAS THE FORM AS FOLLOWS:
   380. C
   390. C
                   1. MIXNO N N1 N2 N3 DAY REMIX XSTART MAX100 YMAX DASH
   400. C
   410. C
                   2. X1
                                Y 1
   420. C
                                 Y2
                   3. X2
                   4.
   430. C
                   5.
   440. C
   450. C
                 N+1. \dot{X}(N-1)
                                Ý(N-1)
                N+2. C1
   460. C
                N+_:
   470. C
   480. C
             N+1+CN. CN
   490. C
   500. C
   510. C
               WHERE:
   520. C
   530. C
              MIXNO = THE MIX NUMBER
                  N = THE TOTAL NUMBER OF DATA POINTS POINTS
   540. C
   550. C
                  N1 = THE NUMBER OF DATA POINTS FOR SPECIMEN NO. 1
                                                                    NO. 2
   560. C
                  N2 =
                        Ħ
   570. C
                                                                    NO.
                 N3 =
              DAY = THE AGE OF THE MIX, IN DAYS

REMIX = "0" IF THE MIX WAS MIXED TOGETHER FOR THE FIRST TIME

= "1" IF THE HARDENED ORIGINAL MIX WAS CRUSHED AND REMIXED
   580. C
   590. C
   600. C
             XSTART = THE EXPERIMENTAL CORRECTION FACTOR TO THE X-VALUES;
   610. C
   620. C
                       XSTART IS POSITIVE IF MOVING THE X-VALUES TO THE LEFT
   630. C
             MAX100 = (SEE DESCRIPTION BELOW)
```

```
LPLOT "Computer Program No. 7"
    640. C
                 YMAX = THE MAXIMUM Y-VALUE OBTAINED IN A SET OF TESTS
   650. C
                DASH = (SEE DESCRIPTION BELOW)
                X&Y'S = THE DATA POINTS
   660. C
    670. C
                   C_ = THE CONSTANTS OF THE BEST FIT EQUATION
   680. C
   690. C TO SATISFY THE "DO" STATEMENT RULE OF ONLY USING INTEGERS 700. C GREATER THAN ZERO AND TO OBTAIN AN INCREMENT OF 0.01% STRAIN
    710. C (X-VALUES) WHEN PLOTTING THE BEST FIT CURVE, MAX100 IS
    720. C DEFINED AS FOLLOWS:
    730. C
    740. C
                         MAX100 = (MAX STRAIN(%) - XSTART + 0.01) * 100
    750. C
   760. C FROM THIS MODIFICATION TO THE MAXIMUM STRAIN VALUE, ONLY 770. C THE INTEGER PART OF THE NUMBER IS PUT INTO THE DATA FILE.
   780. C WHEN PLOTTING IT WILL BECOME CLOSE ENOUGH TO THE MAXIMUM
   790. C STRAIN VALUE OBTAINED IN A MIX. THIS WILL SATISFY THE 800. C INTEGER RULE OF A DO LOOP.
   810. C
   820. C
                  FROM THE PROGRAM THIS MODIFICATION COMES FROM:
   830. C
   840. C
                         X(I) = ((RI/100.0) - 0.01)
   850. C
                  THE "-0.01" IS NEEDED SO THAT X IS EQUAL TO ZERO FOR THE
   860. C
   870. C FIRST VALUE. THIS WILL MAKE THE BEST FIT CURVE PASS THROUGH
   880. C THE ORIGIN.
   890. C
   900. C
                  MAX100 MUST BE DEFINED FOR EACH INDEPENDANT MIX.
   910. C IN ADDITION, IT MUST BE PUT INTO A DATA FILE AS AN 920. C INTEGER, NOT A REAL NUMBER, TO SATISFY THE INTEGER 930. C RULES OF A DO LOOP.
   940. C
   950. C A CHECK WILL BE DONE NEAR THE DEFINED FUNCTION SO AS TO 960. C PREVENT THE BEST FIT CURVE HAVING A NEGATIVE SLOPE AND A
   970. C Y VALUE GREATER THAN THAT OBTAINED IN A SET OF TESTS.
   980. C A NEGATIVE SLOPE IS UNFAVORABLE SINCE IT DOES NOT REPRESENT 990. C WHAT HAPPENED IN THE ACTUAL TESTS.
  1010. C
                  IF THE MIX DID NOT HAVE PEAK LOADS FOR ALL OF THE CUBES,
  1020. C A STRAIGHT DASHED LINE WILL BE DRAWN HORIZONTALLY FROM THE
  1030. C END OF THE BEST FIT CURVE TO THE FAR RIGHT OF THE PLOT.
  1040. C DASHED LINE WILL REPRESENT THAT LOADING WAS CONTINUED AFTER
  1050. C THIS CUT-OFF POINT, BUT NO PEAK LOAD OCCURRED. IT SHOULD BE 1060. C NOTED THOUGH THAT THE PATH OF THIS DASHED LINE DOES NOT
  1070. C NECESSARILY REPRESENT THE ACTUAL PATH TAKEN DURING THE TEST OR
  1080. C OF THE BEST FIT CURVE.
  1090. C THIS DASHED LINE WILL NOT BE DRAWN WHEN THE VALUE OF 1100. C "DASH" IS EQUAL TO "0" (ZERO). WHEN "DASH" IS EQUAL TO
  1090. C
  1110. C "1" (ONE), A DASHED LINE WILL BE DRAWN.
  1120. C
  1130. C
                 AT THE END OF THE DATA FILE(S), THE PROPER JCL MUST BE
  1140. C DEFINED IN ORDER FOR THE PROGRAM TO RUN.
  1150. C
  1160. C
                  DUE TO THE LIMITS ON THE DIMENSION STATEMENTS THE
  1170. C FOLLOWING LIMITS ARE DEFINED:
  1180. C
  1190. C
                         1) XRAY (
                                       __), YRAY_(_
                              MAXIMUM ALLOWABLE NUMBER OF DATA POINTS PER
  1200. C
  1210. C
                              SPECIMEN READ IN IS 77 - 2 = 75
  1220. C
  1230. C
                         2) C()
  1240. C
                              MAXIMUM ALLOWABLE NUMBER OF CONSTANTS
  1250. C
                              READ IN IS 10
```

1260. C

```
LPLOT "Computer Program No. 7"
                             X(___), Y(___)
MAXIMUM ALLOWABLE STRAIN IN THE TESTS
  1270. C
                        3) X(
  1280. C
  1290. C
                             IS (5002 - 2)/100 = 50\%
  1300. C
  1310. C
                        4) XNEW_(_
  1320. C
                             AS FOR XRAY_(__)
  1330. C
  1340. C
                            MXDATA(___), MYDATA(___)
MAXIMUM ALLOWABLE NUMBER OF DATA POINTS
                        5) MXDATA(
  1350. C
  1360. C
                             POINTS PER MIX PER MIXED X AND Y
  1370. C
                             DATA ARRAYS = 225
  1380. C
  1390. C
  1400. C
               IN ORDER FOR THIS PROGRAM TO RUN SATISFACTORY FOR DIFFERENT
  1410. C
           RUNS, ONE MUST ENSURE THAT THE FOLLOWING IS DONE:
  1420. C
  1430. C
               A. CHECK TO SEE THAT THE BEST FIT EQUATION AT THE FOLLOWING
  1440. C
                    TWO (2) LOCATIONS IS THE ONE THAT IS WANTED AND THAT THEY
  1450. C
                    ARE BOTH THE SAME:
  1460. C
 1470. C
                       IN THE PLOTTING SECTION AND
 1480. C
 1490. C
                         IN THE ADJUSTED COEFFICIENT OF MULTIPLE DETERMINATION
 1500. C
                         CALCULATION PART.
 1510. C
 1520. C
               B. ADJUST THE DEVELOP A LEGEND ACCORDINGLY TO THE DATA OR SKIP
                    OVER THIS PART OF THE PROGRAM BY A SIMPLE GO TO STATEMENT.
 1530. C
 1540. C
 1550. C
 1560. C
 1570.
               DIMENSION IBUF (4000),
              &XRAY1(77), YRAY1(77), XRAY2(77), YRAY2(77), XRAY3(77), YRAY3(77), &C(10), X(5002), Y(5002), XNEW1(77), XNEW2(77), XNEW3(77)
 1580.
 1590.
 1600.
               REAL MXDATA(225), MYDATA(225)
 1610.
               INTEGER DAY, DASH, P1, P2, P3, P4, P5, P6, DP
 1620. C
 1630. C
               READ AND WRITE OUT THE NUMBER OF PLOTS TO BE DRAWN AND THE
 1640. C NUMBER OF CONSTANTS (C'S) THAT ARE TO BE USED.
 1650. C
 1660.
               READ (5,*) NOFIT,M
           WRITE (6,70) NOFIT

70 FORMAT ('1',/////,4X,'THE NUMBER OF PLOT(S) THAT ', &'ARE TO BE DRAWN IS',3X,I3)
 1670.
 1680.
 1690.
           WRITE (6,80) M
80 FORMAT (////,4X,
&'THE NUMBER OF CONSTANTS "M" READ IN FOR THIS PROGRAM IS',15)
 1700.
 1710.
 1720.
               DO 780 NF=1,NOFIT CALL PLOTS (IBUF,4000)
 1730.
 1740.
 1750. C
 1760. C
                DEFINE SOME CHARACTERISTICS OF THE PLOT.
 1770. C
 1780.
               CALL PLOT (0.0,-11.0,-3)
 1790.
               CALL PLOT (0.0,2.0625,-3)
 1800.
               CALL FACTOR (1.0)
 1810.
               CALL AXIS (0.0,0.0, 'STRAIN - %',-10,4.0,0.0,0.0,1.0)
CALL AXIS (0.0,0.0, 'STRESS - PSI',12,7.0,90.0,0.0,25.0)
 1820.
 1830. C
 1840. C
               DRAW A RECTANGULAR FRAME AROUND THE PLOT
 1850. C
 1860.
               CALL NEWPEN (4)
 1870.
               CALL RECT (-0.75,-1.25,9.0,5.5,0.0,3)
 1880.
               CALL NEWPEN (1)
 1890. C
```

```
LPLOT "Computer Program No. 7"
   1900. C
                    READ AND WRITE OUT SOME BASIC INFORMATION ABOUT THE MATERIAL.
  1910. C
                   READ (5,*) MIXNO,N,N1,N2,N3,DAY,REMIX,XSTART,MAX100,YMAX,DASH
  1920.
              WRITE (6,90) MIXNO,DAY
90 FORMAT ('1',////,4X,
   1930.
  1940.
                 &'THIS IS THE PLOT PROGRAM FOR MIX NUMBER', 3X,
  1950.
                 &13,3X,'AT THE',3X,12,3X,'DAY STRENGTH')
IF (REMIX.EQ.1) GO TO 110
  1960.
  1970.
             WRITE (6,100)
100 FORMAT (////,4x,'THE FOLLOWING DATA IS FOR THE MIX
  1980.
  1990.
                 &'WHEN ITS COMPONENTS WERE COMBINED FOR THE FIRST TIME')
  2000.
  2010.
                  GO TO 130
             110 WRITE (6,120)
  2020.
  2030.
             120 FORMAT (/////,4X,'THE FOLLOWING DATA IS FOR WHEN THE ',
  2040.
                 & 'HARDENED ORIGINAL MIXTURE WAS CRUSHED AND REMIXED')
             130 WRITE (6,140) XSTART
140 FORMAT (////,4X,'THE VALUE OF XSTART READ IN IS',
  2050.
  2060.
  2070.
                 &2X,F6.3)
             WRITE (6,150) MIXNO,MAX100
150 FORMAT (////,4X,
  2080.
  2090.
            &'THE VALUE OF MAX100 THAT WAS READ IN FOR MIX NUMBER', 15, &3x,'IS',3x,14)

WRITE (6,160) YMAX

160 FORMAT (////,4x,'THE HIGHEST STRESS THAT WAS REACHED', &'DURING THE TEST WAS',3x,F6.1,3x,'PSI')

IF (DASH.EQ.0) GO TO 180
  2100.
  2110.
  2120.
  2130.
  2140.
  2150.
             WRITE (6,170)
170 FORMAT (////,4x,'DURING THE TESTING,'
  2160.
  2170.
                 &' THIS MIX DID NOT HAVE PEAK LOADS FOR ALL OF THE SPECIMENS.')
  2180.
            GO TO 200

180 WRITE (6,190)

190 FORMAT (////,4X, DURING THE TESTING,
  2190.
  2200.
  2210.
  2220.
                 &' THIS MIX HAD PEAK LOADS FOR ALL OF THE SPECIMENS.')
             200 WRITE (6,210) MIXNO,N
210 FORMAT (////,4X,
  2230.
  2240.
  2250.
                 &'THE TOTAL NUMBER OF DATA POINTS READ IN FOR MIX NUMBER',
                 &I6,4X,'IS',I7)
WRITE (6,220) N1,N2,N3
  2260.
  2270.
             220 FORMAT (////,4X, &'THE NUMBER OF DATA POINTS READ IN FOR SPECIMEN NUMBER 1 =',
  2280.
  2290.
                 &1X,13,//,42X,'SPECIMEN NUMBER 2 =',1X,13,//,42X,
  2300.
  2310.
                 &'SPECIMEN NUMBER 3 ='.1x.13)
  2320. C
  2330. C
                   READ AND WRITE OUT THE DATA POINTS FOR THE MIX.
  2340. C
                  READ (5,*) (XRAY1(I),YRAY1(I),I=1,N1)
READ (5,*) (XRAY2(J),YRAY2(J),J=1,N2)
  2350.
  2360.
                  READ (5,*) (XRAY3(K),YRAY3(K),K=1,N3)
  2370.
  2380. C
            WRITE (6,230) MIXNO, DAY

230 FORMAT ('1',/////,32x,'DATA POINTS',//,30x,
&'MIX NUMBER',15,//,29x,12,3x,'DAY STRENGTH')
IF (REMIX.EQ.0) GO TO 250
  2390.
  2400.
  2410.
  2420.
            WRITE (6,240)
240 FORMAT (/,35X,'REMIX')
  2430.
  2440.
            250 WRITE(6,260)
260 FORMAT(//,4X,'DATA NUMBER',10X,'X-VALUES (STRAIN-%)',10X,
&'Y-VALUES (STRESS-PSI)',/)
  2450.
  2460.
  2470.
  2480.
                  WRITE (6,270)
            270 FORMAT (/,4x,'SPECIMEN NUMBER 1',/)
WRITE (6,300) (I,XRAY1(I),YRAY1(I),I=1,N1)
  2490.
  2500.
                  WRITE (6,280)
  2510.
  2520.
             280 FORMAT (//,4x,'SPECIMEN NUMBER 2',/)
```

```
LPLOT "Computer Program No. 7"
  2530.
                  WRITE (6,300) (J,XRAY2(J),YRAY2(J),J=1,N2)
             WRITE (6,290)

290 FORMAT (//,4X,'SPECIMEN NUMBER 3',/)
WRITE (6,300) (K,XRAY3(K),YRAY3(K),K=1,N3)

300 FORMAT ('',7X,I3,17X,F10.3,19X,F10.1)
  2540.
  2550.
  2560.
  2570.
  2580. C
  2590. C
                    ADJUST THE X-VALUES WITH XSTART TO CORRECT FOR
  2600. C EXPERIMENTAL ERROR.
  2610. C
  2620.
                  DO 310 I=1,N1
  2630.
                  XNEW1(I) = XRAY1(I) - XSTART
  2640.
             310 CONTINUE
  2650.
                  DO 320 J=1,N2
  2660.
                  XNEW2(J) = XRAY2(J) - XSTART
  2670.
             320 CONTINUE
  2680.
                  DO 330 K=1,N3
  2690.
                  XNEW3(K) = XRAY3(K) - XSTART
  2700.
             330 CONTINUE
  2710. C
  2720. C
                   WRITE OUT THE NEW ADJUSTED X-VALUES AND ITS CORRESPONDING
  2730. C
            Y-VALUES.
  2740. C
            WRITE (6,340) MIXNO,DAY

340 FORMAT ('1',/////,27X,'ADJUSTED DATA POINTS',//,30X,
&'MIX NUMBER',15,//,29X,12,3X,'DAY STRENGTH')
  2750.
  2760.
  2770.
  2780.
                  IF (REMIX.EQ.0) GO TO 360
             WRITE (6,350)
350 FORMAT (/,35x,'REMIX')
  2790.
  2800.
            360 WRITE(6,370)
370 FORMAT(//,4X,'DATA NUMBER',10X,'X-VALUES (STRAIN-%)',10X,
&'Y-VALUES (STRESS-PSI)',/)
  2810.
  2820.
  2830.
            WRITE (6,380)
380 FORMAT (/,4x,'SPECIMEN NUMBER 1',/)
WRITE (6,410) (I,XNEW1(I),YRAY1(I),I=1,N1)
  2840.
  2850.
  2860.
            WRITE (6,390)
390 FORMAT (//,4x,'SPECIMEN NUMBER 2',/)
WRITE (6,410) (J,XNEW2(J),YRAY2(J),J=1,N2)
  2870.
  2880.
  2890.
  2900.
                  WRITE (6,400)
            400 FORMAT (//,4x,'SPECIMEN NUMBER 3',/)
WRITE (6,410) (K,XNEW3(K),YRAY3(K),K=1,N3)
410 FORMAT ('',7x,I3,17x,F10.3,19x,F10.1)
  2910.
  2920.
  2930.
  2940. C
  2950. C
                   PLOT OUT THE ADJUSTED DATA POINTS.
  2960. C
  2970.
                  XNEW1 (N1+1)=
                                       0.0
  2980.
                  YRAY1 (N1+1)=
                                       0.0
  2990.
                  XNEW1 (N1+2) =
                                       1.0
  3000.
                  YRAY1 (N1+2) =
                                      25.0
  3010. C
  3020.
                  XNEW2 (N2+1) =
                                       0.0
  3030.
                  YRAY2 (N2+1) =
                                       0.0
  3040.
                  XNEW2 (N2+2) =
                                       1.0
  3050.
                  YRAY2 (N2+2) =
                                      25.0
  3060. C
  3070.
                  XNEW3 (N3+1) =
                                       0.0
  3080.
                  YRAY3 (N3+1)=
                                       0.0
  3090.
                  XNEW3 (N3+2) =
                                       1.0
  3100.
                  YRAY3 (N3+2) =
                                      25.0
  3110. C
  3120.
                  CALL LINE (XNEW1, YRAY1, N1, 1, -1, 0)
  3130.
                  CALL LINE (XNEW2, YRAY2, N2, 1, -1, 2)
  3140.
                  CALL LINE (XNEW3, YRAY3, N3, 1, -1, 3)
  3150. C
```

```
LPLOT "Computer Program No. 7"
  3160. C
                  READ AND WRITE OUT THE CONSTANTS (C-VALUES).
  3170. C
  3180.
                 READ (5,*) (C(I),I=1,M)
            WRITE (6,420) MIXNO,DAY

420 FORMAT ('1',/////,11X,'C VALUES',//,9X,'MIX NUMBER',
&1X,12,//,8X,12,1X,'DAY STRENGTH')
  3190.
  3200.
  3210.
  3220.
                 IF (REMIX.EQ.0) GO TO 440
            WRITE (6,430)
430 FORMAT (/,13X,'REMIX')
  3230.
  3240.
            440 WRITE (6,450)
  3250.
            450 FORMAT (//,4x,'C()',15x,'VALUE',/)
WRITE (6,460) (I,C(I),I=1,M)
  3260.
  3270.
  3280.
            460 FORMAT('0',4x,12,12x,F12.7)
  3290. C
  3300. C
                  CALCULATE THE PLOTTING POINTS FOR THE BEST FIT CURVE.
  3310. C
  3320.
                NSUM = 0
  3330.
                DO 480 I=1,MAX100,1
  3340.
                RI = I
  3350.
                X(I) = ((RI/100.0) - 0.01)
  3360.
                XTEMP = X(I) + XSTART
  3370. C
  3380. C
                THE USER OF THIS PROGRAM SHOULD TAKE NOTE OF THE
  3390. C FOLLOWING:
  3400. C
  3410. C
                              THE FUNCTION DEFINED ON THE NEXT RECORD OF THE
  3420. C
                               PROGRAM. THIS IS THE FUNCTION OF THE BEST FIT
  3430. C
                               CURVE THAT WILL BE DRAWN THROUGH THE DATA
  3440. C
                               POINTS.
  3450. C
  3460. C
                               THE NUMBER OF CONSTANT'S (C'S) READ INTO THE
  3470. C
                               PROGRAM MUST BE EQUAL TO AMOUNT DEFINED IN
  3480. C
                               THIS FUNCTION.
  3490. C
  3500. C
                          ONE MUST MAKE SURE THAT THE CONSTANTS ARE READ
  3510. C
                               IN THE PROPER ORDER TO THE CORRESPONDING ONES
  3520. C
                               DEFINED BY THE FUNCTION.
  3530. C
  3540.
                Y(I) = (C(1)) + (C(2)*XTEMP) + (C(3)*(XTEMP**2))
  3550. C
 3560.
                IF (I.EQ.1) GO TO 470
  3570.
                IF (Y(I).LT.Y(I-1)) GO TO 490
  3580.
                IF (Y(I).GT.YMAX) GO TO 490
  3590.
           470 \text{ NSUM} = \text{NSUM} + 1
  3600.
           480 CONTINUE
 3610. C
  3620. C
                 LIST THE BEST FIT CURVE PLOTTING VALUES.
  3630. C
           490 WRITE (6,500) MIXNO,DAY
500 FORMAT ('1',/////,24x,
&'BEST FIT CURVE PLOTTING VALUES',//,31x,'MIX NUMBER',15,
 3640.
 3650.
 3660.
 3670.
               &//,29X,12,3X,'DAY STRENGTH')
 3680.
                IF (REMIX.EQ.0) GO TO 520
 3690.
           WRITE (6,510)
510 FORMAT (/,35X,'REMIX')
 3700.
           510 FORMAT (/,35%, REMIX')
520 WRITE (6,530)
530 FORMAT (//,4%, 'PLOTTING NUMBER',10%, 'X-VALUES (STRAIN-%)',
&10%, 'Y-VALUES (STRESS-PSI)',/)
WRITE (6,540) (I,%(I),Y(I),I=1,NSUM)
540 FORMAT ('',9%,I3,21%,F8.3,22%,F7.1)
 3710.
 3720.
 3730.
 3740.
 3750.
                            ',9x,13,21x,F8.3,22x,F7.1)
 3760. C
 3770. C
                 PLOT OUT THE BEST FIT CURVE.
 3780. C
```

```
LPLOT "Computer Program No. 7"
     3790.
                                     X (NSUM+1) =
                                                                          0.0
     3800.
                                          (NSUM+1) =
                                                                          0.0
     3810.
                                         (NSUM+2)=
                                                                          1.0
     3820.
                                     Y (NSUM+2) =
                                                                      25.0
     3830. C
     3840.
                                     CALL NEWPEN (8)
                                    CALL FLINE (X,Y,-NSUM,1,0,0) IF (DASH.EQ.0) GO TO 550
     3850.
     3860.
     3870.
                                    XDASH = (X(NSUM)/1.0) + 0.12
                                     YDASH = Y(NSUM)/25.0
     3880.
     3890.
                                    XEND = 4.0 - XDASH
                                     CALL PLOT (XDASH, YDASH, -3)
     3900.
     3910.
                                    CALL DASHP (XEND, 0.0, 0.12)
                                     CALL PLOT (-XDASH,-YDASH,-3)
     3920.
     3930.
                          550 CALL NEWPEN (1)
     3940. C
     3950. C
                                       ----- DEVELOP A LEGEND -----
     3960. C
     3970. C
                                       PUT MAJOR AND MINOR INFORMATION INTO THE LEGEND.
     3980. C
                                   IF (NF.NE.1) GO TO 551

CALL SYMBOL (2.25,6.86,0.14,'MIX NO. 18',0.0,10)

CALL SYMBOL (1.90,6.58,0.14,'LIME:SAND = 1:6',0.0,15)

CALL SYMBOL (2.53,6.37,0.07,'LIME BRAND B',0.0,12)

CALL SYMBOL (2.46,6.23,0.07,'7-DAY STRENGTH',0.0,14)

CALL SYMBOL (2.60,6.09,0.07,'19.0% M.C.',0.0,10)

CALL SYMBOL (2.74,5.88,0.07,'= CUBE 1',0.0,8)

CALL SYMBOL (2.74,5.74,0.07,'= CUBE 2',0.0,8)

CALL SYMBOL (2.74,5.60,0.07,'= CUBE 3',0.0,8)
     3990.
    4000.
     4010.
     4020.
     4030.
    4040.
    4050.
    4060.
    4070.
                        CALL SYMBOL (2.74,5.60,0.07, = CUBE 3,0.0,0)
GO TO 600

551 IF (NF.NE.2) GO TO 552
    CALL SYMBOL (2.25,6.86,0.14,'MIX NO. 19',0.0,10)
    CALL SYMBOL (1.90,6.58,0.14,'LIME:SAND = 1:5',0.0,15)
    CALL SYMBOL (2.53,6.37,0.07,'LIME BRAND B',0.0,12)
    CALL SYMBOL (2.46,6.23,0.07,'7-DAY STRENGTH',0.0,14)
    CALL SYMBOL (2.60,6.09,0.07,'18.4% M.C.',0.0,10)
    CALL SYMBOL (2.74,5.88,0.07,'= CUBE 1',0.0,8)
    CALL SYMBOL (2.74,5.74,0.07,'= CUBE 2',0.0,8)
    CALL SYMBOL (2.74,5.60,0.07,'= CUBE 3',0.0,8)
    GO TO 600
    4080.
    4090.
    4100.
    4110.
    4120.
    4130.
    4140.
    4150.
    4160.
    4170.
                        CALL SYMBOL (2.74,5.60,0.07,'= CUBE 3',0.0,8)
GO TO 600

552 IF (NF.NE.3) GO TO 553
CALL SYMBOL (2.25,6.86,0.14,'MIX NO. 20',0.0,10)
CALL SYMBOL (1.76,6.58,0.14,'LIME:SAND = 1:4.5',0.0,17)
CALL SYMBOL (2.53,6.37,0.07,'LIME BRAND B',0.0,12)
CALL SYMBOL (2.46,6.23,0.07,'7-DAY STRENGTH',0.0,14)
CALL SYMBOL (2.60,6.09,0.07,'18.1% M.C.',0.0,10)
CALL SYMBOL (2.74,5.88,0.07,'= CUBE 1',0.0,8)
CALL SYMBOL (2.74,5.74,0.07,'= CUBE 2',0.0,8)
CALL SYMBOL (2.74,5.60,0.07,'= CUBE 3',0.0,8)
GO TO 600
    4180.
    4190.
    4200.
    4210.
    4220.
    4230.
    4240.
    4250.
    4260.
    4270.
    4280.
                                    GO TO 600
                          553 IF (NF.NE.4) GO TO 554
    4290.
                                   CALL SYMBOL (2.25,6.86,0.14,'MIX NO. 20',0.0,10)

CALL SYMBOL (2.60,6.58,0.14,'REMIX',0.0,5)

CALL SYMBOL (1.76,6.30,0.14,'LIME:SAND = 1:4.5',0.0,17)

CALL SYMBOL (2.53,6.09,0.07,'LIME BRAND B',0.0,12)

CALL SYMBOL (2.285,5.95,0.07,'REMIX AGE = 19 DAYS',0.0,19)

CALL SYMBOL (2.46,5.81,0.07,'7-DAY STRENGTH',0.0,14)

CALL SYMBOL (2.60,5.67,0.07,'18.0% M.C.',0.0,10)
    4300.
    4310.
    4320.
    4330.
    4340.
    4350.
    4360.
                                   CALL SYMBOL (2.74,5.46,0.07,'= CUBE 1',0.0,8)
CALL SYMBOL (2.74,5.32,0.07,'= CUBE 2',0.0,8)
CALL SYMBOL (2.74,5.18,0.07,'= CUBE 3',0.0,8)
    4370.
    4380.
    4390.
    4400.
                                   GO TO 600
    4410.
                         554 IF (NF.NE.5) GO TO 555
```

```
LPLOT "Computer Program No. 7"
                                                         CALL SYMBOL (2.25,6.86,0.14,'MIX NO. 21',0.0,10)
CALL SYMBOL (1.69,6.58,0.14,'LIME:SAND = 1:3.65',0.0,18)
CALL SYMBOL (2.53,6.37,0.07,'LIME BRAND B',0.0,12)
CALL SYMBOL (2.46,6.23,0.07,'7-DAY STRENGTH',0.0,14)
CALL SYMBOL (2.60,6.09,0.07,'17.8% M.C.',0.0,10)
CALL SYMBOL (2.74,5.88,0.07,'= CUBE 1',0.0,8)
CALL SYMBOL (2.74,5.74,0.07,'= CUBE 2',0.0,8)
CALL SYMBOL (2.74,5.60,0.07,'= CUBE 3',0.0,8)
GO TO 600
         4420.
         4430.
         4440.
         4450.
         4460.
         4470.
         4480.
         4490.
         4500.
                                                           GO TO 600
                                          555 IF (NF.NE.6) GO TO 556
        4510.
                                                        IF (NF.NE.6) GO TO 556

CALL SYMBOL (2.25,6.86,0.14,'MIX NO. 21',0.0,10)

CALL SYMBOL (2.60,6.58,0.14,'REMIX',0.0,5)

CALL SYMBOL (1.69,6.30,0.14,'LIME:SAND = 1:3.65',0.0,18)

CALL SYMBOL (2.53,6.09,0.07,'LIME BRAND B',0.0,12)

CALL SYMBOL (2.285,5.95,0.07,'REMIX AGE = 19 DAYS',0.0,1

CALL SYMBOL (2.46,5.81,0.07,'7-DAY STRENGTH',0.0,14)

CALL SYMBOL (2.60,5.67,0.07,'17.5% M.C.',0.0,10)

CALL SYMBOL (2.74,5.46,0.07,'= CUBE 1',0.0,8)

CALL SYMBOL (2.74,5.32,0.07,'= CUBE 2',0.0,8)

CALL SYMBOL (2.74,5.18,0.07,'= CUBE 3',0.0,8)

GO TO 600
        4520.
        4530.
        4540.
        4550.
        4560.
        4570.
        4580.
       4590.
       4600.
       4610.
       4620.
                                                          GO TO 600
       4630.
                                          556 IF (NF.NE.7) GO TO 557
                                                       IF (NF.NE.7) GO TO 557

CALL SYMBOL (2.25,6.86,0.14,'MIX NO. 22',0.0,10)

CALL SYMBOL (1.90,6.58,0.14,'LIME:SAND = 1:3',0.0,15)

CALL SYMBOL (2.53,6.37,0.07,'LIME BRAND B',0.0,12)

CALL SYMBOL (2.46,6.23,0.07,'7-DAY STRENGTH',0.0,14)

CALL SYMBOL (2.60,6.09,0.07,'17.4% M.C.',0.0,10)

CALL SYMBOL (2.74,5.88,0.07,'= CUBE 1',0.0,8)

CALL SYMBOL (2.74,5.74,0.07,'= CUBE 2',0.0,8)

CALL SYMBOL (2.74,5.60,0.07,'= CUBE 3',0.0,8)
       4640.
       4650.
       4660.
       4670.
       4680.
       4690.
       4700.
       4710.
                                        GO TO 600
557 IF (NF.NE.8) GO TO 558
       4720.
       4730.
                                                       IF (NF.NE.8) GO TO 558

CALL SYMBOL (2.25,6.86,0.14,'MIX NO. 22',0.0,10)

CALL SYMBOL (2.60,6.58,0.14,'REMIX',0.0,5)

CALL SYMBOL (1.90,6.30,0.14,'LIME:SAND = 1:3',0.0,15)

CALL SYMBOL (2.53,6.09,0.07,'LIME BRAND B',0.0,12)

CALL SYMBOL (2.285,5.95,0.07,'REMIX AGE = 16 DAYS',0.0,19)

CALL SYMBOL (2.46,5.81,0.07,'7-DAY STRENGTH',0.0,14)

CALL SYMBOL (2.60,5.67,0.07,'17.3% M.C.',0.0,10)

CALL SYMBOL (2.74,5.46,0.07,'= CUBE 1',0.0,8)

CALL SYMBOL (2.74,5.32,0.07,'= CUBE 2',0.0,8)

CALL SYMBOL (2.74,5.18,0.07,'= CUBE 3',0.0,8)

GO TO 600
       4740.
       4750.
       4760.
       4770.
       4780.
       4790.
       4800.
       4810.
       4820.
       4830.
       4840.
                                      GO TO 600

558 IF (NF.NE.9) GO TO 559

CALL SYMBOL (2.25,6.86,0.14,'MIX NO. 23',0.0,10)

CALL SYMBOL (1.90,6.58,0.14,'LIME:SAND = 1:2',0.0,15

CALL SYMBOL (2.53,6.37,0.07,'LIME BRAND B',0.0,12)

CALL SYMBOL (2.46,6.23,0.07,'7-DAY STRENGTH',0.0,14)

CALL SYMBOL (2.60,6.09,0.07,'16.2% M.C.',0.0,10)

CALL SYMBOL (2.74,5.88,0.07,'= CUBE 1',0.0,8)

CALL SYMBOL (2.74,5.74,0.07,'= CUBE 2',0.0,8)

CALL SYMBOL (2.74,5.60,0.07,'= CUBE 3',0.0,8)

GO TO 600
                                                         GO TO 600
       4850.
       4860.
       4870.
       4880.
       4890.
       4900.
      4910.
       4920.
       4930.
      4940.
                                      GO TO 600

559 IF (NF.NE.10) GO TO 560

CALL SYMBOL (2.25,6.86,0.14,'MIX NO. 23',0.0,10)

CALL SYMBOL (2.60,6.58,0.14,'REMIX',0.0,5)

CALL SYMBOL (1.90,6.30,0.14,'LIME:SAND = 1:2',0.0,15)

CALL SYMBOL (2.53,6.09,0.07,'LIME BRAND B',0.0,12)

CALL SYMBOL (2.285,5.95,0.07,'REMIX AGE = 17 DAYS',0.0,19)

CALL SYMBOL (2.46,5.81,0.07,'7-DAY STRENGTH',0.0,14)

CALL SYMBOL (2.60,5.67,0.07,'15.8% M.C.',0.0,10)

CALL SYMBOL (2.74,5.46,0.07,'= CUBE 1',0.0,8)

CALL SYMBOL (2.74,5.32,0.07,'= CUBE 2',0.0,8)
                                                        GO TO 600
      4950.
      4960.
      4970.
      4980.
      4990.
      5000.
      5010.
      5020.
      5030.
      5040.
```

```
LPLOT "Computer Program No. 7"
                   CALL SYMBOL (2.74,5.18,0.07,'= CUBE 3',0.0,8)
   5060.
                   GO TO 600
   5070.
             560 IF (NF.NE.11) GO TO 600
                  IF (NF.NE.11) GO TO 600

CALL SYMBOL (2.25,6.86,0.14,'MIX NO. 18',0.0,10)

CALL SYMBOL (1.90,6.58,0.14,'LIME:SAND = 1:6',0.0,15)

CALL SYMBOL (2.53,6.37,0.07,'LIME BRAND B',0.0,12)

CALL SYMBOL (2.46,6.23,0.07,'7-DAY STRENGTH',0.0,14)

CALL SYMBOL (2.60,6.09,0.07,'19.0% M.C.',0.0,10)

CALL SYMBOL (2.74,5.88,0.07,'= CUBE 1',0.0,8)

CALL SYMBOL (2.74,5.74,0.07,'= CUBE 2',0.0,8)

CALL SYMBOL (2.74,5.60,0.07,'= CUBE 3',0.0,8)

GO TO 600
  5080.
  5090.
  5100.
  5110.
  5120.
  5130.
   5140.
  5150.
  5160.
                   GO TO 600
  5170. C
  5180. C
                    THE FOLLOWING RECORDS WILL PLACE THE SYMBOLS USED FOR
  5190. C PLOTTING THE DATA POINTS INTO THE LEGEND. ONE SYMBOL WILL BE
  5200. C USED FOR EACH DIFFERENT CUBE.
  5210. C
  5220.
             600 IF (REMIX.EQ.1) GO TO 610
                  CALL SYMBOL (2.635,5.915,0.07,0,0.0,-1)
CALL SYMBOL (2.635,5.763333,0.07,2,0.0,-1)
CALL SYMBOL (2.635,5.635,0.07,3,0.0,-1)
  5230.
  5240.
  5250.
  5260.
                   GO TO 620
  5270.
             610 CALL SYMBOL (2.635,5.495,0.07,0,0.0,-1)
CALL SYMBOL (2.635,5.343333,0.07,2,0.0,-1)
  5280.
  5290.
                   CALL SYMBOL (2.635,5.215,0.07,3,0.0,-1)
  5300. C
  5310.
             620 CALL PLOT (12.0,0.0,999)
  5320. C
  5330. C
                    ----- END OF PLOTTING -----
  5340. C
  5350. C
  5360. C
  5370. C *****
  5380. C *
  5390. C *
  5400. C
                      ADJUSTED COEFFICIENT OF MULTIPLE DETERMINATION
  5410. C *
  5420. C *
  5430. C
  5440. C
  5450. C
  5460. C
  5470. C
             NOTES: 1) THIS PROGRAM FOR CALCULATING THE ADJUSTED COEFFICIENT
  5480. C
                             OF MULTIPLE DETERMINATION WILL TAKE INTO ACCOUNT ALL
  5490. C
                             THE DATA POINTS READ IN, UP TO AND INCLUDING BOTH THE MAXIMUM X AND Y VALUES. IT IS REMINDED THOUGH, THAT
  5500. C
  5510. C
                             THE BEST FIT CURVE IS PLOTTED JUST TO THE POINT
  5520. C
                             BEFORE A NEGATIVE SLOPE STARTS OR AFTER YMAX IS
  5530. C
                             REACHED. THEREFORE THE BEST FIT CURVE MAY OR MAY NOT
  5540. C
                             OF BEEN DRAWN TO THE MAXIMUM X-VALUE DATA POINT.
  5550. C
  5560. C
                        2) FOR THE ADJUSTED COEFFICIENT OF MULTIPLE DETERMINATION
  5570. C
                             TO BE CORRECTLY CALCULATED, THE BEST FIT EQUATION USED
  5580. C
                             IN THIS PART MUST MATCH WITH THE ONE USED ABOVE
  5590. C
                              (SEE "THE BEST FIT EQUATION").
  5600. C
  5610. C
  5620. C
                    TRANSFER THE ARRAYS XRAY1,2,3 AND YRAY1,2,3 TO ARRAYS
  5630. C
             MXDATA AND MYDATA RESPECTIVELY.
  5640. C
  5650. C
  5660.
                  P1 = 1
                  P2 = P1 + (N1-1)
  5670.
```

```
LPLOT "Computer Program No. 7"
  5680.
                 DO 630 DP=P1,P2
  5690.
                 I = DP
  5700.
                 MXDATA(DP) = XRAY1(I)
  5710.
                 MYDATA(DP) = YRAY1(I)
  5720.
            630 CONTINUE
  5730.
                 P3 = P2 + 1
  5740.
                 P4 = P3 + (N2-1)
                 DO 640 DP=P3,P4
  5750.
  5760.
                 J = DP - N1
  5770.
                 MXDATA(DP) = XRAY2(J)
  5780.
                 MYDATA(DP) = YRAY2(J)
  5790.
            640 CONTINUE
  5800.
                 P5 = P4 + 1
                 P6 = P5 + (N3-1)
  5810.
                 DO 650 DP=P5,P6
  5820.
                 K = DP - N2 - N1
  5830.
                 MXDATA(DP) = XRAÝ3(K)
  5840.
  5850.
                 MYDATA(DP) = YRAY3(K)
  5860.
            650 CONTINUE
  5870. C
  5880. C
                  CHECK TO SEE IF THE TRANSFER OF THE ARRAYS WAS
  5890. C SUCCESSFULLY DONE BY WRITING OUT THE ARRAYS MXDATA AND MYDATA.
  5900. C
            WRITE (6,660) MIXNO,DAY
660 FORMAT ('1',/////,32x,'DATA POINTS',//,30x,
&'MIX NUMBER',15,//,29x,12,3x,'DAY STRENGTH')
IF (REMIX.EQ.0) GO TO 680
  5910.
  5920.
  5930.
  5940.
            WRITE (6,670)
670 FORMAT (/,35x,'REMIX')
680 WRITE (6,690)
690 FORMAT (/,26x,'"ARRAY TRANSFER CHECK"')
  5950.
  5960.
  5970.
  5980.
            WRITE (6,700)

700 FORMAT (/,4x,'DATA NUMBER',10x,'x-VALUES (STRAIN-%)',10x, &'Y-VALUES (STRESS-PSI)',/)
WRITE (6,710) (L,MXDATA(L),MYDATA(L),L=1,N)

710 FORMAT ('',7x,13,17x,F10.3,19x,F10.1)
  5990.
  6000.
  6010.
  6020.
  6030.
  6040. C
  6050. C
                  DETERMINE THE ERROR SUM OF SQUARES
  6060. C WITH RESPECT TO Y - (SSEY).
  6070. C
  6080. C
                 ---- "THE BEST FIT EQUATION" -----
  6090. C
  6100.
                 SSEY = 0.0
                 DO 720 NR=1,N
  6110.
                 XR2 = MXDATA(NR)
  6120.
  6130.
                 YBF = (C(1)) + (C(2)*XR2) + (C(3)*(XR2**2))
                 DIFFE = MYDATA(NR) - YBF
  6140.
  6150.
                 ADIFFE = ABS(DIFFE)
                 SSEY = SSEY + ((ADIFFE)**2)
  6160.
  6170.
            720 CONTINUE
  6180. C
                  DETERMINE THE TOTAL SUM OF SQUARES
  6190. C
  6200. C WITH RESPECT TO Y - (SSTY).
  6210. C
  6220.
                 SSTY = 0.0
  6230.
                 SUMY = 0.0
                 DO 730 NR=1,N
  6240.
  6250.
                 SUMY = SUMY + MYDATA(NR)
            730 CONTINUE
  6260.
  6270.
                 RN = N
  6280.
                 AVGY = SUMY/RN
  6290.
                 DO 740 NR=1,N
  6300.
                 DIFFY = (MYDATA(NR) - AVGY)
```

```
LPLOT "Computer Program No. 7"
   6310.
                      ADIFFY = ABS(DIFFY)
   6320.
                      SSTY = SSTY + ((ADIFFY)**2)
   6330.
                740 CONTINUE
   6340. C
                       DEFINE THE R-SQUARED ADJUSTMENT FACTOR.
   6350. C
   6360. C
   6370. C THE PURPOSE OF THE R-SQUARED ADJUSTMENT FACTOR IS TO 6380. C BALANCE THE COST OF USING MORE PARAMETERS (A HIGHER DEGREE
   6390. C POLYNOMIAL) AGAINST THE GAIN IN R-SQUARED. SUCH THAT, AS
               ONE USES A HIGHER DEGREE POLYNOMINAL AS A BEST FIT CURVE,
   6400. C
   6410. C
               THE R-SQUARED WILL ALSO RISE.
   6420. C
   6430.
                      RN = N
                      RM = M
   6440.
   6450.
                      ADJFAC = (RN - 1.0)/(RN - (RM + 1.0))
   6460. C
   6470. C
                       CALCULATE AND WRITE OUT THE ADJUSTED COEFFICIENT OF
   6480. C MULTIPLE DETERMINATION (R-SQUARED).
   6490. C
                     R2 = 1.0 - (ADJFAC * (SSEY/SSTY))
IF (REMIX.EQ.0) GO TO 760
   6500.
   6510.
               WRITE (6,750) MIXNO,DAY,R2

750 FORMAT ('1',//////////,62x,'2',/,9x,
&'THE ADJUSTED COEFFICIENT OF MULTIPLE DETERMINATION (R )',
&' FOR MIX NUMBER',3X,I2,',',/,4x,'REMIX AT THE',3X,I2,3x,
&'DAY STRENGTH, RELATIVE TO THE BEST FIT EQUATION',/,4X,
&'WHICH WAS USED, IS:',3X,F10.7)
   6520.
   6530.
   6540.
   6550.
   6560.
   6570.
   6580.
                     GO TO 780
               760 WRITE (6,770) MIXNO,DAY,R2

770 FORMAT ('1',/////////,62x,'2',/,9x,
&'THE ADJUSTED COEFFICIENT OF MULTIPLE DETERMINATION (R )',
&' FOR MIX NUMBER',3X,I2,',',/,4x,'AT THE',3X,I2,3x,
&'DAY STRENGTH, RELATIVE TO THE BEST FIT EQUATION',//,4x,
&'WHICH WAS USED, IS:',3X,F10.7)
   6590.
   6600.
   6610.
   6620.
   6630.
  6640.
   6650. C
               780 CONTINUE
   6660.
  6670.
                     CALL PLOT (0.0,0.0,9999)
   6680.
                     STOP
   6690.
                     END
```

G.8 COMPUTER PROGRAM NO. 8 [25, 27]

Computer Program No. 8 performs the same job as Computer Program No. 5 but is modified to be used for the lime-sand mortar mixes. Modifications were necessary due to the lower stress-strain values obtained with the lime-sand mortar mixes. This involved a reduction of the plot scales. More details of this program can be obtained from the description of Computer Program No. 5 and within the program itself.

```
LIMECOMB "Computer Program No. 8"
    10. //LIMBRAND JOB ',,,T=1M,L=10,I=10,C=0','RANDY ZAPOTOTSKY',CLASS=F, 20. // MSGLEVEL=(1,1)
    30. /*ROUTE PRINT SELF
    40. /*D800 VPLOT
    50. // EXEC FORTHCLG, USERLIB='SYS3. VPLOTLIB'.SIZE=256K
    60. //FORT.SYSIN DD *
    70. C
    80. C
    90. C
   100. C
                    --- THIS IS THE COMBINATION PLOTTING PROGRAM ---
   110. C
                              --- LIME-SAND MORTAR MIXES ---
   120. C
   130. C
   140. C
   150. C
               WHAT THIS PROGRAM BASICALLY DOES IS THAT IT DRAWS FROM ONE
   60. C UP TO SIX CURVES ON ONE SET OF AXES. ONE SUCH PLOT IS CALLED A
   170. C
          COMBINATION PLOT. THE NUMBER OF COMBINATION PLOT(S) TO BE DRAWN
   180. C IS DEPENDANT UPON THE VALUE OF NOCOMB, OF WHICH IS READ IN.
   190. C
   200. C
                                                   LIMECOMB
               THE ORDER OF FILE SUBMISSION IS:
   210. C
                                                   NOCOMB
   220. C
                                                   COMBDATA - "COMBINATION DATA"
   230. C
   240. C
               WHERE: LIMECOMB = THE NAME OF THIS PROGRAM
   250. C
   260. C
                         NOCOMB - HAS THE FORM AS FOLLOWS:
                                   1.//GO.SYSIN DD *
   270. C
   280. C
                                   2. "NUMBER OF COMBINATION PLOT(S) THAT ARE
   290. C
                                       TO BE DRAWN - NOCOMB"
   300. C
                                   3. "NUMBER OF CURVES TO BE DRAWN ON EACH
                                       COMBINATION PLOT - NOCURV"
   310. C
   320. C
   330. C
                       COMBDATA - HAS THE FORM AS FOLLOWS:
   340. C
   350. C

    MIXNO,M,DAY,REMIX,XSTART,MAX10,XLAST,YMAX,DASH

   360. C
                         2. C1
   370. C
                         3. C2
   380. C
                         4.
   390. C
                       M+1. CM
   400. C
   410. C
               WHERE:
   420. C
   430. C
            MIXNO = THE MIX NUMBER
   440. C
                M = THE NUMBER OF CONSTANT(S) USED FOR THE BEST FIT EQUATION
            DAY = THE AGE OF THE MIX, IN DAYS
REMIX = "0" IF THE MIX WAS MIXED TO
   450. C
                   = "0" IF THE MIX WAS MIXED TOGETHER FOR THE FIRST TIME
= "1" IF THE HARDENED ORIGINAL MIX WAS CRUSHED AND REMIXED
   460. C
   470. C
   480. C
           XSTART = THE EXPERIMENTAL CORRECTION FACTOR TO THE X-VALUES;
   490. C
                     XSTART IS POSITIVE IF MOVING THE X-VALUES TO THE LEFT
   500. C
            MAX10 = (SEE DESCRIPTION BELOW)
   510. C
            XLAST = THE MAXIMUM X-VALUE OBTAINED DURING THE BEST FIT PLOTTING
                                  Y-VALUE
   520. C
              YMAX =
   530. C
              DASH = (SEE DESCRIPTION BELOW)
   540. C
                C_ = THE CONSTANT(S) OF THE BEST FIT EQUATION
   550. C
   560. C
               IT SHOULD BE NOTED HERE THAT LINES 1 TO M+1 ARE TO BE REPEATED
   570. C THE SAME NUMBER OF TIMES (UP TO A MAXIMUM OF SIX) AS THE NUMBER OF
   580. C CURVES THAT ARE TO BE PLOTTED ON EACH COMBINATION PLOT.
   590. C
   600. C
               ALSO, THE NUMBER AND THE CORRESPONDING CONSTANT(S) MUST MATCH
   610. C THOSE DEFINED FOR EACH CURVE DRAWN ON ANY COMBINATION PLOT.
   620. C IF MORE THAN ONE COMBINATION PLOT IS TO BE DRAWN, THEY MUST ALL BE
   630. C SIMILAR IN NATURE DUE TO THE DEFINED BEST FIT EQUATION(S) FOR
```

```
LIMECOMB "Computer Program No. 8"
   640. C EACH OF THE CURVE(S).
   650. C
                 TO SATISFY THE "DO" STATEMENT RULE OF ONLY USING INTEGERS
   660. C
   670. C GREATER THAN ZERO AND TO OBTAIN AN INCREMENT OF 0.1% STRAIN
   680. C (X-VALUES) WHEN PLOTTING THE BEST FIT CURVE, MAX10 IS
   690. C DEFINED AS FOLLOWS:
   700. C
   710. C
                       MAX10 = (MAX STRAIN(%) - XSTART + 0.1) * 10
   720. C
   730. C FROM THIS MODIFICATION TO THE MAXIMUM STRAIN VALUE, ONLY
   740. C THE INTEGER PART OF THE NUMBER IS PUT INTO THE DATA FILE,
   750. C IN ORDER TO SATISY THE INTEGER RULE OF A DO LOOP.
   760. C WHEN PLOTTING IT WILL BECOME CLOSE ENOUGH TO THE MAXIMUM 770. C STRAIN VALUE OBTAINED IN A MIX. THE LAST DATA POINT PLOTTED
   780. C DURING THE BEST FIT PLOTTING WILL BE OBTAINED WITH THE USE
   790. C OF XLAST.
   800. C
   810. C
                 FROM THE PROGRAM THIS MODIFICATION COMES FROM:
   820. C
   830. C
                        X_{(I)} = ((R_/10.0) - 0.1)
   840. C
                THE "-0.1" IS NEEDED SO THAT X IS EQUAL TO ZERO FOR THE
   850. C
   860. C FIRST VALUE. THIS WILL MAKE THE BEST FIT CURVE PASS THROUGH 870. C THE ORIGIN.
   880. C
   890. C
                MAX10 MUST BE DEFINED FOR EACH INDEPENDANT MIX.
   900. C AGAIN, IT MUST BE PUT INTO A DATA FILE AS AN
   910. C INTEGER, NOT A REAL NUMBER, TO SATISFY THE INTEGER
   920. C RULE OF A DO LOOP.
   930. C
                 A CHECK WILL BE DONE NEAR THE DEFINED FUNCTION SO AS TO
   940. C
   950. C PREVENT THE BEST FIT CURVE HAVING A NEGATIVE SLOPE AND A 960. C Y VALUE GREATER THAN THAT OBTAINED DURING THE BEST FIT PLOTTING.
   970. C THIS IS DONE WITH THE USE OF YMAX AS DEFINED ABOVE.
   980. C A NEGATIVE SLOPE IS UNFAVORABLE SINCE IT DOES NOT REPRESENT 990. C WHAT HAPPENED IN THE ACTUAL TESTS.
  1000. C
  1010. C
                 IF THE MIX DID NOT HAVE PEAK LOADS FOR ALL OF THE CUBES,
  1020. C A STRAIGHT DASHED LINE WILL BE DRAWN HORIZONTALLY FROM THE
  1030. C END OF THE BEST FIT CURVE TO THE FAR RIGHT OF THE PLOT.
  1040. C DASHED LINE WILL REPRESENT THAT LOADING WAS CONTINUED AFTER
  1050. C THIS CUT-OFF POINT, BUT NO PEAK LOAD OCCURRED. IT SHOULD SHOULD THOUGH THAT THE PATH OF THIS DASHED LINE DOES NOT
                                                                  IT SHOULD BE
  1070. C NECESSARILY REPRESENT THE ACTUAL PATH TAKEN DURING THE TEST OR
  1080. C OF THE BEST FIT CURVE.
  1090. C THIS DASHED LINE WILL NOT BE DRAWN WHEN THE VALUE OF 1100. C "DASH" IS EQUAL TO "0" (ZERO). WHEN "DASH" IS EQUAL TO
  1110. C "1" (ONE), A DASHED LINE WILL BE DRAWN.
  1120. C
  1130. C
                A LEGEND MAY BE INSERTED AT THE END OF EACH COMBINATION
  1140. C PLOT(S) BY INSERTING THE PROPER "CALL SYMBOL" STATEMENTS AT THE
  1150. C END OF THE OUTER DO LOOP.
  1160. C
  1170. C
                AT THE END OF THE DATA FILE(S), THE PROPER JCL MUST BE
  1180. C DEFINED IN ORDER FOR THE PROGRAM TO RUN.
  1190. C
  1200. C
                 DUE TO THE LIMITS ON THE DIMENSION STATEMENTS THE
  1210. C FOLLOWING LIMITS ARE DEFINED:
  1220. C
  1230. C
                            MAXIMUM ALLOWABLE NUMBER OF CONSTANT(S)
  1240. C
  1250. C
1260. C
                            PER PLOTTED CURVE IS 10
```

```
LIMECOMB "Computer Program No. 8"
  1270. C
                             X_(_
                                   _),Y_(
                              MAXIMUM ALLOWABLE NUMBER OF PLOTTING DATA POINTS
  1280. C
  1290. C
                              PER CURVE IS 502 - 2 = 500
  1300. C
  1310. C
  1320. C
  1330.
                DIMENSION IBUF (4000)
               EC(10), X1(502), Y1(502), X2(502), Y2(502), X3(502), Y3(502), 

£X4(502), Y4(502), X5(502), Y5(502), X6(502), Y6(502)
  1340.
  1350.
  1360.
                INTEGER DAY, REMIX
  1370. C
  1380. C
                  READ AND WRITE OUT THE NUMBER OF COMBINATION PLOT(S) AND THE
  1390. C
                  NUMBER OF CURVE(S) PER PLOT THAT ARE TO BE DRAWN
  1400. C
  1410.
                READ (5,*) NOCOMB, NOCURV
             WRITE (6,50) NOCOMB

50 FORMAT ('1',///,4x,'THE NUMBER OF COMBINATION PLOT(S) ', &'THAT ARE TO BE DRAWN IS',3x,13)
  1420.
  1430.
  1440.
             WRITE (6,60) NOCURV
60 FORMAT (///,4x,'THE NUMBER OF CURVE(S) TO BE DRAWN ON ',
  1450.
  1460.
  1470.
               &'EACH PLOT IS',3X,13)
  1480. C
  1490.
                DO 610 NC=1, NOCOMB
  1500.
                CALL PLOTS (IBUF, 4000)
  1510. C
  1520. C
                 DEFINE SOME CHARACTERISTICS OF THE PLOT
  1530. C
  1540.
                CALL PLOT (0.0,-11.0,-3)
                CALL PLOT (0.0,2.0625,-3)
  1550.
  1560.
                CALL FACTOR (1.0)
                CALL AXIS (0.0,0.0, 'STRAIN - %',-10,4.0,0.0,0.0,1.0)
CALL AXIS (0.0,0.0, 'STRESS - PSI',12,7.0,90.0,0.0,25.0)
  1570.
  1580.
  1590. C
  1600. C
                DRAW A RECTANGULAR FRAME AROUND THE PLOT
  1610. C
                CALL NEWPEN (4)
  1620.
  1630.
                CALL RECT (-0.75,-1.25,9.0,5.5,0.0,3)
  1640.
                CALL NEWPEN (1)
  1650. C
  1660.
                DO 590 NCURV=1, NOCURV
  1670. C
  1680. C
                READ AND WRITE OUT SOME BASIC INFORMATION ABOUT THE MIX
  1690. C
  1700.
                READ (5,*) MIXNO,M,DAY,REMIX,XSTART,MAX10,XLAST,YMAX,DASH
  1710. C
             WRITE (6,70) MIXNO,DAY 70 FORMAT ('1',////,4X,
  1720.
  1730.
  1740.
               &'THIS IS THE LIMECOMB PROGRAM INFORMATION FOR MIX NUMBER', 3X,
             &13,3X,'AT THE',3X,12,3X,'DAY STRENGTH')
WRITE (6,80) MIXNO,M
80 FORMAT (////,4X,'THE NUMBER OF CONSTANT(S)-M READ IN FOR ',
  1750.
  1760.
  1770.
               &'MIX NUMBER',3X,13,3X,'IS',3X,13,3X)
  1780.
  1790.
                IF (REMIX.EQ.1) GO TO 100
             WRITE (6,90)
90 FORMAT (////,4x,'THE FOLLOWING DATA IS FOR THE MIX
  1800.
  1810.
  1820.
               &'WHEN ITS COMPONENTS WERE COMBINED FOR THE FIRST TIME')
                GO TO 120
  1830.
            100 WRITE (6,110)
110 FORMAT (////,4x,'THE FOLLOWING DATA IS FOR WHEN THE ',
  1840.
  1850.
  1860.
               &'HARDENED ORIGINAL MIXTURE WAS CRUSHED AND REMIXED')
  1870.
            120 WRITE (6,130) XSTART
            130 FORMAT (/////,4x,'THE VALUE OF XSTART READ IN IS',
  1880.
  1890.
               &2X,F6.3)
```

```
LIMECOMB "Computer Program No. 8"
            WRITE (6,140) MIXNO,MAX10
140 FORMAT (////,4X,
  1900.
  1910.
                &'THE VALUE OF MAX10 THAT WAS READ IN FOR MIX NUMBER', 15,
  1920.
                &3X,'IS',3X,I4)
  1930.
            WRITE (6,150) XLAST

150 FORMAT (/////,4X,'THE HIGHEST STRAIN THAT WAS REACHED ', &'DURING THE BEST FIT PLOTTING IS',3X,F7.3,3X,'%')
  1940.
  1950.
  1960.
            WRITE (6,160) YMAX

160 FORMAT (////,4X,'THE HIGHEST STRESS THAT WAS REACHED ',
  1970.
  1980.
                &'DURING THE BEST FIT PLOTTING IS',3X,F6.1,3X,'PSI')
  1990.
  2000.
                 IF (DASH.EQ.0) GO TO 180
            WRITE (6,170)
170 FORMAT (////,4x,'DURING THE TESTING,'
  2010.
  2020.
  2030.
                &' THIS MIX DID NOT HAVE PEAK LOADS FOR ALL OF THE SPECIMENS.')
            GO TO 200
180 WRITE (6,190)
190 FORMAT (////,4X,'DURING THE TESTING,'
  2040.
  2050.
  2060.
  2070.
                &' THIS MIX HAD PEAK LOADS FOR ALL OF THE SPECIMENS.')
  2080. C
                  READ AND WRITE OUT THE CONSTANTS (C-VALUES)
  2090. C
  2100. C
  2110.
            200 READ (5,*) (C(I),I=1,M)
  2120. C
            WRITE (6,210) MIXNO,DAY
210 FORMAT ('1',/////,11X,'C VALUES',//,9X,'MIX NUMBER',
&1X,I2,//,8X,I2,1X,'DAY STRENGTH')
  2130.
  2140.
  2150.
  2160.
                 IF (REMIX.EQ.0) GO TO 230
            WRITE (6,220)

220 FORMAT (/,13X,'REMIX')

230 WRITE (6,240)

240 FORMAT (//,4X,'C()',15X,'VALUE',/)

WRITE (6,250) (I,C(I),I=1,M)

250 FORMAT('0',4X,I2,12X,F12.7)
  2170.
  2180.
  2190.
  2200.
  2210.
  2220.
  2230. C
  2240. C
                 CALCULATE THE BEST FIT CURVE PLOTTING POINTS - CURVE NO. 1
  2250. C
  2260.
                 IF (NCURV.NE.1) GO TO 340
  2270.
                 NSUM1 = 0
                 DO 260 I=1,MAX10
  2280.
  2290.
                 RI = I
  2300.
                 X1(I) = ((RI/10.0) - 0.1)
                 IF (X1(I).GE.XLAST) GO TO 270
  2310.
                 XTEMP = X1(I) + XSTART
  2320.
                 Y1(I) = (C(1)) + (C(2)*XTEMP) + (C(3)*(XTEMP**2)) +
  2330.
  2340.
                \&(C(4)*(XTEMP**3))
  2350.
                 IF (Y1(I).GT.YMAX) GO TO 270
                 NSUM1 = NSUM1 + 1
  2360.
  2370.
            260 CONTINUE
  2380.
            270 \times 1(NSUM1 + 1) = XLAST
  2390.
                 XLTEMP = XLAST + XSTART
  2400.
                 Y1(NSUM1 + 1) = (C(1)) + (C(2)*XLTEMP) + (C(3)*(XLTEMP**2)) +
                &(C(4)*(XLTEMP**3))
  2410.
  2420.
                 NSUM1 = NSUM1 + 1
  2430. C
  2440. C
                  LIST THE BEST FIT CURVE PLOTTING VALUES - CURVE NO. 1
  2450. C
            WRITE (6,280) MIXNO,DAY
280 FORMAT ('1',/////,24X,
&'BEST FIT CURVE PLOTTING VALUES',//,31X,'MIX NUMBER',15,
  2460.
  2470.
  2480.
  2490.
                £//,29X,12,3X,'DAY STRENGTH')
  2500.
                 IF (REMIX.EQ.0) GO TO 300
            WRITE (6,290)
290 FORMAT (/,35x,'REMIX')
  2510.
  2520.
```

```
LIMECOMB
           "Computer Program No. 8"
           300 WRITE (6,310)
310 FORMAT (//,4x,'PLOTTING NUMBER',10x,'X-VALUES (STRAIN-%)',
  2530.
  2540.
           &10X,'Y-VALUES (STRESS-PSI)',/)
WRITE (6,320) (I,X1(I),Y1(I),I=1,NSUM1)
320 FORMAT ('',9X,I3,21X,F8.3,22X,F7.1)
  2550.
  2560.
  2570.
  2580. C
  2590. C
               PLOT OUT THE BEST FIT CURVE - CURVE NO. 1
  2600. C
  2610.
               X1(NSUM1+1)=
                               0.0
  2620.
               Y1(NSUM1+1)=
                              0.0
  2630.
               X1(NSUM1+2)=
                               1.0
  2640.
               Y1(NSUM1+2) = 25.0
  2650. C
  2660.
               CALL NEWPEN(8)
               CALL FLINE (X1,Y1,-NSUM1,1,0,0)
IF (DASH.EQ.0) GO TO 330
  2670.
  2680.
 2690.
               XDASH = (X1(NSUM1)/1.0) + 0.12
               YDASH = Y1(NSUM1)/25.0
 2700.
               XEND = 4.0 - XDASH
 2710.
 2720.
               CALL PLOT (XDASH, YDASH, -3)
 2730.
               CALL DASHP (XEND, 0.0, 0.12)
               CALL PLOT (-XDASH,-YDASH,-3)
 2740.
 2750.
          330 CALL PLOT (0.0,0.0,3)
 2760.
               CALL NEWPEN(1)
 2770.
               GO TO 590
 2780. C
 2790. C
               CALCULATE THE BEST FIT CURVE PLOTTING POINTS - CURVE NO. 2
 2800. C
 2810.
          340 IF (NCURV.NE.2) GO TO 390
 2820.
               NSUM2 = 0
 2830.
               DO 350 J=1,MAX10
 2840.
               RJ=J
 2850.
               X2(J) = ((RJ/10.0) - 0.1)
 2860.
               IF (X2(J).GE.XLAST) GO TO 360
 2870.
               XTEMP = X2(J) + XSTART
 2880.
               Y2(J) = (C(1)) + (C(2)*XTEMP) + (C(3)*(XTEMP**2)) +
 2890.
              &(C(4)*(XTEMP**3))
 2900.
               IF (Y2(J).GT.YMAX) GO TO 360
 2910.
              NSUM2 = NSUM2 + 1
 2920.
          350 CONTINUE
 2930.
          360 \times 2(NSUM2 + 1) = XLAST
              XLTEMP = XLAST + XSTART
 2940.
 2950.
               Y2(NSUM2 + 1) = (C(1)) + (C(2)*XLTEMP) + (C(3)*(XLTEMP**2)) +
 2960.
              \&(C(4)*(XLTEMP**3))
 2970.
              NSUM2 = NSUM2 + 1
 2980. C
              LIST THE BEST FIT CURVE PLOTTING VALUES - CURVE NO. 2
 2990. C
 3000. C
 3010.
              WRITE (6,280) MIXNO, DAY
              IF (REMIX.EQ.0) GO TO 370
 3020.
              WRITE (6,290)
 3030.
 3040.
          370 WRITE (6,310)
 3050.
              WRITE (6,320) (J,X2(J),Y2(J),J=1,NSUM2)
 3060. C
              PLOT OUT THE BEST FIT CURVE - CURVE NO. 2
 3070. C
 3080. C
 3090.
              X2(NSUM2+1) =
                              0.0
 3100.
              Y2(NSUM2+1) =
                              0.0
 3110.
              X2(NSUM2+2) =
                             1.0
 3120.
              Y2(NSUM2+2) = 25.0
 3130. C
 3140.
              CALL NEWPEN(8)
 3150.
              CALL FLINE (X2, Y2, -NSUM2, 1, 0, 0)
```

```
LIMECOMB "Computer Program No. 8"
               IF (DASH.EQ.0) GO TO 380
  3160.
               XDASH = (X2(NSUM2)/1.0) + 0.12
  3170.
               YDASH = Y2(NSUM2)/25.0
  3180.
  3190.
               XEND = 4.0 - XDASH
               CALL PLOT (XDASH, YDASH, -3)
  3200.
               CALL DASHP (XEND, 0.0, 0.12)
  3210.
               CALL PLOT (-XDASH,-YDASH,-3)
  3220.
           380 CALL PLOT (0.0,0.0,3)
  3230.
               CALL NEWPEN(1)
  3240.
  3250.
               GO TO 590
  3260. C
  3270. C
               CALCULATE THE BEST FIT CURVE PLOTTING POINTS - CURVE NO. 3
  3280. C
  3290.
          390 IF (NCURV.NE.3) GO TO 440
  3300.
               NSUM3 = 0
  3310.
               DO 400 K=1,MAX10
  3320.
               RK=K
  3330.
               X3(K) = ((RK/10.0) - 0.1)
  3340.
               IF (X3(K).GE.XLAST) GO TO 410
  3350.
               XTEMP = X3(K) + XSTART
               Y3(K) = (C(1)) + (C(2)*XTEMP) + (C(3)*(XTEMP**2)) +
  3360.
  3370.
              &(C(4)*(XTEMP**3))
  3380.
               IF (Y3(K).GT.YMAX) GO TO 410
  3390.
               NSUM3 = NSUM3 + 1
  3400.
          400 CONTINUE
  3410.
          410 \times 3(NSUM3 + 1) = XLAST
               XLTEMP = XLAST + XSTART
  3420.
               Y3(NSUM3 + 1) = (C(1)) + (C(2)*XLTEMP) + (C(3)*(XLTEMP**2)) +
  3430.
              &(C(4)*(XLTEMP**3))
  3440.
  3450.
               NSUM3 = NSUM3 + 1
  3460. C
  3470. C
               LIST THE BEST FIT CURVE PLOTTING POINTS - CURVE NO. 3
  3480. C
  3490.
               WRITE (6,280) MIXNO, DAY
  3500.
               IF (REMIX.EQ.0) GO TO 420
          WRITE (6,290)
420 WRITE (6,310)
  3510.
  3520.
  3530.
               WRITE (6,320) (K,X3(K),Y3(K),K=1,NSUM3)
  3540. C
  3550. C
               PLOT OUT THE BEST FIT CURVE - CURVE NO. 3
  3560. C
  3570.
               X3(NSUM3+1) =
               Y3(NSUM3+1) =
  3580.
              Y3(NSUM3+1) = 0.0
X3(NSUM3+2) = 1.0
  3590.
               Y3(NSUM3+2) = 25.0
  3600.
  3610. C
  3620.
               CALL NEWPEN(8)
  3630.
               CALL FLINE (X3, Y3, -NSUM3, 1, 0, 0)
  3640.
              IF (DASH.EQ.0) GO TO 430
XDASH = (X3(NSUM3)/1.0) + 0.12
  3650.
               YDASH = Y3(NSUM3)/25.0
  3660.
  3670.
               XEND = 4.0 - XDASH
               CALL PLOT (XDASH, YDASH, -3)
  3680.
  3690.
               CALL DASHP (XEND, 0.0, 0.12)
  3700.
               CALL PLOT (-XDASH,-YDASH,-3)
          430 CALL PLOT (0.0,0.0,3)
  3710.
  3720.
               CALL NEWPEN(1)
  3730.
               GO TO 590
  3740. C
  3750. C
               CALCULATE THE BEST FIT CURVE PLOTTING POINTS - CURVE NO. 4
  3760. C
  3770.
          440 IF (NCURV.NE.4) GO TO 490
  3780.
              NSUM4 = 0
```

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LIMECOMB "Computer Program No. 8"
  3790.
               DO 450 L=1,MAX10
  3800.
               RL=L
  3810.
               X4(L) = ((RL/10.0) - 0.1)
  3820.
               IF (X4(L).GE.XLAST) GO TO 460
  3830.
               XTEMP = X4(L) + XSTART
               Y4(L) = (C(1)) + (C(2)*XTEMP) + (C(3)*(XTEMP**2)) +
  3840.
  3850.
              \&(C(4)*(XTEMP**3))
               IF (Y4(L).GT.YMAX) GO TO 460
  3860.
  3870.
               NSUM4 = NSUM4 + 1
  3880.
           450 CONTINUE
  3890.
           460 \times 4(NSUM4 + 1) = XLAST
  3900.
               XLTEMP = XLAST + XSTART
               Y4(NSUM4 + 1) = (C(1)) + (C(2)*XLTEMP) + (C(3)*(XLTEMP**2)) +
  3910.
  3920.
              &(C(4)*(XLTEMP**3))
  3930.
               NSUM4 = NSUM4 + 1
  3940. C
  3950. C
               LIST THE BEST FIT CURVE PLOTTING POINTS - CURVE NO. 4
  3960. C
  3970.
               WRITE (6,280) MIXNO, DAY
  3980.
               IF (REMIX.EQ.0) GO TO 470
          WRITE (6,290)
470 WRITE (6,310)
  3990.
  4000.
  4010.
               WRITE (6,320) (L,X4(L),Y4(L),L=1,NSUM4)
  4020. C
  4030. C
               PLOT OUT THE BEST FIT CURVE - CURVE NO. 4
  4040. C
  4050.
               X4(NSUM4+1) =
                              0.0
  4060.
               Y4(NSUM4+1)=
                              0.0
  4070.
               X4(NSUM4+2)=
                               1.0
  4080.
               Y4(NSUM4+2) = 25.0
 4090. C
 4100.
               CALL NEWPEN(8)
               CALL FLINE (X4,Y4,-NSUM4,1,0,0)
IF (DASH.EQ.0) GO TO 480
XDASH = (X4(NSUM4)/1.0) + 0.12
 4110.
 4120.
 4130.
               YDASH = Y4(NSUM4)/25.0
 4140.
               XEND = 4.0 - XDASH
 4150.
 4160.
               CALL PLOT (XDASH, YDASH, -3)
               CALL DASHP (XEND, 0.0, 0.12)
 4170.
          CALL PLOT (-XDASH,-YDASH,-3)
480 CALL PLOT (0.0,0.0,3)
 4180.
 4190.
 4200.
               CALL NEWPEN(1)
 4210.
               GO TO 590
 4220. C
 4230. C
               CALCULATE THE BEST FIT CURVE PLOTTING POINTS - CURVE NO. 5
 4240. C
 4250.
          490 IF (NCURV.NE.5) GO TO 540
 4260.
               NSUM5 = 0
               DO 500 MJ=1,MAX10
 4270.
 4280.
               RMJ=MJ
 4290.
               X5(MJ) = ((RMJ/10.0) - 0.1)
 4300.
               IF (X5(MJ).GE.XLAST) GO TO 510
               XTEMP = X5(MJ) + XSTART

Y5(MJ) = (C(1)) + (C(2)*XTEMP) + (C(3)*(XTEMP**2)) +
 4310.
 4320.
 4330.
              \&(C(4)*(XTEMP**3))
 4340.
               IF (Y5(MJ).GT.YMAX) GO TO 510
 4350.
               NSUM5 = NSUM5 + 1
 4360.
          500 CONTINUE
 4370.
          510 \times 5(NSUM5 + 1) = XLAST
 4380.
               XLTEMP = XLAST + XSTART
 4390.
               Y5(NSUM5 + 1) = (C(1)) + (C(2)*XLTEMP) + (C(3)*(XLTEMP**2)) +
 4400.
              \&(C(4)*(XLTEMP**3))
 4410.
              NSUM5 = NSUM5 + 1
```

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LIMECOMB "Computer Program No. 8"
  4420. C
  4430. C
              LIST THE BEST FIT CURVE PLOTTING POINTS - CURVE NO. 5
  4440. C
  4450.
              WRITE (6,280) MIXNO, DAY
  4460.
              IF (REMIX.EQ.0) GO TO 520
  4470.
              WRITE (6,290)
          520 WRITE (6,310)
  4480.
  4490.
              WRITE (6,320) (MJ,X5(MJ),Y5(MJ),MJ=1,NSUM5)
  4500. C
 4510. C
              PLOT OUT THE BEST FIT CURVE - CURVE NO. 5
  4520. C
  4530.
              X5(NSUM5+1)=
              Y5(NSUM5+1)=
 4540.
                            0.0
 4550.
              X5(NSUM5+2)=
 4560.
              Y5(NSUM5+2) = 25.0
 4570. C
 4580.
              CALL NEWPEN(8)
              CALL FLINE (X5,Y5,-NSUM5,1,0,0)
 4590.
 4600.
              IF (DASH.EQ.0) GO TO 530
              XDASH = (X5(NSUM5)/1.0) + 0.12
 4610.
 4620.
              YDASH = Y5(NSUM5)/25.0
              XEND = 4.0 - XDASH
 4630.
              CALL PLOT (XDASH, YDASH, -3)
CALL DASHP (XEND, 0.0, 0.12)
 4640.
 4650.
              CALL PLOT (-XDASH,-YDASH,-3)
 4660.
          530 CALL PLOT (0.0,0.0,3)
 4670.
 4680.
              CALL NEWPEN(1)
 4690.
              GO TO 590
 4700. C
 4710. C
              CALCULATE THE BEST FIT CURVE PLOTTING POINTS - CURVE NO. 6
 4720. C
 4730.
          540 IF (NCURV.NE.6) GO TO 590
 4740.
              NSUM6 = 0
              DO 550 NJ=1,MAX10
 4750.
 4760.
              RNJ=NJ
 4770.
              X6(NJ) = ((RNJ/10.0) - 0.1)
 4780.
              IF (X6(NJ).GE.XLAST) GO TO 560
 4790.
              XTEMP = X6(NJ) + XSTART
              Y6(NJ) = (C(1)) + (C(2)*XTEMP) + (C(3)*(XTEMP**2)) +
 4800.
 4810.
             &(C(4)*(XTEMP**3))
 4820.
              IF (Y6(NJ).GT.YMAX) GO TO 560
              NSUM6 = NSUM6 + 1
 4830.
 4840.
          550 CONTINUE
 4850.
          560 \times 6(NSUM6 + 1) = XLAST
              4860.
 4870.
 4880.
             &(C(4)*(XLTEMP**3))
 4890.
              NSUM6 = NSUM6 + 1
 4900. C
 4910. C
              LIST THE BEST FIT CURVE PLOTTING POINTS - CURVE NO. 6
 4920. C
 4930.
              WRITE (6,280) MIXNO, DAY
 4940.
              IF (REMIX.EQ.0) GO TO 570
 4950.
              WRITE (6,290)
          570 WRITE (6,310)
 4960.
 4970.
              WRITE (6,320) (NJ,X6(NJ),Y6(NJ),NJ=1,NSUM6)
 4980. C
 4990. C
              PLOT OUT THE BEST FIT CURVE - CURVE NO. 6
 5000. C
                            0.0
 5010.
              X6(NSUM6+1)=
             Y6(NSUM6+1) = 0.0
X6(NSUM6+2) = 1.0
 5020.
 5030.
              Y6(NSUM6+2) = 25.0
 5040.
```

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LIMECOMB "Computer Program No. 8"
    5050. C
                           CALL NEWPEN(8)
    5060.
                           CALL FLINE (X6, Y6, -NSUM6, 1, 0, 0)
    5070.
                           IF (DASH.EQ.0) GO TO 580
    5080.
   5090.
                           XDASH = (X6(NSUM6)/1.0) + 0.12
                           YDASH = Y6(NSUM6)/25.0
   5100.
                           XEND = 4.0 - XDASH
   5110.
                           CALL PLOT (XDASH, YDASH, -3)
   5120.
                           CALL DASHP (XEND, 0.0, 0.12)
   5130.
                           CALL PLOT (-XDASH, -YDASH, -3)
   5140.
                   580 CALL PLOT (0.0,0.0,3)
   5150.
   5160.
                           CALL NEWPEN(1)
   5170. C
   5180.
                   590 CONTINUE
   5190. C
   5200. C
                           DEVELOP A LEGEND FOR COMBINATION PLOT NO. 1
   5210. C
   5220.
                           IF (NC.NE.1) GO TO 591
                          CALL SYMBOL (1.76,6.86,0.14,'LIME:SAND MORTAR',0.0,16)
CALL SYMBOL (1.76,6.58,0.14,'LIME BRAND STUDY',0.0,16)
CALL SYMBOL (1.83,6.30,0.14,'LIME:SAND = 1:6',0.0,15)
CALL SYMBOL (2.32,6.09,0.07,'MIX NOS. 12 & 18',0.0,16)
CALL SYMBOL (2.39,5.95,0.07,'7-DAY STRENGTH',0.0,14)
   5230.
   5240.
   5250.
   5260.
   5270.
   5280.
                          GO TO 609
   5290. C
   5300. C
                          DEVELOP A LEGEND FOR COMBINATION PLOT NO. 2
   5310. C
                  591 IF (NC.NE.2) GO TO 592

CALL SYMBOL (1.76,6.86,0.14,'LIME:SAND MORTAR',0.0,16)

CALL SYMBOL (1.76,6.58,0.14,'LIME BRAND STUDY',0.0,16)

CALL SYMBOL (1.83,6.30,0.14,'LIME:SAND = 1:6',0.0,15)

CALL SYMBOL (2.32,6.09,0.07,'MIX NOS. 12 & 18',0.0,16)

CALL SYMBOL (2.355,5.95,0.07,'28-DAY STRENGTH',0.0,15)
   5320.
   5330.
   5340.
   5350.
   5360.
   5370.
   5380.
                          GO TO 609
   5390. C
   5400. C
                          DEVELOP A LEGEND FOR COMBINATION PLOT NO. 3
   5410. C
                  592 IF (NC.NE.3) GO TO 593

CALL SYMBOL (1.76,6.86,0.14,'LIME:SAND MORTAR',0.0,16)

CALL SYMBOL (1.76,6.58,0.14,'LIME BRAND STUDY',0.0,16)

CALL SYMBOL (1.83,6.30,0.14,'LIME:SAND = 1:5',0.0,15)

CALL SYMBOL (2.32,6.09,0.07,'MIX NOS. 13 & 19',0.0,16)

CALL SYMBOL (2.39,5.95,0.07,'7-DAY STRENGTH',0.0,14)
   5420.
   5430.
   5440.
   5450.
   5460.
   5470.
   5480.
                          GO TO 609
   5490. C
   5500. C
                          DEVELOP A LEGEND FOR COMBINATION PLOT NO. 4
   5510. C
   5520.
                   593 IF (NC.NE.4) GO TO 594
                          CALL SYMBOL (1.76,6.86,0.14,'LIME:SAND MORTAR',0.0,16)
CALL SYMBOL (1.76,6.58,0.14,'LIME BRAND STUDY',0.0,16)
CALL SYMBOL (1.83,6.30,0.14,'LIME:SAND = 1:5',0.0,15)
CALL SYMBOL (2.32,6.09,0.07,'MIX NOS. 13 & 19',0.0,16)
CALL SYMBOL (2.355,5.95,0.07,'28-DAY STRENGTH',0.0,15)
   5530.
   5540.
   5550.
   5560.
   5570.
   5580.
                          GO TO 609
   5590. C
   5600. C
                          DEVELOP A LEGEND FOR COMBINATION PLOT NO. 5
   5610. C
   5620.
                   594 IF (NC.NE.5) GO TO 595
                          CALL SYMBOL (1.69,6.86,0.14,'LIME:SAND MORTAR',0.0,16)
CALL SYMBOL (1.69,6.58,0.14,'LIME BRAND STUDY',0.0,16)
CALL SYMBOL (1.62,6.30,0.14,'LIME:SAND = 1:4.5',0.0,17)
CALL SYMBOL (2.25,6.09,0.07,'MIX NOS. 14 & 20',0.0,16)
CALL SYMBOL (2.32,5.95,0.07,'7-DAY STRENGTH',0.0,14)
   5630.
   5640.
   5650.
   5660.
   5670.
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"Computer Program No. 8"
LIMECOMB
                              GO TO 609
    5680.
    5690. C
    5700. C
                              DEVELOP A LEGEND FOR COMBINATION PLOT NO. 6
    5710. C
    5720.
                      595 IF (NC.NE.6) GO TO 596
                             CALL SYMBOL (1.69,6.86,0.14,'LIME:SAND MORTAR',0.0,16)
CALL SYMBOL (1.69,6.58,0.14,'LIME BRAND STUDY',0.0,16)
CALL SYMBOL (1.62,6.30,0.14,'LIME:SAND = 1:4.5',0.0,17
CALL SYMBOL (2.25,6.09,0.07,'MIX NOS. 14 & 20',0.0,16)
CALL SYMBOL (2.285,5.95,0.07,'28-DAY STRENGTH',0.0,15)
    5730.
    5740.
    5750.
                                                                                                                                     ,0.0,17)
    5760.
    5770.
    5780.
                              GO TO 609
    5790. C
                              DEVELOP A LEGEND FOR COMBINATION PLOT NO. 7
    5800. C
    5810. C
                     596 IF (NC.NE.7) GO TO 597
    5820.
                              CALL SYMBOL (1.62,6.86,0.14,'LIME:SAND MORTAR',0.0,16)
CALL SYMBOL (1.62,6.58,0.14,'LIME BRAND STUDY',0.0,16)
CALL SYMBOL (1.48,6.30,0.14,'LIME:SAND = 1:3.65',0.0,18)
CALL SYMBOL (2.18,6.09,0.07,'MIX NOS. 15 & 21',0.0,16)
CALL SYMBOL (2.32,5.95,0.07,'7-DAY STRENGTH',0.0,14)
    5830.
    5840.
    5850.
    5860.
    5870.
                              GO TO 609
    5880.
    5890. C
    5900. C
                              DEVELOP A LEGEND FOR COMBINATION PLOT NO. 8
    5910. C
                      597 IF (NC.NE.8) GO TO 598
    5920.
                             CALL SYMBOL (1.62,6.86,0.14,'LIME:SAND MORTAR',0.0,16)
CALL SYMBOL (1.62,6.58,0.14,'LIME BRAND STUDY',0.0,16)
CALL SYMBOL (1.48,6.30,0.14,'LIME:SAND = 1:3.65',0.0,18)
CALL SYMBOL (2.18,6.09,0.07,'MIX NOS. 15 & 21',0.0,16)
CALL SYMBOL (2.215,5.95,0.07,'28-DAY STRENGTH',0.0,15)
    5930.
    5940.
    5950.
    5960.
    5970.
    5980.
                              GO TO 609
    5990. C
                              DEVELOP A LEGEND FOR COMBINATION PLOT NO. 9
    6000. C
    6010. C
                     598 IF (NC.NE.9) GO TO 599

CALL SYMBOL (1.76,6.86,0.14,'LIME:SAND MORTAR',0.0,16)

CALL SYMBOL (1.76,6.58,0.14,'LIME BRAND STUDY',0.0,16)

CALL SYMBOL (1.83,6.30,0.14,'LIME:SAND = 1:3',0.0,15)

CALL SYMBOL (2.32,6.09,0.07,'MIX NOS. 16 & 22',0.0,16)

CALL SYMBOL (2.39,5.95,0.07,'7-DAY STRENGTH',0.0,14)
    6020.
    6030.
    6040.
    6050.
    6060.
    6070.
    6080.
    6090. C
    6100. C
                              DEVELOP A LEGEND FOR COMBINATION PLOT NO. 10
    6110. C
                     599 IF (NC.NE.10) GO TO 600
    6120.
                              CALL SYMBOL (1.76,6.86,0.14,'LIME:SAND MORTAR',0.0,16)
CALL SYMBOL (1.76,6.58,0.14,'LIME BRAND STUDY',0.0,16)
CALL SYMBOL (1.83,6.30,0.14,'LIME:SAND = 1:3',0.0,15)
CALL SYMBOL (2.32,6.09,0.07,'MIX NOS. 16 & 22',0.0,16)
CALL SYMBOL (2.355,5.95,0.07,'28-DAY STRENGTH',0.0,15)
    6130.
    6140.
    6150.
    6160.
    6170.
    6180.
                              GO TO 609
    6190. C
                              DEVELOP A LEGEND FOR COMBINATION PLOT NO. 11
    6200. C
    6210. C
                     600 IF (NC.NE.11) GO TO 601

CALL SYMBOL (1.76,6.86,0.14,'LIME:SAND MORTAR',0.0,16)

CALL SYMBOL (1.76,6.58,0.14,'LIME BRAND STUDY',0.0,16)

CALL SYMBOL (1.83,6.30,0.14,'LIME:SAND = 1:2',0.0,15)

CALL SYMBOL (2.32,6.09,0.07,'MIX NOS. 17 & 23',0.0,16)

CALL SYMBOL (2.39,5.95,0.07,'7-DAY STRENGTH',0.0,14)
    6220.
    6230.
    6240.
    6250.
    6260.
    6270.
    6280.
                              GO TO 609
    6290. C
                              DEVELOP A LEGEND FOR COMBINATION PLOT NO. 12
    6300. C
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LIMECOMB "Computer Program No. 8"
    6310. C
                     601 IF (NC.NE.12) GO TO 602
    6320.
                             CALL SYMBOL (1.76,6.86,0.14,'LIME:SAND MORTAR',0.0,16)
CALL SYMBOL (1.76,6.58,0.14,'LIME BRAND STUDY',0.0,16)
CALL SYMBOL (1.83,6.30,0.14,'LIME:SAND = 1:2',0.0,15)
CALL SYMBOL (2.32,6.09,0.07,'MIX NOS. 17 & 23',0.0,16)
CALL SYMBOL (2.355,5.95,0.07,'28-DAY STRENGTH',0.0,15)
    6330.
    6340.
    6350.
    6360.
    6370.
    6380.
                             GO TO 609
    6390. C
                             DEVELOP A LEGEND FOR COMBINATION PLOT NO. 13
    6400. C
    6410. C
    6420.
                     602 IF (NC.NE.13) GO TO 603
                             CALL SYMBOL (1.76,6.86,0.14,'LIME:SAND MORTAR',0.0,16)
CALL SYMBOL (1.76,6.58,0.14,'LIME BRAND STUDY',0.0,16)
CALL SYMBOL (1.83,6.30,0.14,'LIME:SAND = 1:2',0.0,15)
CALL SYMBOL (2.32,6.09,0.07,'MIX NOS. 17 & 23',0.0,16)
CALL SYMBOL (2.705,5.95,0.07,'REMIX',0.0,5)
CALL SYMBOL (2.39,5.81,0.07,'7-DAY STRENGTH',0.0,14)
    6430.
    6440.
    6450.
    6460.
    6470.
    6480.
   6490.
                             GO TO 609
   6500. C
   6510. C
                             DEVELOP A LEGEND FOR COMBINATION PLOT NO. 14
   6520. C
                     603 IF (NC.NE.14) GO TO 604
   6530.
                             CALL SYMBOL (1.76,6.86,0.14,'LIME:SAND MORTAR',0.0,16)
CALL SYMBOL (1.76,6.58,0.14,'LIME BRAND STUDY',0.0,16)
CALL SYMBOL (1.83,6.30,0.14,'LIME:SAND = 1:2',0.0,15)
CALL SYMBOL (2.32,6.09,0.07,'MIX NOS. 17 & 23',0.0,16)
CALL SYMBOL (2.705,5.95,0.07,'REMIX',0.0,5)
CALL SYMBOL (2.355,5.81,0.07,'28-DAY STRENGTH',0.0,15)
   6540.
   6550.
   6560.
   6570.
   6580.
   6590.
   6600.
                             GO TO 609
   6610. C
   6620. C
                             DEVELOP A LEGEND FOR COMBINATION PLOT NO. 15
   6630. C
   6640.
                     604 IF (NC.NE.15) GO TO 609
                            CALL SYMBOL (1.76,6.86,0.14,'LIME:SAND MORTAR',0.0,16)
CALL SYMBOL (1.76,6.58,0.14,'LIME BRAND STUDY',0.0,16)
CALL SYMBOL (1.83,6.30,0.14,'LIME:SAND = 1:6',0.0,15)
CALL SYMBOL (2.32,6.09,0.07,'MIX NOS. 12 & 18',0.0,16)
CALL SYMBOL (2.39,5.95,0.07,'7-DAY STRENGTH',0.0,14)
   6650.
   6660.
   6670.
   6680.
   6690.
   6700. C
   6710.
                    609 CALL PLOT (12.0,0.0,999)
   6720.
                    610 CONTINUE
   6730.
                             CALL PLOT (0.0,0.0,9999)
   6740.
                             STOP
   6750.
                             END
```

G.9 COMPUTER PROGRAM NO. 9 [25, 27]

Computer Program No. 9 was used only for the lime-sand mortar mixes. This program plots the maximum compressive stress, as defined by the best-fit curve using Computer Program No. 7, versus the lime-sand ratio of the mix. More details of this program are included in the program itself.

```
RATIOPLOT "Computer Program No. 9"
    10. //FMREMIXB JOB ',,,T=1M,L=5,I=10,C=0','RANDY ZAPOTOTSKY',CLASS=F, 20. // MSGLEVEL=(1,1)
    30. /*ROUTE PRINT SELF
    40. /*D800 VPLOT
    50. // EXEC FORTHCLG, USERLIB='SYS3. VPLOTLIB', SIZE=256K
    60. //FORT.SYSIN DD *
    70. C
    80. C
    90. C
   100. C
                                      --- RATIOPLOT ---
   110. C
   120. C
               --- THIS IS THE PROGRAM FOR STRENGTH VS RATIO PLOTTING ---
   130. C
   140. C
   150. C
               IN THIS PROGRAM THE FIRST THING THAT IS READ IN IS THE
   160. C
   170. C NUMBER OF PLOTS TO BE DRAWN. THE CHARACTERISTICS, NAMELY
   180. C THE ORGIN AND AXES, ARE THEN DEFINED AND PLOTTED OUT.
   190. C FOR AESTHETICS PURPOSES ONLY, A FRAME IS THEN DRAWN AROUND
   200. C THIS SET OF AXES.
   210. C
   220. C
               FOLLOWING THE ABOVE, THE DATA POINTS ARE THEN READ IN.
   230. C PLOTTED OUT WITHIN THE LIMITS OF THE CHARACTERISTICS OF THE
   240. C PLOT AND THEN A SMOOTH LINE JOINS EACH SET OF POINTS.
   250. C FOR EACH PLOT TWO SETS OF CURVES ARE SET OUT TO BE PLOTTED.
260. C ERRATIC DATA POINTS NOT INCLUDED IN THE CURVE ARE PLOTTED OUT
   270. C AT THE END OF THE PROGRAM.
   280. C
   290. C
               IN THE END, A LEGEND MAY BE INSERTED.
   300. C
   310. C
               WHEN SUBMITTING A JOB, THE ORDER OF SUBMISSION IS:
   320. C
   330. C
                         RATIOPLOT
   340. C
                     2)
                         NOPLOT
                     3)
                          "FIRST DATA FILE"
   350. C
   360. C
                         "SECOND DATA FILE"
   370. C
                         "THIRD DATA FILE"
                    5)
   380. C
   390. C
                         "N-2TH DATA FILE (LAST ONE)"
   400. C
                    N)
   410. C
   420. C
               WHERE:
   430. C
   440. C
                       RATIOPLOT: IS THE NAME OF THIS PLOTTING PROGRAM.
   450. C
   460. C
                          NOPLOT:
                                    CONTAINS THE FIRST JCL STATEMENT AND
   470. C
                                    SPECIFIES THE NUMBER OF PLOTS TO BE
                                    PLOTTED. THE FORM OF THIS FILE IS:
   480. C
   490. C
                                    1. //GO.SYSIN.DD *
2. "NUMBER OF PLOTS"
   500. C
   510. C
   520. C
   530. C
                       DATA FILE:
                                    THE FIRST OR ANY OTHER DATA FILE
                                    CONTAINS SOME BASIC INFORMATION ABOUT THE PLOT AND ITS DATA POINTS. THE
   540. C
   550. C
   560. C
                                    FORM OF A DATA FILE IS:
   570. C
   580. C
                                    1. N1
                                                 N2
   590. C
                                    2. X1
                                                ¥1
   600. C
                                    3. X2
                                                 Y2
   610. C
  620. C
  630. C
                                    N. X(N-1) Y(N-1)
```

```
RATIOPLOT "Computer Program No. 9"
   640. C
   650. C
                           WHERE:
                                        N1 = THE NUMBER OF DATA POINTS TO DEFINE
   660. C
                                             CURVE NUMBER 1
   670. C
   680. C
                                        N2 = THE NUMBER OF DATA POINTS TO DEFINE
   690. C
                                             CURVE NUMBER 2
   700. C
   710, C
                                    X&Y'S = THE DATA POINTS.
   720. C
   730. C
               ALSO, WHEN SUBMITTING A JOB, ONE MUST MAKE SURE THAT THE
   740. C
   750. C JCL ENDING THE DATA INFORMATION MUST BE PLACED AT THE CORRECT
   760. C POSITION. IF ONLY ONE PLOT IS TO BE PLOTTED, IT GOES AT THE
   770. C END OF THE FIRST DATA FILE.
                                          IN THE CASE WHERE MORE THAN TWO
   780. C PLOTS WILL BE DRAWN, THE JCL MUST BE PUT AT THE END OF THE
   790. C LAST DATA FILE.
   800. C
               DEPENDING ON THE NUMBER AND TYPE OF PLOTS TO BE DONE, THE
   810. C
   820. C "DEVELOP A LEGEND" PART OF THE PROGRAM MUST BE MODIFIED
   830. C ACCORDINGLY, IF USED.
   840. C
   850. C
               LIMITATIONS OF THE DIMENSION STATEMENTS ARE AS FOLLOWS:
   860. C
   870. C
                        RATIO_(__),STRES_(
   880. C
                         MAXIMUM ALLOWABLE NUMBER OF DATA POINTS PER CUBE
   890. C
                         READ IN IS 52 - 2 = 50
   900. c
   910. C
   920. C
   930.
               DIMENSION IBUF (4000), RATIO1(52), STRES1(52), RATIO2(52),
   940.
              &STRES2(52)
   950. C
               READ AND WRITE OUT THE NUMBER OF PLOTS TO BE DRAWN
   960. C
   970. C
               READ (5,*) NOPLOT
   980.
            WRITE (6,10) NOPLOT

10 FORMAT ('1',/////,4x,'THE NUMBER OF PLOTS THAT ', &'ARE TO BE DRAWN IS',3x,13)
   990.
  1000.
  1010.
  1020.
               DO 70 NP=1,NOPLOT
  1030.
               CALL PLOTS (IBUF, 4000)
  1040. C
  1050. C
               DEFINE SOME CHARACTERISTICS OF THE PLOT.
  1060. C
               CALL PLOT (0.0,-11.0,-3)
CALL PLOT (0.0,3.50,-3)
  1070.
  1080.
  1090.
               CALL FACTOR (1.0)
               CALL AXIS (0.0,0.0, 'LIME: SAND RATIO - 1:X',-21,7.0,0.0,0.0,1.0)
CALL AXIS (0.0,0.0, 'MORTAR STRENGTH - PSI',21,4.0,90.0,0.0,50.0)
  1100.
  1110.
  1120. C
  1130. C
                ---- DRAW A RECTANGULAR FRAME AROUND THE PLOT -----
  1140. C
  1150.
               CALL NEWPEN (4)
               CALL RECT (-1.0,-1.25,6.0,9.0,0.0,3)
  1160.
               CALL NEWPEN (1)
  1170.
  1180. C
  1190. C
               WRITE OUT THE PLOT NUMBER
  1200. C
            WRITE (6,20) NP 20 FORMAT ('1',/////,4x,'THE FOLLOWING INFORMATION IS FOR ',
  1210.
  1220.
  1230.
              &'PLOT NUMBER',3X,15)
  1240. C
  1250. C
               READ AND WRITE OUT THE NUMBER OF DATA POINTS FOR EACH CURVE.
  1260. C
```

```
RATIOPLOT "Computer Program No. 9"
                 READ (5,*) N1,N2
  1270.
             WRITE (6,30) N1,N2

30 FORMAT (/////,4X,'THE NUMBER OF DATA POINTS READ IN FOR ', &'CURVE NO. 1 IS:',3X,I5,//,42X,'CURVE NO. 2 IS:',3X,I5)
  1280.
  1290.
  1300.
  1310. C
  1320. C
                 READ AND WRITE OUT THE DATA POINTS FOR THE MIX.
  1330. C
  1340.
                 READ (5,\star) (RATIO1(I), STRES1(I), I=1,N1)
                 READ (5,*) (RATIO2(J), STRES2(J), J=1,N2)
  1350.
  1360. C
              WRITE (6,40) NP
40 FORMAT ('1',/////,32x,'DATA POINTS',//,30x,
  1370.
  1380.
                &'PLOT NUMBER', 15)
  1390.
             % PLOT NUMBER ,157
WRITE(6,50)
50 FORMAT(//,4X,'DATA NUMBER',10X,'X-VALUES (RATIO)',10X,
&'Y-VALUES (STRENGTH-PSI)',/)
WRITE (6,60) (I,RATIO1(I),STRES1(I),I=1,N1)
WRITE (6,60) (J,RATIO2(J),STRES2(J),J=1,N2)
60 FORMAT (' ',7X,I3,15X,F10.3,19X,F10.1)
  1400.
  1410.
  1420.
  1430.
  1440.
  1450.
  1460. C
  1470. C
                 PLOT OUT THE DATA POINTS.
  1480. C
  1490.
                 RATIO1 (N1+1) =
                                      0.0
  1500.
                 STRES1 (N1+1) = 0.0
  1510.
                 RATIO1 (N1+2) = 1.0
  1520.
                 STRES1 (N1+2) = 50.0
  1530. C
  1540.
                 RATIO2 (N2+1) =
                                      0.0
                 STRES2 (N2+1)=
  1550.
                                      0.0
                 RATIO2 (N2+2) = 1.0
  1560.
                 STRES2 (N2+2) = 50.0
  1570.
  1580. C
                 CALL LINE (RATIO1, STRES1, N1, 1, -1, 0)
  1590.
  1600.
                 CALL LINE (RATIO2, STRES2, N2, 1, -1, 2)
  1610. C
  1620. C
                 JOIN THE POINTS WITH A SMOOTH LINE.
  1630. C
                 XBEG1 = RATIO1(1)/1.0
  1640.
                 YBEG1 = STRES1(1)/50.0
  1650.
  1660.
                 CALL NEWPEN (4)
                 CALL PLOT (XBEG1, YBEG1, 3)
CALL FLINE (RATIO1, STRES1, -N1, 1, 0, 0)
  1670.
  1680.
  1690.
                 CALL NEWPEN (1)
  1700. C
                 XBEG2 = RATIO2(1)/1.0
  1710.
  1720.
                 YBEG2 = STRES2(1)/50.0
                 CALL NEWPEN (4)
  1730.
  1740.
                 CALL PLOT (XBEG2, YBEG2, 3)
                 CALL FLINE (RATIO2, STRES2, -N2,1,0,2)
  1750.
  1760.
                 CALL NEWPEN (1)
  1770. C
  1780. C
                 THE FOLLOWING RECORDS WILL PLOT OUT ERRATIC DATA POINTS.
  1790. C
  1800.
                 CALL SYMBOL (3.65,1.866,0.08,2,0.0,-1)
  1810. C
  1820. C
                  ----- DEVELOP A LEGEND -----
  1830. C
  1840. C
                 PUT MAJOR AND MINOR INFORMATION INTO THE LEGEND.
  1850. C
                 CALL SYMBOL (2.52,3.86,0.14,'LEGEND',0.0,6)
CALL SYMBOL (2.80,3.58,0.14,'= LIME BRAND B REMIX AT 7-DAY',
  1860.
  1870.
  1880.
                £0.0,30)
  1890.
                 CALL SYMBOL (2.80,3.30,0.14.'= LIME BRAND B REMIX AT 28-DAY',
```

```
RATIOPLOT "Computer Program No. 9"
                 &0.0,30)
  1900.
  1910. C
  1920. C THE FOLLOWING RECORDS WILL PLACE THE SYMBOLS USED FOR 1930. C PLOTTING THE DATA POINTS INTO THE LEGEND. ONE SYMBOL WILL BE
  1940. C USED FOR EACH DIFFERENT LIME BRAND.
  1950. C
                  CALL SYMBOL (2.59,3.65,0.14,0,0.0,-1)
CALL SYMBOL (2.59,3.37,0.14,2,0.0,-1)
  1960.
  1970.
  1980. C
  1990.
              CALL PLOT (12.0,0.0,999)
70 CONTINUE
  2000.
                  CALL PLOT (0.0,0.0,9999)
  2010.
                  STOP
  2020.
  2030.
                  END
```

Appendix H

TESTING-DATA FOR CLAY MORTAR MIXES

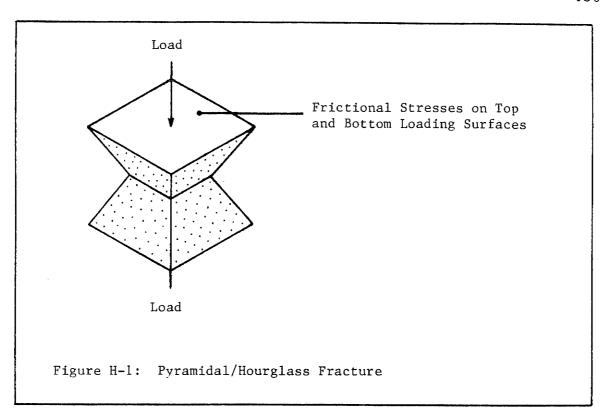
Testing-data for each clay mortar mix consisted of three parts: 1) pre-sanding data, 2) compression testing data, and 3) post-testing data. Detailed first and fully in this appendix is the Pre-Sanding and Post-Testing Data. Tabulated at the end of this appendix is the Compression Testing Information, which is only part of the compression testing data. The remaining compression testing data results (stress-strain data) are presented in Chapter IV, Subsection 4.1.3, Plots. In Chapter IV, the stress-strain data points are plotted to scale on computer plots.

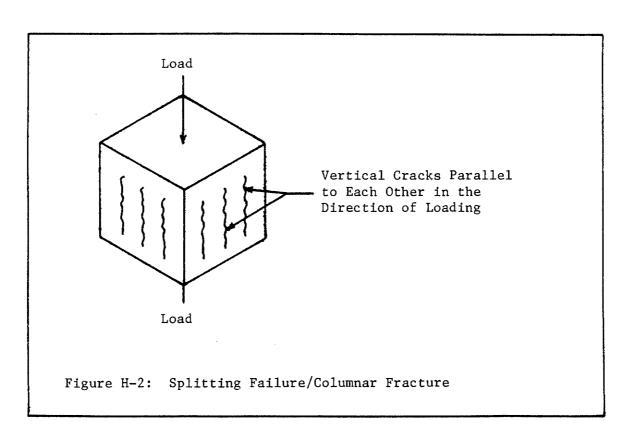
Classified as the Pre-Sanding Data are the notes taken on the specimens prior to sanding in preparation for the compression test. Notes on the specimens included the colour, shape, surface texture, cracks, density (for Mix Nos. 7 to 11 only) plus other assorted features.

Termed the Post-Testing Data are the notes taken on the specimens after the compression test. This included the mode of fracture/failure, the angle of rupture and general notes.

Two types of mode of failure were noted throughout the compression testing of the clay mortar mixes -- 1) pyramidal/hourglass fracture, and 2) splitting failure/columnar fracture. A sketch of a typical pyramidal fracture and splitting failure are shown respectively in Figures H-1 and H-2. Photographs H-1 and H-2, respectively show occurrence of a pyramidal fracture and splitting failure; in these photographs, the sample pyramidal fracture took place with lime-sand mortar Mix No. 17 at the 28-day age and the sample splitting failure took place with clay mortar Mix No. 2 at the 28-day age. These two respective photographs also show the general shape of the clay and lime-sand mortar specimens after testing; in the case of the clay mortar mixes, this applied only to those specimens which had a peak failure load.

Both of the above modes of failure are essentially a shear failure due to lateral tension. For the pyramidal fracture, the friction between the loaded surfaces of the specimen and the machine platens hold the material next to the loaded surfaces together, while the lateral tension shear off the free sides (see Figure H-1). If the above stated friction is eliminated or reduced, the lateral tension is able to act more evenly over the full length of the specimen. With this type of action, cracks form vertically and parallel to each other in the direction of loading, which is a characteristic of a splitting failure (see Figure



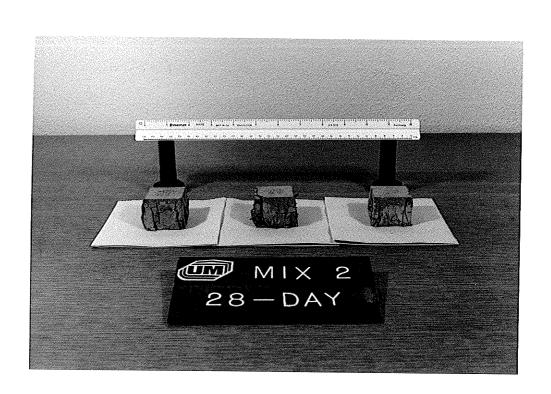




Photograph H-1: Lime-Sand Mortar Original Mix No. 17 Tested Specimens (28-Day)

H-2). Splitting failure tends to occur for brittle materials with high compressive strength and for short specimens.

Noted along with the mode of failure was the angle of rupture (θ) . Figure H-3 shows the measurement of this angle. If $\theta=45^{\circ}$, the failure is due only to the cohesion of the material. In the case where θ is greater than 45° , the failure is due to internal friction as well as cohesion of the material. The angle of rupture is expressed as follows:



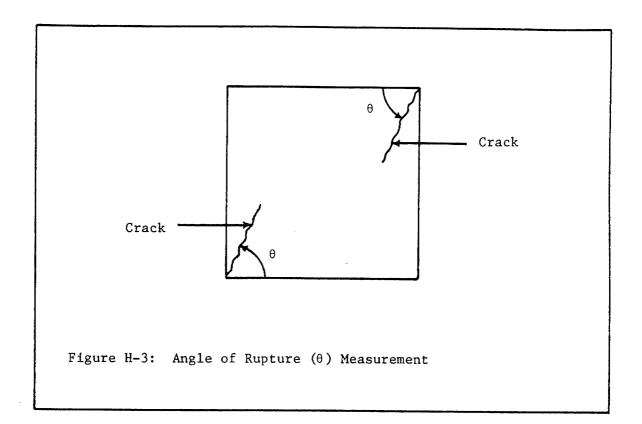
Photograph H-2: Clay Mortar Mix No. 2 Tested Specimens (28-Day)

 $\theta = 45 + \phi/2$

where ϕ = the angle of internal friction.

Both θ and φ assume homogeneity of the material and that the material follows the Mohr theory of rupture.

In this appendix and investigation in general, when a list of numbers in a table has an index such as "x 0.001", it means to take the numbers listed and to apply that index to those numbers. It does not mean that the index was previously applied to the listed numbers. This system of tabulation was used to be consistent with the computer plotting.



H.1 MIX NO. 1

H.1.1 Pre-Sanding Data

Colour: dark greyish-brown

Shape: top - concave

sides - concave, corners at the top and

bottom point out noticeably

bottom - convex

- see Figure H-4 for a sketch of the shape

Surface Texture: top - smooth to rough

sides - " " "

bottom - rough with bumps

Cracks: - mostly hairline cracks measuring up to 3/8 inch in length

- separation crack occurred on one bottom corner of each specimen having an approximate length of one inch and a maximum width of 0.035 inch

Other Features: - the bottom separation crack/corner crack

chip which occurred for each specimen

was unique among all of the clay mortar

mixes (Photograph H-3)

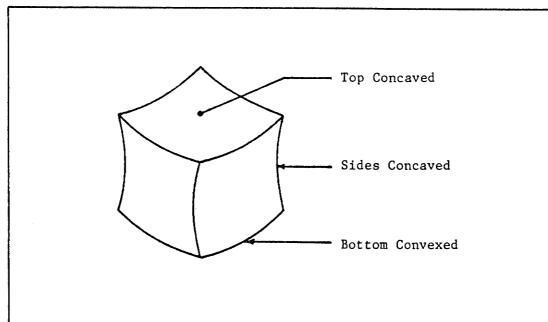


Figure H-4: Shape of Clay Mortar Mix No. 1 Specimens Before Sanding



Photograph H-3: Bottom Separation Crack/Corner Chip Characteristic of the Specimens of Clay Mortar Mix No. 1 Upon Drying

H.1.2 Post-Testing Data

Mode of Failure: - splitting failure with a sign of pyramidal fracture

Angle of Rupture -- θ : - 90°, for the splitting failure cracks

- 80°, for the pyramidal fracture cracks

General Notes: - top loading surface showed

evidence of being restrained by

the loading platen

 splitting failure occurred along the top perimeter on the sides

H.2 MIX NO. 2

H.2.1 Pre-Sanding Data

Colour: grey

Shape: top - concave

sides - concave but to a lesser degree than Mix No. 1

 top and bottom corners point out slightly

bottom - convex

Surface Texture: top - a thin powdery and crumbly material existed on the top with a smooth to rough surface beneath

sides - smooth to rough with odd bumps

bottom - rough with bumps

Cracks: - hairline cracks

- larger cracks with length up to 5/8 inch and a maximum width of 0.035 inch

Other Features: - most of the cracks were on the bottom of the specimens and near the bottom on the sides; none existed on the top

H.2.2 Post-Testing Data

Mode of Failure: splitting failure

Angle of Rupture -- θ: 90°

General Notes: - specimens had a crushed appearance

- sides at mid-height slightly bowed

out

 top loading surface showed evidence of being restrained by the loading platen

H.3 MIX NO. 3

H.3.1 Pre-Sanding Data

Colour: grey

Shape: top - concave

sides - fairly vertical

- the concave shape that existed in Mix Nos. 1 and 2 did not exist, especially with respect to Mix

No. 1

bottom - convex

Surface Texture: - same notes as for Mix No. 2

Cracks: - same notes as for Mix No. 2

Other Features: - same notes as for Mix No. 2

H.3.2 Post-Testing Data

- same notes as for Mix No. 2

H.4 MIX NO. 4

H.4.1 Pre-Sanding Data

- same notes as for Mix No. 2 except the larger cracks have lengths up to 7/8 inch and a maximum width of 0.065 inch

H.4.2 Post-Testing Data

- same notes as for Mix No. 2

H.5 MIX NO. 5^A (AIR-DRY)

H.5.1 Pre-Sanding Data

- same notes as for Mix No. 4, except the larger cracks have a maximum width of 0.075 inch and that the density of cracks, especially on the bottom, had decreased

H.5.2 Post-Testing Data

Mode of Failure: - splitting failure

 Specimen No. 3 showed a slight pyramidal type of fracture

Angle of Rupture -- θ : - 90°, for the splitting failure cracks

- 60°, for pyramidal fracture crack on one side of Specimen No. 3

General Notes: - same notes as for Mix No. 2 but

less bowing out of the sides

H.6 MIX NO. 5^B (MOIST-CURED)

H.6.1 Pre-Sanding Data

Colour: grey

Shape: top - concave, but to a lesser degree than Mix Nos. 1 to 5^{A}

sides - same notes as for Mix No. 3

bottom - mostly even

Surface Texture: top - fairly smooth with slight bumps

sides - smooth to rough with odd bumps

- powdery

bottom - fairly smooth with odd bumps

- powdery

Cracks: - same notes as for Mix No. 2 except the larger cracks have lengths up to 3/4 inch and a maximum width of 0.080 inch

Other Features: - cracks were evenly distributed on the specimens

- While sanding the moist-cured specimens of Mix No. 5, the original top surface developed a cellular appearance as shown in Figure H-5 and Photograph H-4. Although it looked broken up, the specimens were in fact still intact.

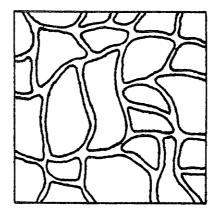
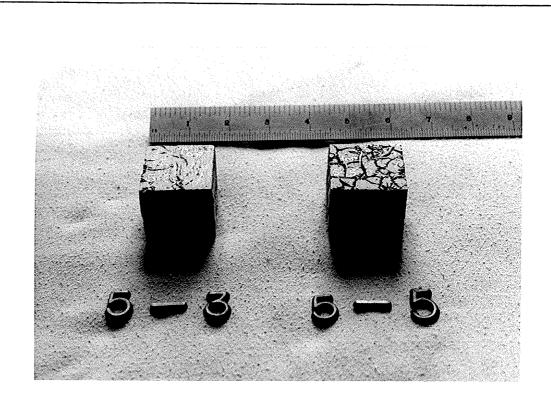


Figure H-5: General Top View of Clay Mortar Mix No. 5 Moist-Cured Specimens After Sanding



Photograph H-4: Comparison of Dry-Cured (Left) and Moist-Cured (Right) Specimens of Clay Mortar Mix No. 5 After Sanding

H.6.2 <u>Post-Testing Data</u>

- same notes as for Mix No. 5^A (air-dry)

H.7 MIX NO. 6

H.7.1 Pre-Sanding Data

Colour: grey

Shape: top - concave

- depth of concaveness = 2 to 3 mm.

measured at the centre of the

specimens

sides - same notes as for Mix No. 3

bottom - uneven

Surface Texture: - same notes as for Mix No. 2

Cracks: - hairline cracks

- larger cracks with length up to 5/8 inch

and a maximum width of 0.035 inch

- one crack had a length of one inch

- " " width of 0.050 inch

Other Features: - same notes as for Mix No. 2

H.7.2 Post-Testing Data

Mode of Failure: - splitting failure with some

erratic cracking patterns

Angle of Rupture -- θ : - 90°, for splitting failure

General Notes: - same notes as for Mix No. 2

H.8 MIX NO. 7

H.8.1 Pre-Sanding Data

Colour: grey

Shape: top - concave

- depth of concaveness = 1 to 3 mm.
measured at the centre of the
specimens

sides - fairly vertical with some concavity and convexity

bottom - uneven

Surface Texture: top - same notes as for Mix No. 2

sides - " " " " " " "

bottom - smooth with odd bumps

Cracks: - same notes as for Mix No. 2 except the larger cracks have lengths up to 13/16 inch and a maximum width of 0.065 inch

Average Density: 84 pcf.

Other Features: - cracks were evenly distributed on the specimens

- While sanding, the surfaces of the specimens became gritty and developed a cracked up appearance as shown in Figure H-6 and Photograph H-5.

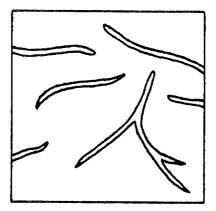


Figure H-6: General Surface View of Clay Mortar Mix No. 7 Specimens $\,$ After Sanding



Photograph H-5: Clay Mortar Mix No. 7 Specimens After Being Sanded

H.8.2 Post-Testing Data

Mode of Failure: - crushed with no peak load

- no distinct type of failure mode except for a very slight indication of some splitting failure cracks

Angle of Rupture -- θ : - 90°, for the slight indication of splitting failure cracks

General Notes: - specimens had a crushed appearance as illustrated in Photograph H-6; this is the general shape of the clay mortar specimens that had no peak failure load (Mix Nos. 7, 8, 10 and 11)

- see Table H-I for the last compression reading taken for each specimen of Mix No. 7 with no failure



Photograph H-6: Clay Mortar Mix No. 7 Tested Specimens (28-Day)

Table H-I Last Compression Readings Taken For Mix No. 7 With No Failure Specimen Deformation Strain Load Stress (x 0.001 in.) No. (%) (pounds) (psi.) 1 374.0 28.7 668 243.2 2 671.6 49.0 900 336.8 3 709.0 52.9 1,600 597.2

Table H-II Last Compression Readings Taken For Mix No. 8 With No Failure								
Specimen No.	Deformation (x 0.001 in.)	Strain (%)	Load (pounds)	Stress (psi.)				
1	649.0	47.4	1,000	365.0				
2	633.0	48.5	1,000	371.7				
3	622.0	45.7	1,000	359.5				

H.9 MIX NO. 8

H.9.1 Pre-Sanding Data

Colour: grey

Shape: top - concave

- depth of concaveness = 1.5 to
2 mm. measured at the centre of
the specimens

sides - vertically straight with a very slight inward angle change from the vertical on some of the sides

bottom - even

Surface Texture: top - same notes as for Mix No. 2 sides - fairly smooth

bottom - " "

Cracks: - same notes as for Mix No. 2 except the larger cracks have lengths up to 15/16 inch and a maximum width of 0.060 inch

Average Density: 88 pcf.

Other Features: - cracks were evenly distributed on the specimens

- different from the previous mixes: very little bump formation or distortion from the shape of a cube took place for the specimens of Mix No. 8 - As with Mix No. 7, while sanding, the surfaces of the specimens became gritty and developed a cracked up appearance as shown in Figure H-6, page 444, but with only about half the amount of cracking.

H.9.2 Post-Testing Data

- same notes as for Mix No. 7
- see Table H-II, page 447 for the last compression reading taken for each specimen of Mix No. 8 with no failure

H.10 MIX NO. 9

H.10.1 Pre-Sanding Data

Colour: grey

Shape: top - concave

- depth of concaveness = 1 to 2 mm.
measured at the centre of the
specimens

sides - vertically straight

bottom - two specimens convex, one specimen even

Surface Texture: top - same notes as for Mix No. 2

sides - smooth with odd bumps

bottom - " " " "

Cracks: - same notes as for Mix No. 2 except the

larger cracks have lengths up to 7/8

inch and a maximum width of 0.082 inch

Average Density: 93 pcf.

Other Features: - cracks were evenly distributed on the

specimens

- very little distortion from the shape of

a cube took place

H.10.2 Post-Testing Data

Mode of Failure: - splitting failure with some erratic cracking

Angle of Rupture -- θ : - 90°, for the splitting failure cracks

General Notes: - slight bowing out of the sides at mid-height

- top and bottom loading surfaces showed evidence of being restrained by the loading platens

H.11 MIX NO. 10

H.11.1 Pre-Sanding Data

Colour: grey

Shape: - same notes as for Mix No. 6

Surface Texture: - same notes as for Mix No. 6

Cracks: - same notes as for Mix No. 2 except the larger cracks have lengths up to one

inch and a maximum width of 0.074 inch

Average Density: 85 pcf.

Other Features: - same notes as for Mix No. 9

H.11.2 Post-Testing Data

- same notes as for Mix No. 7
- see Table H-III for the last compression reading taken for each specimen of Mix No. 10 with no failure

Table H-III Last Compression Readings Taken For Mix No. 10 With No Failure Specimen Deformation Strain Load Stress (x 0.001 in.) (%) (pounds) (psi.) No. 605.0 42.6 1,100 419.2 1 2 545.0 37.9 1,100 403.1 3 463.0 35.0 1,200 428.3

Table H-IV Last Compression Readings Taken For Nix No. 11 With No Failure									
1	591.5	41.5	1,500	507.6					
2	510.5	35.0	1,500	502.0					
3	478.0	34.3	1,525	515.6					

H.12 MIX NO. 11

H.12.1 Pre-Sanding Data

Colour: grey

Shape: - same notes as for Mix No. 6

Surface Texture: - same notes as for Mix No. 6

Cracks: - mostly hairline cracks

- larger cracks with length up to 1/2 inch

and a maximum width of 0.051 inch

Average Density: 77 pcf.

Other Features: - same notes as for Mix No. 5^{B}

H.12.2 Post-Testing Data

- same notes as for Mix No. 7 but not as crushed

- see Table H-IV, page 452 for the last compression reading taken for each specimen of Mix No. 11 with no failure

H.13 COMPRESSION TESTING INFORMATION

Included as the Compression Testing Information are the dimensions of the cube specimens, the resultant testing surface area, the time required to perform the compression test for each specimen and the age of the mix at the time of testing. This information is in Table H-V.

		Age ⁴ (days)	33	88	37	37	36	36	36
		Time ³ (minutes)	15 15	20 20 25	10 12 12 12	11 14 13	12 12 13	12 14	10 10 12
	tion	Area ² (in. ²)	1.77 2.00 1.90	2.23 2.19 2.21	2.34 2.33 2.28	2.31 2.35 2.37	2.47 2.43 2.41	2.41 2.52 2.40	2.53 2.51 2.48
Table H-V	Compression Testing Information For Clay Mortar Mixes	Height ² (inches)	1.310 1.330 1.439	1.390 1.412 1.322	1.404 1.376 1.440	1.425 1.395 1.401	1.460 1.433 1.457	1.400 1.450 1.439	1.442 1.374 1.355
Tab	mpression Ter For Clay I	Width ¹ (inches)	1.290 1.454 1.415	1.500 1.486 1.470	1.547 1.517 1.515	1.510 1.515 1.540	1.588 1.573 1.532	1.534 1.600 1.550	1.568 1.615 1.591
And the second s	၀၁	Length ¹ (inches)	1.372 1.377 1.340	1.489 1.476 1.500	1.510 1.535 1.505	1.529 1.550 1.538	1.556 1.544 1.574	1.573 1.577 1.550	1.615 1.555 1.560
		Specimen No.	3 23 11	– ଅଟ	- 2 E	= ଅ ଅ	- a s	⊣ ର ଚ	- N E
		Mix No.	-	20	. თ	4	5A	58	9

			Tab	Table H-V		-	
			(Con	(Continued)			
Mix No.	Specimen No.	Length ¹ (inches)	Width1 (inches)	Height ² (inches)	Area ² (in.2)	Time ³ (minutes)	Age ⁴ (days)
7	3 2 1	1.647 1.630 1.619	1.668 1.639 1.655	1.304 1.372 1.340	2.75 2.67 2.68	9 9 12	40
x 0	ଘଷଟ	1.626 1.640 1.674	1.685 1.640 1.662	1.369 1.306 1.360	2.74 2.69 2.78	10 9 10	40
ກ	- a &	1.590 1.595 1.630	1.645 1.598 1.643	1.418 1.435 1.431	2.62 2.55 2.68	7 8 10	45
10	- a &	1.600 1.629 1.688	1.640 1.675 1.660	1.420 1.439 1.324	2.62 2.73 2.80	11	44
-	- 2 E	1.733 1.720 1.730	1.705 1.737 1.710	1.425 1.460 1.395	2.96 2.99 2.96	13 11 10	45
Load 2Aver 3comp 4Age	Loading surface Average loading Compression test Age at the time	ace length/width. ing height/area. test duration. ime of the compression test for the	ssion test f	or the set of	set of three specimens	cimens.	

Appendix I

TESTING DATA FOR LIME-SAND MORTAR MIXES

Testing data for each of the lime-sand mortar mixes consisted of three parts: 1) pre-testing data, 2) compression testing data, and 3) post-testing data. The Pre-Testing Data is summarized in Chapter IV, Subsection 4.2.2, Testing Data. Pre-testing data included notes on the colour, shape, surface texture and density measurements of the specimens.

Tabulated first in this appendix is the Compression Test Information, which is only part of the compression testing data. The remaining compression testing results (stress-strain data) are presented in Chapter IV, Subsection 4.2.3, Plots. In Chapter IV, the stress-strain data-points are plotted to scale on computer plots. Tabulated at the end of this appendix is the Post-Testing Data.

Included as the Compression Testing Information are the dimensions of the cube specimens, the resultant testing surface area, the time required to perform the compression test for each specimen, and the age of the mix at the time of the testing. All of this information is in Table I-I. The length and width dimensions in this table are average values based on three measurements: one measurement was taken at the top, one at mid-height and one at the bottom of the

specimen. The loading area is also an average value but based only on the dimensions at the top and bottom of the specimen. Since the mid-height dimensions were not used for the area calculations, the average length multiplied by the average width may or may not equal the recorded average area. Average areas greater than or equal to 3.94 square inches were taken as 4.00 square inches, as directed by CSA A8-1970, Subsection 7.11.10 [15].

After the compression test, notes termed as Post-Testing Data were recorded for each set of specimens. Recorded were the mode(s) of fracture(s)/failure, the angle of rupture(s) and general notes. All of this information is in Table I-II. Each set of data in this table represents a summary of three specimens per mix per age group. Specimens with no indication of fracture(s)/failure on the surface were assumed to have fractures beneath the surface.

Three types of mode of fracture(s)/failure were noted throughout the compression testing of the lime-sand mortar specimens: 1) pyramidal/hourglass fracture; 2) splitting failure or columnar fracture; and 3) corner fracture. Details of the first two modes, how the angle of rupture is measured, and the significance of the angle of rupture is detailed in Appendix H. A sketch of a typical corner fracture is shown in Figure I-1. Photograph I-1 shows an occurrence of corner fracture with the tested specimens of Mix No. 12 at the 28-day age. The cause of a corner fracture

was due to local stresses created by the corner(s) being slightly higher than the remaining loading surface.

a cyle a cyranyddiai		Age ⁴ (days)	2	58	ဘ	78	\$	88
		Time ³ (minutes)	4 V Ū	ব ৰা এ	4 9 4	ত কে ক	4 3 9	ाट का का
		Area ² (in. ²)	(4.00) (4.00) (4.00)	3.90 3.89 3.88	(4.00) (4.00) (4.00)	(4.00) (4.00) (4.00)	(4.00) (4.00) (4.00)	4.00 4.00 (4.00)
	nformation ar Mixes	Height ² (inches)	1.960 2.000 1.991	1.975 1.976 1.974	1.985 1.980 1.985	1.995 1.999 1.998	1.985 1.986 1.985	1.999 1.999 1.920
Table I-I	Compression Testing Information for Lime-Sand Mortar Mixes	Width ¹ (inches)	2.000 2.000 2.000	1.980 1.982 1.980	1.999 1.996 1.995	1.998 1.998 1.994	1.995 1.994 1.995	1.999 1.999 1.998
	Compressi for Li	Length ¹ (inches)	1.969 1.986 1.979	1.967 1.958 1.960	1.988 1.992 1.994	1.989 1.982 1.979	1.998 1.996 1.998	1.998 1.997 1.972
	-	Specimen No.	- ଷ ଶ	4 73 30	- N 6	4 C O	ન તા જ	4 % 9
		Mix No.	<u>~</u>		e e	2	21	H 1
		Lime Brand			<	ē.		

			Table I-I (Continued)				
	Specimen No.	Length ¹ (inches)	Width ¹ (inches)	Height ² (inches)	Area ² (in. ²)	Time ³ (minutes)	Age ⁴ (days)
	H 87 E	1.994 1.974 1.967	1.990 2.000 1.997	1.985 1.999 2.000	(4.00) (4.00) (4.00)	တ ထ သ	ာ
	4 & 9	1.953 1.960 1.962	1.967 1.971 1.968	1.965 1.968 1.965	3.86 3.87 3.88	ব ব ব	78
	- 2 E	1.953 1.960 1.961	1.988 1.989 1.986	1.988 1.986 1.981	3.90 3.91 3.91	C C 4	æ
	4 5 9	1.938 1.934 1.943	1.962 1.966 1.961	1.956 1.958 1.954	3.82 3.81 3.82	4 4 4	88
1	4 2 8	1.917 1.915 1.906	1.954 1.958 1.967	1.954 1.955 1.957	3.76 3.79 3.79	7 7 7	∞
	4 N O	1.882 1.897 1.890	1.924 1.934 1.926	1.933 1.928 1.933	3.65 3.70 3.66	२२ व	28

				Table I-I			· cere · a management management, and a management of a manage	· made angles of the part of t
	1			(Continued)				
Lime Brand	Mix No.	Specimen No.	Length1 (inches)	Width ¹ (inches)	Height ² (inches)	Area ² (in. ²)	Time ³ (minutes)	Age ⁴ (days)
∢	17-R	11 01 to to to	1.931 1.928 1.936 1.896 1.892 1.899	1.989 1.983 1.982 1.934 1.939	1.973 1.973 1.974 1.936 1.939 1.938	3.86 3.84 3.84 3.68 3.68 3.68	ਰਾਹਾਰਾ ਨਰਾਹ	7 28
æ	18	പ ഗായ 4 രാ ര	1.970 1.980 1.977 1.977 1.968 1.968	1.979 1.979 1.980 1.977 1.980	1.976 1.979 1.979 1.976 1.980	3.90 3.92 3.92 3.92 3.90 3.90	4 to to 4 4 to	7 288
	19	1 01 E 4 10 D	1.969 1.977 1.974 1.973 1.967 1.967	1.982 1.982 1.978 1.977 1.982 1.978	1.980 1.980 1.979 1.978 1.972 1.972	3.90 3.92 3.91 3.90 3.91 3.91	444 444	7 288

			20 Table 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	Table I-I (Continued)				
Lime Brand	Mix No.	Specimen No.	Length ¹ (inches)	Width1 (inches)	Height ² (inches)	Area2 (in.2)	Time3	Age ⁴ (days)
	20	ଳରର 4ଓଣ	1.974 1.969 1.961 1.965 1.965	1.981 1.981 1.979 1.977	1.979 1.979 1.974 1.969	3.91 3.90 3.89 3.89 3.88	ಬಬ 4 4	7 288
		- N 8	1.962 1.965 1.963	1.979 1.979 1.982	1.966 1.967 1.969	3.88	r 444	∞
n	20-R	409	1.969 1.965 1.958	1.978 1.976 1.977	1.961 1.966 1.967	3.90 3.89 3.89	क २८ क	8 8
	21	– พ.ต	1.962 1.958 1.963	1.979 1.981 1.978	1.972 1.974 1.976	3.89 3.89 3.88	ကမာ	<i>L</i>
		4 rc o	1.968 1.965 1.961	1.982 1.986 1.973	1.975 1.978 1.977	3.90 3.91 3.88	4 to to	8

ŀ	- The state of the	(Continued)				
Specimen No.	Length ¹ (inches)	Width ¹ (inches)	Height ² (inches)	Area2 (in.2)	Time ³ (minutes)	Age ⁴ (days)
	1.945	1.992	1.972	3.89	4	
	1.954	1.981	1.972	3.88	ۍ 4	∞
	0,00) (
	1.951	1.981	1.974	3.88	· 4	28
	1.944	1.988	1.960	3.87	က) I
	1.964	1.975	1.978	3.88	5	
	1.965	1.977	1.979	3.89	7	7
	1.966	1.973	1.979	3.88	9	
	1.962	1.970	1.977	3.88	9	
	1.967	1.976	1.968	3.89	ဟ	58
	1.962	1.975	1.967	3.89	C)	
	1.935	1.977	1 972	3 84	~	
	1.926	1.987	1.985	3.84) ກ	2
	1.933	1.977	1.976	3.82	n	
	1.952	1.971	1.969	3.85	ß	
	1.956	1.977	1.974	3.88	4	28
	1.970	1.970	1.965	3.89	4	

· · · · · · · · · · · · · · · · · · ·				Table I-I				
		THE COMPANY AND ADDRESS OF THE COMPANY AND ADDRE		(Continued)	(
Lime Brand	Mix No.	Specimen No.	Length ¹ (inches)	Width1 (inches)	Height ² (inches)	Area2 (in.2)	Time3 (minutes)	Age ⁴ (days)
	23	1 2 3	1.949 1.947 1.959	1.977 1.978 1.977	1.965 1.971 1.970	3.86 3.87 3.88	10 T T	7
æ	1	4 rv 9	1.953 1.965 1.952	1.970 1.976 1.977	1.976 1.982 1.972	3.86 3.90 3.87	വവവ	58
	×	ન રા છ	1.975 1.952 1.964	1.974 1.979 1.974	1.972 1.973 1.973	3.90 3.87 3.88	C 4 4	7
		400	1.950 1.955 1.955	1.975 1.972 1.972	1.977 1.970 1.977	3.87 3.86 3.86	6 6 7	27
Notes:	i) Averatii) Averiii) Averiii) Area	Average length/width is based from three measurements: one measurement at the top, one at mid-height and one at the bottom of the specimen; Average loading area is based only on the top and bottom measurements; Area shown as (4.00) indicates that the area was greater than or equal in.2 but taken as 4.00 in.2 as directed by CSA A8-1970, Subsection 7.11	width is based from three measurements: one measurement at mid-height and one at the bottom of the specimen; area is based only on the top and bottom measurements; 1.00) indicates that the area was greater than or equal is 4.00 in. ² as directed by CSA A8-1970, Subsection 7.1	ed from three of and one at ed only on the tes that the a as directed b	from three measurements: one measurement was take and one at the bottom of the specimen; only on the top and bottom measurements; that the area was greater than or equal to 3.94 idirected by CSA A8-1970, Subsection 7.11.10 [15].	er of	one measurement was taken he specimen; measurements; than or equal to 3.94 Subsection 7.11.10 [15].	s taken 8.94 [15].
Averag 2Averag 3Compre 4Age at	Average length/wid1 2Average loading he 3Compression test du 4Age at the time of	3.37 3 7	n of a cube specimen. ght/area. ration. the compression test for the set of three specimens.	n. : for the set	of three sp	ecimens.		

Lime Mix Age Splitting Pyramidal Corner θρ θς Gegrees) (degrees) 12 7 Yes No No Yes No Ges No Hole Of Rupture Angle of Rupture θρ θς Gegrees) (degrees) (d	here === b Miscellaneous Notes θ _C (See Footnotes for See Footn
B 18 7 NO NO Yes n.a. 120	120, 130 1, 2, 5

Table I-II (Continued)	Age Splitting Pyramidal Corner $\theta_{\rm D}$ (degrees) (degrees) (degrees) Notes Notes	7 No Yes No 60 n.a. 1, 2, 5 28 No Yes No 60 n.a. 1, 2	7 No Yes No 70 n.a. 1, 2, 3, 4, 5 28 No Yes No 60 n.a. 1, 2	8 No Yes No 60 n.a. 1, 2, 3, 4 28 Yes No 75 n.a. 6, 7	7 No Yes Yes 60 110-120 1, 2 28 No Yes Yes 60 110-130 1, 2	8 Yes Yes No 60 n.a. 6, 7, 8 28 No Yes No 60-70 n.a. 6, 7, 8	7 No Yes No 70 n.a. 1, 2, 3, 5 28 Yes Yes No 60, 70 n.a. 1, 2, 5	7 Yes Yes No 60-70 n.a. 1, 2, 9 28 Yes No 60-70 n.a. 1, 2, 9	7 Yes Yes No 60 n.a. 1, 2, 9 28 Yes Yes 50-70 130 1, 2, 4, 9	7 Yes Yes No 35,60,70 n.a. 1, 2, 9 27 Yes No 60-70 n.a. 1, 2, 4, 9
	s 0	7 28	28		7 28					
	Lime Mix Brand No. (19	50	20-R	21	21-R	52	22-R	53	23-R

Table I-II

(Continued)

Notes: i) θ_S indicates angle of rupture of splitting failure; ii) θ_D indicates angle of rupture of pyramidal fracture; iii) θ_C indicates angle of rupture of corner fracture (measured for informational purposes only);

iv) n.a. indicates not applicable.

1Top loading surface(s) showed evidence of being restrained of lateral expansion by the loading platen.

Bottom loading surfaces(s) showed evidence of being restrained of lateral expansion by the loading platen.

 3 Odd vertical crack present with pyramidal and/or corner fracture dominating.

⁴Some random cracks present.

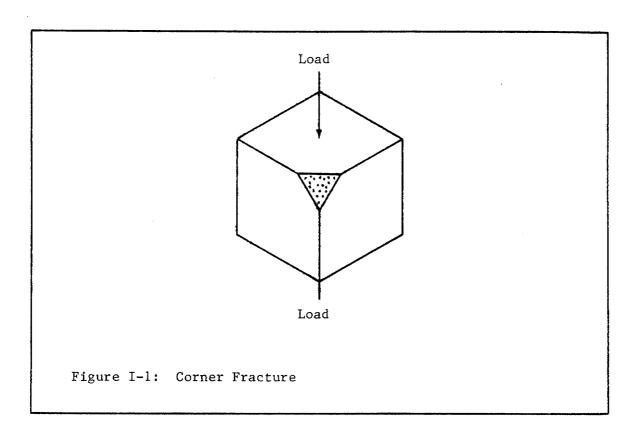
Surface cracks non-existent on one specimen.

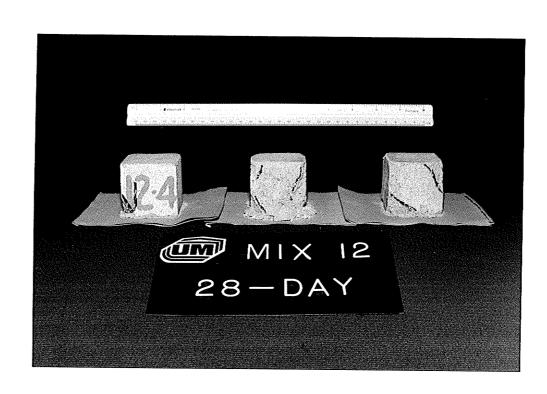
⁶Material fractured off loose from the sides.

 $^{7}\mathrm{Fracture}(s)$ occurred on the top loading surface.

 $^{8}\mathrm{Fracture}(s)$ occurred on the bottom loading surface.

⁹Pyramidal fracture lines not completely defined.



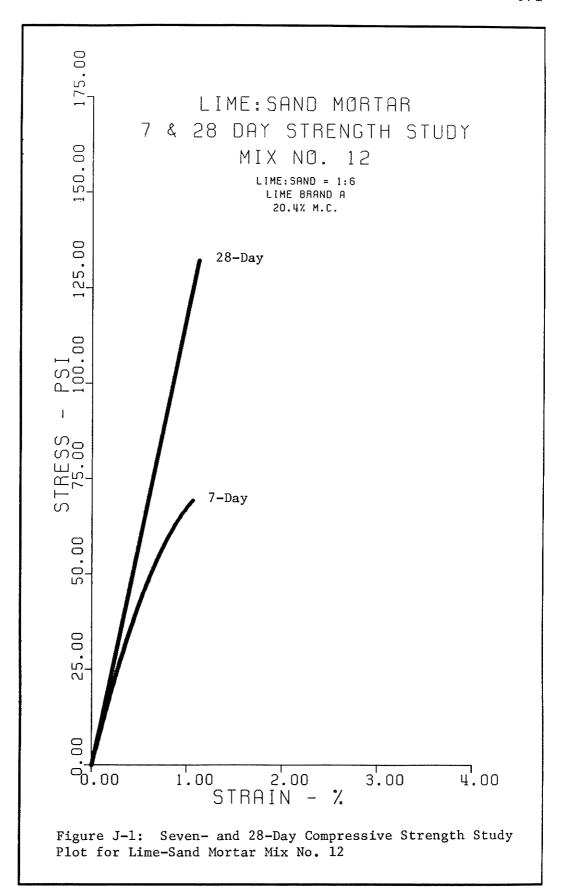


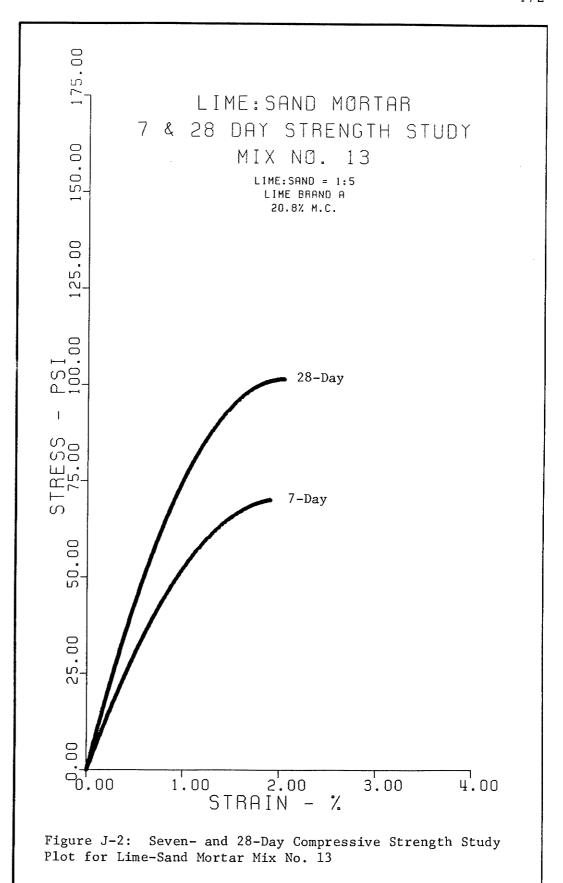
Photograph I-1: Lime-Sand Mortar Mix No. 12 Tested Specimens (28-Day)

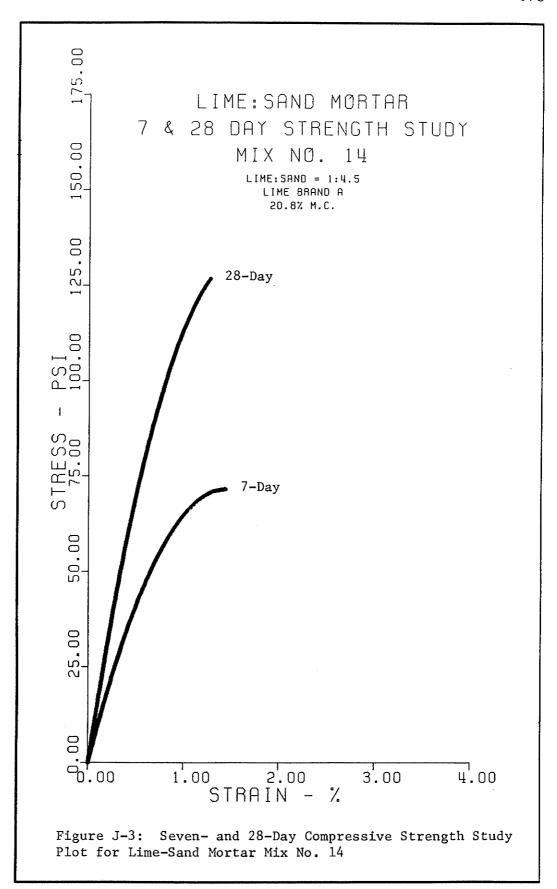
Appendix J

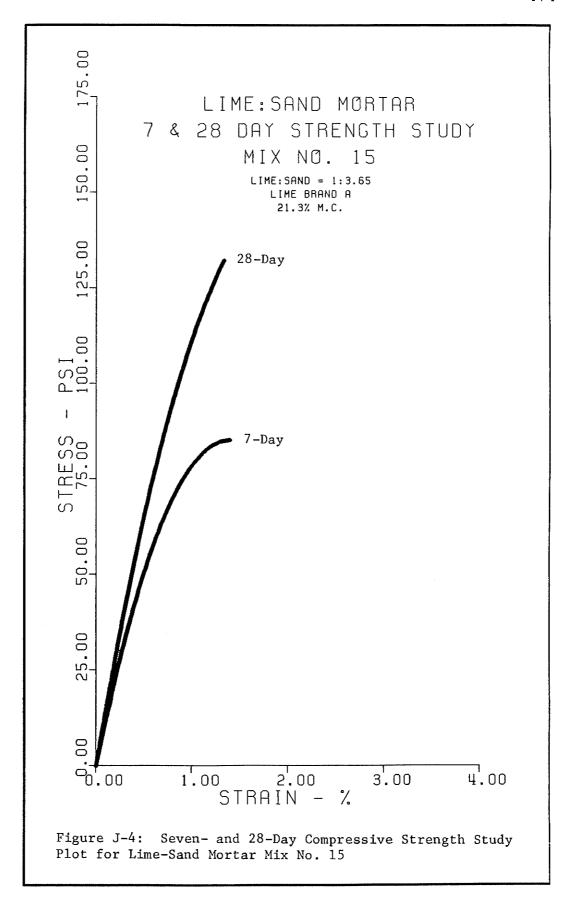
COMPUTER STUDY PLOTS FOR LIME-SAND MORTAR MIXES

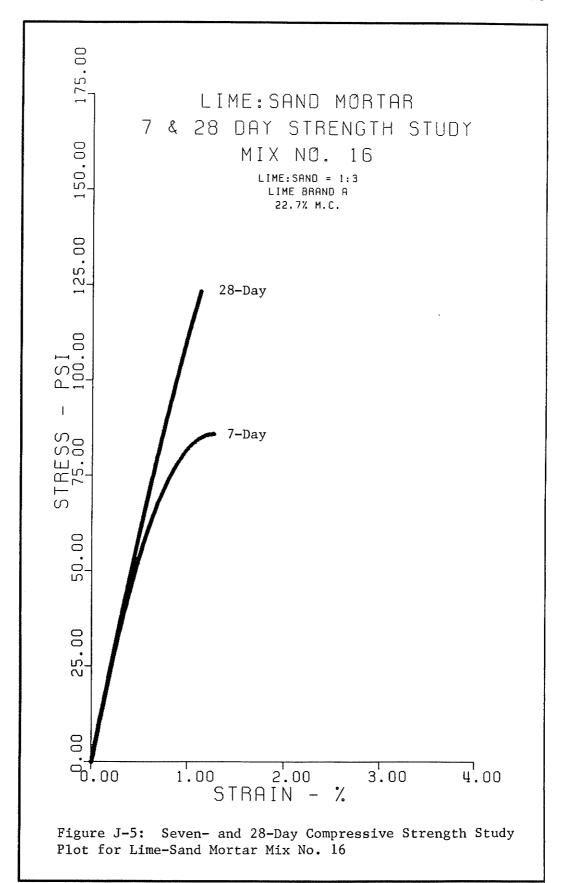
The compressive strength and failure characteristics of each lime-sand mortar mix, at the age of seven and 28 days, is described by the curves given in Figures 33 to 66, pages 163 From these figures, different combinations of the curves were put together to obtain four different studies: 1) lime-sand ratio studies; 2) remix strength studies; 3) seven- and 28-day strength studies; and 4) lime brand stud-These studies were put together into computer plot ies. form with the use of Computer Program No. 8 of Appendix G. More information about these studies is in, Chapter IV, Article 4.2.3.2, Study Plots. Also under this Article, are the results of the first two studies. Results of the two remaining studies are in this appendix. The Seven- and 28-Day Compressive Strength Study plots are in Figures J-1 to J-17 and the Lime Brand Study plots are in Figures J-18to J-31.

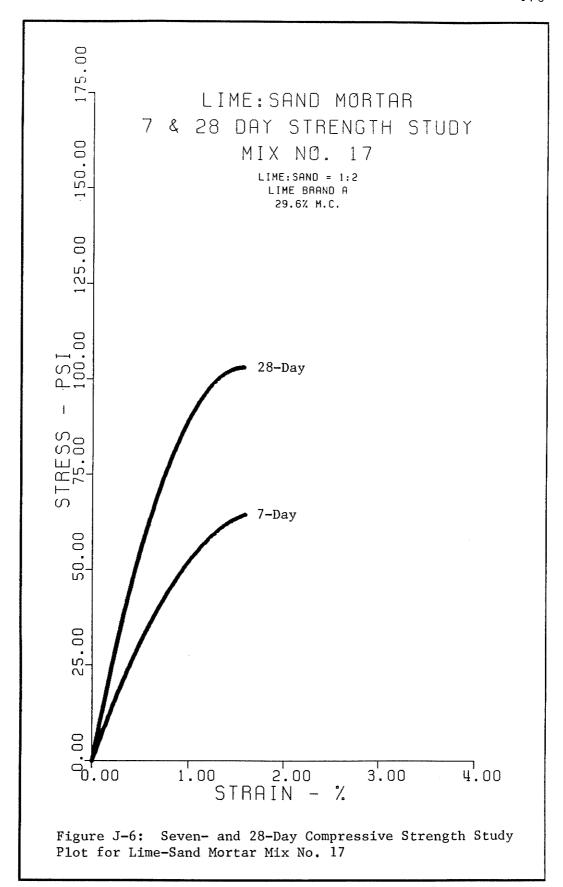


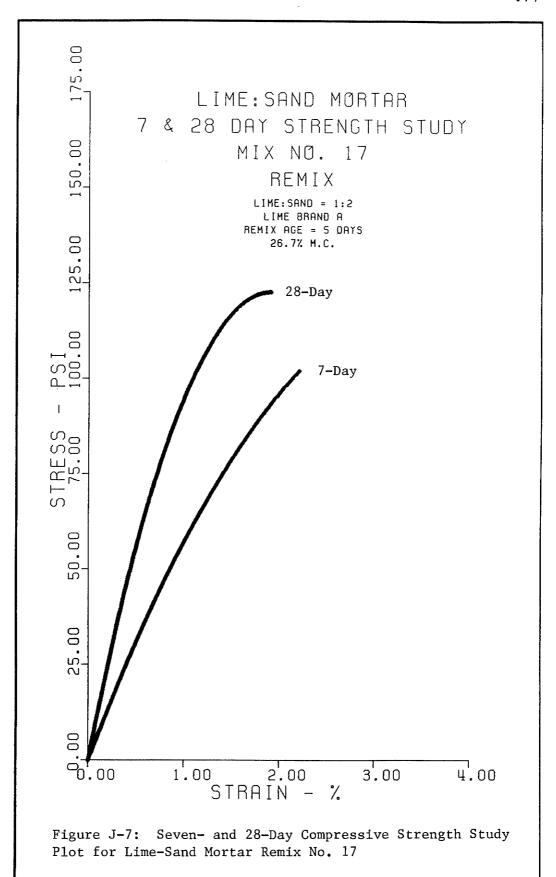


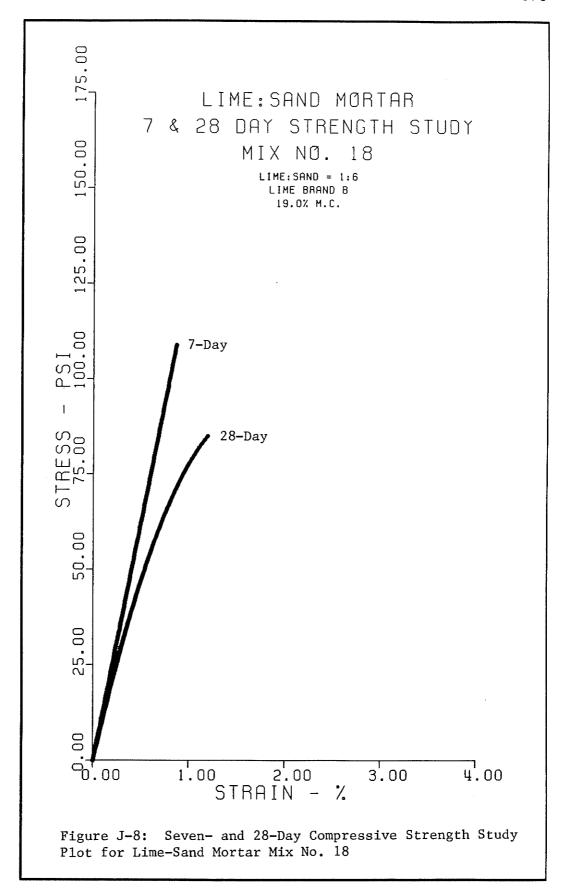


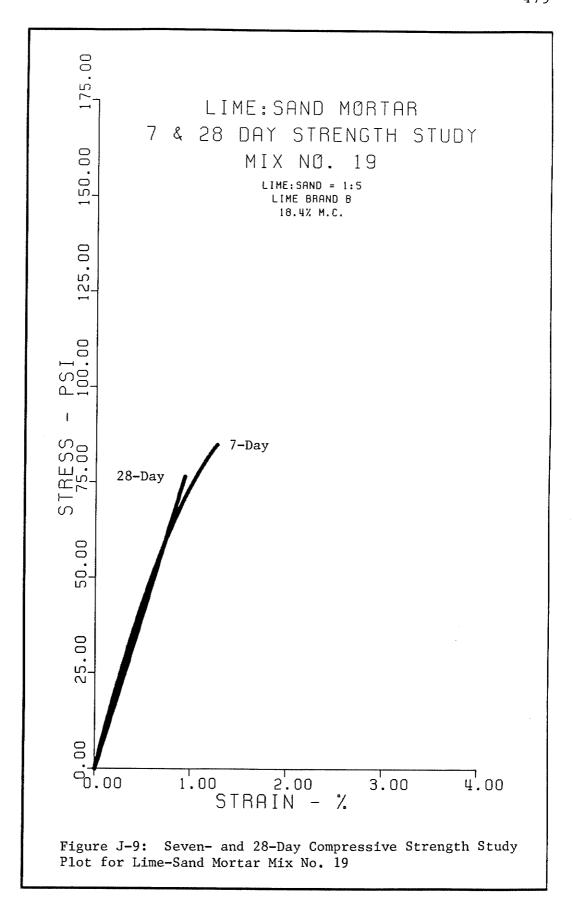


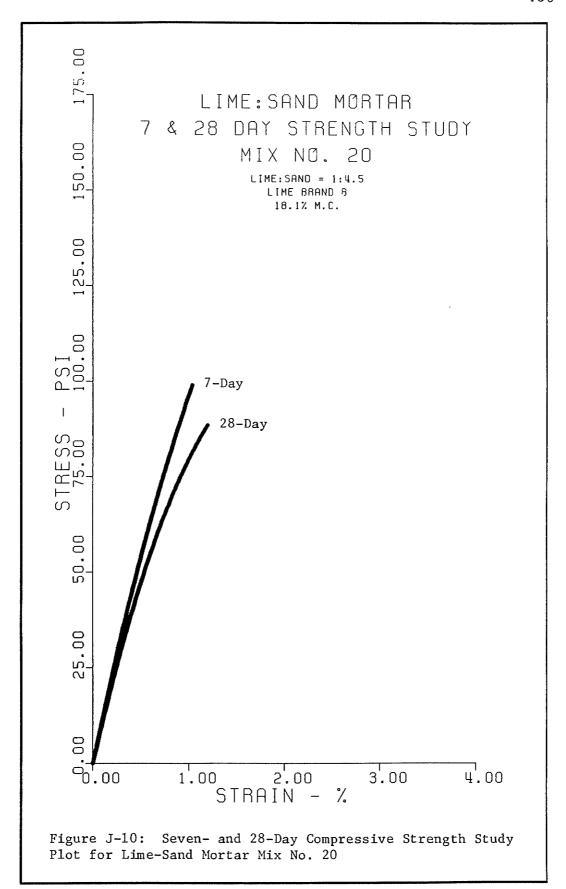


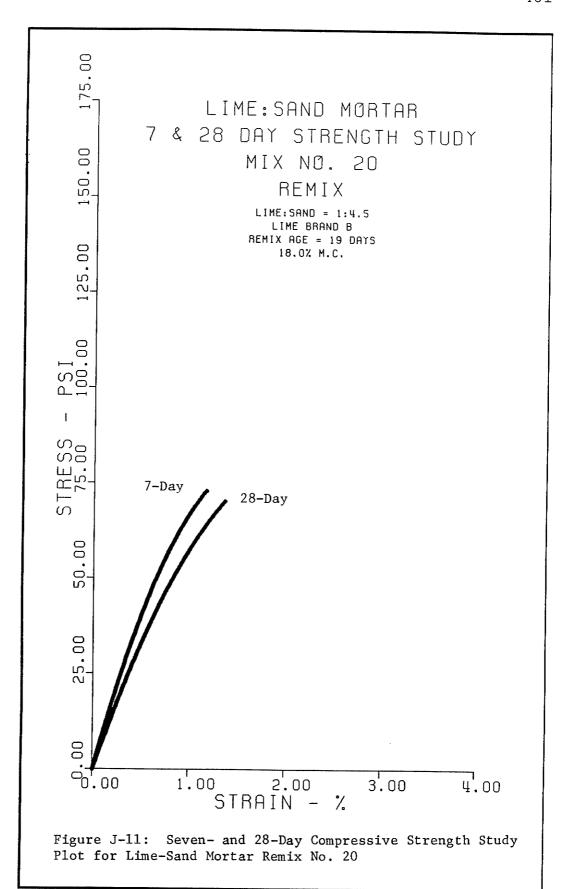


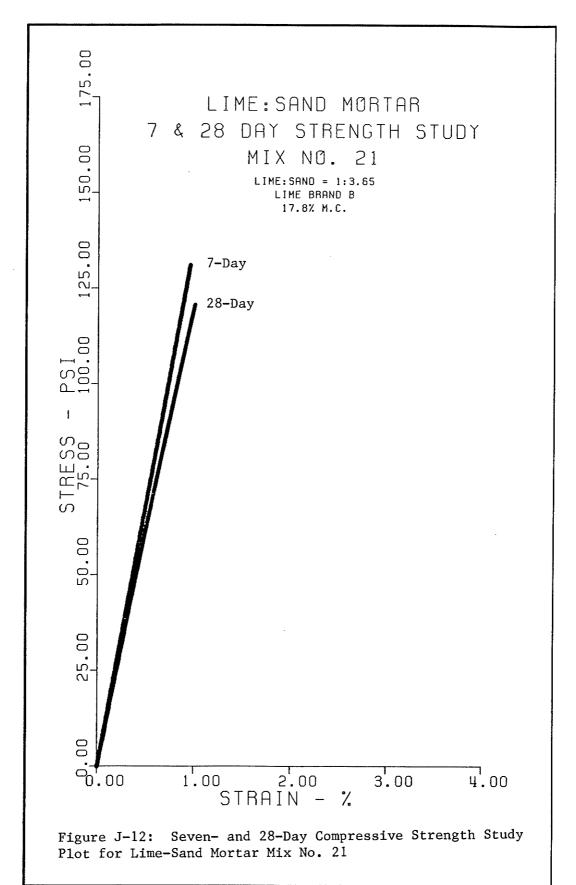


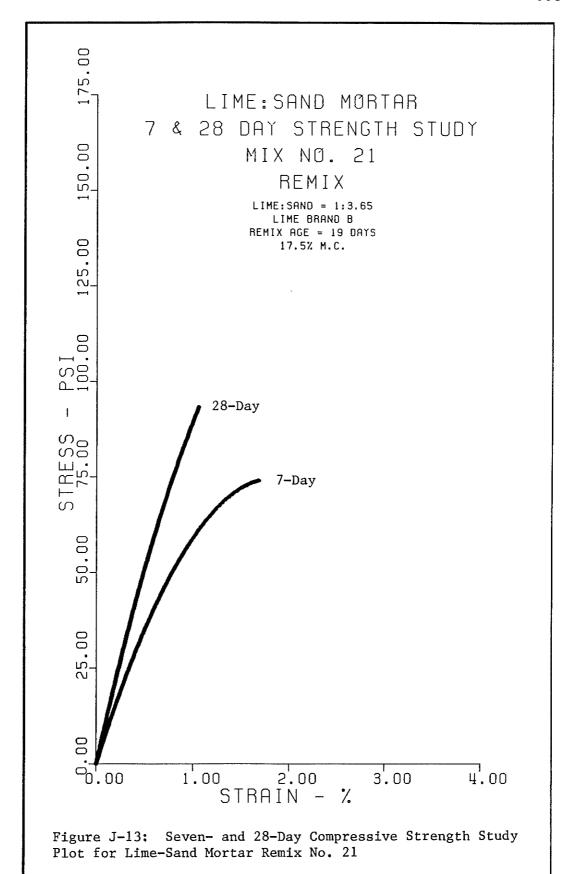


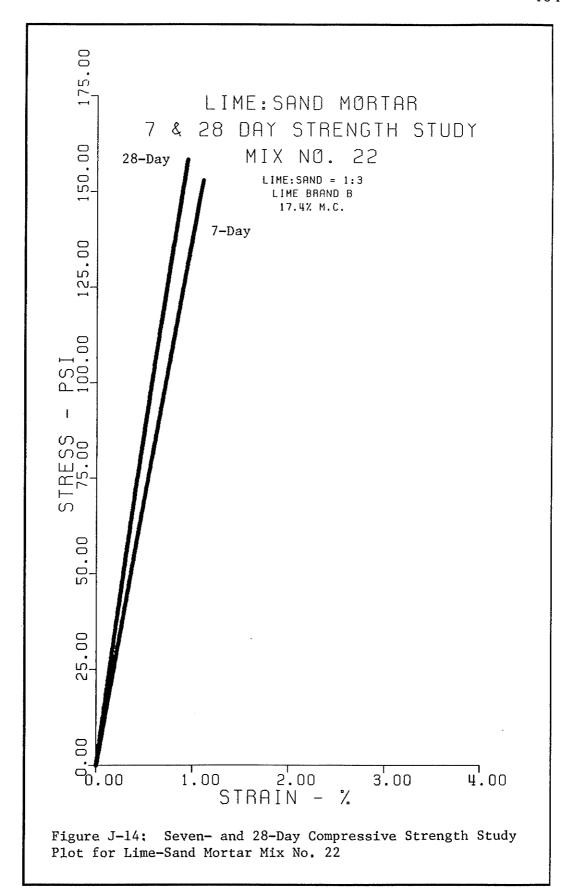


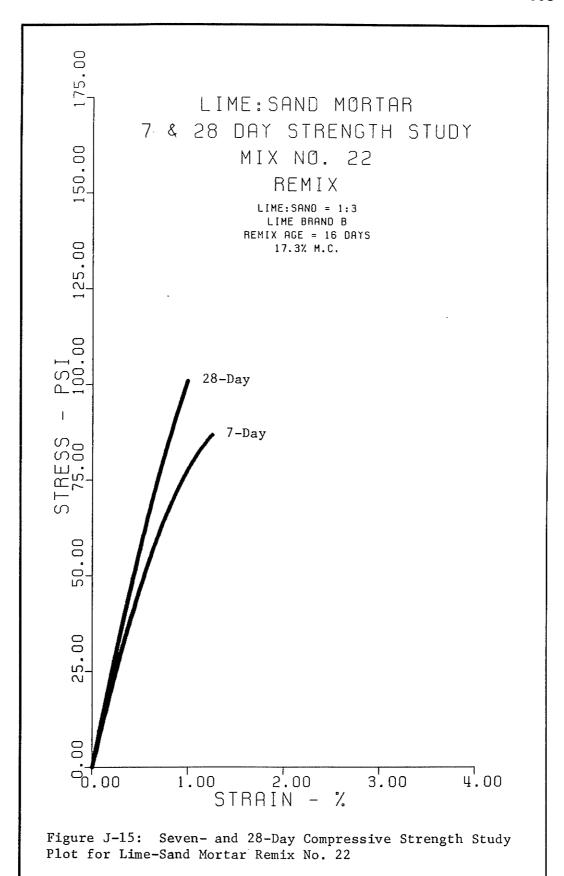


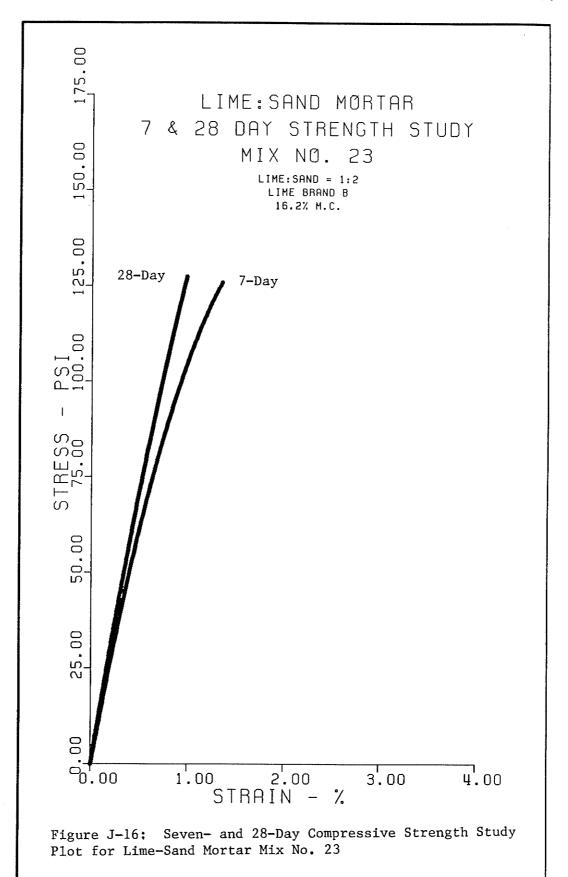


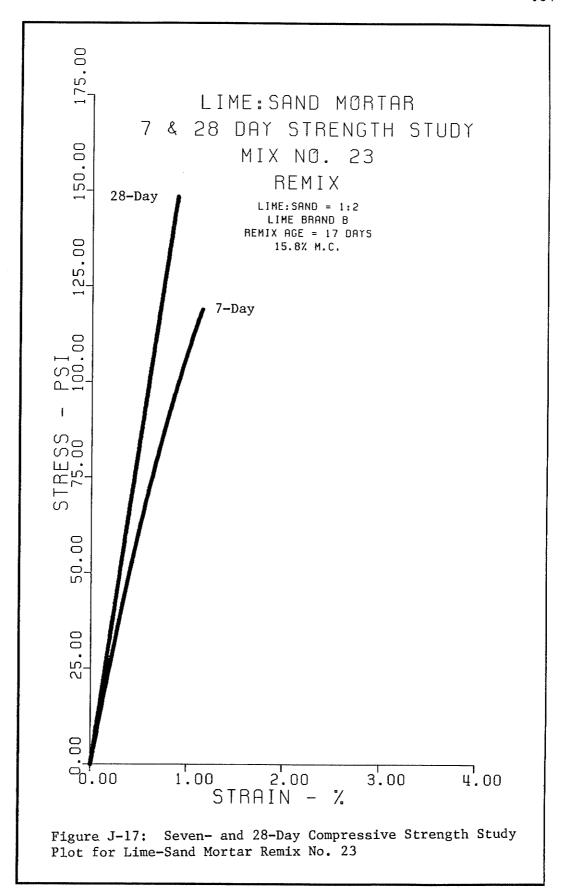


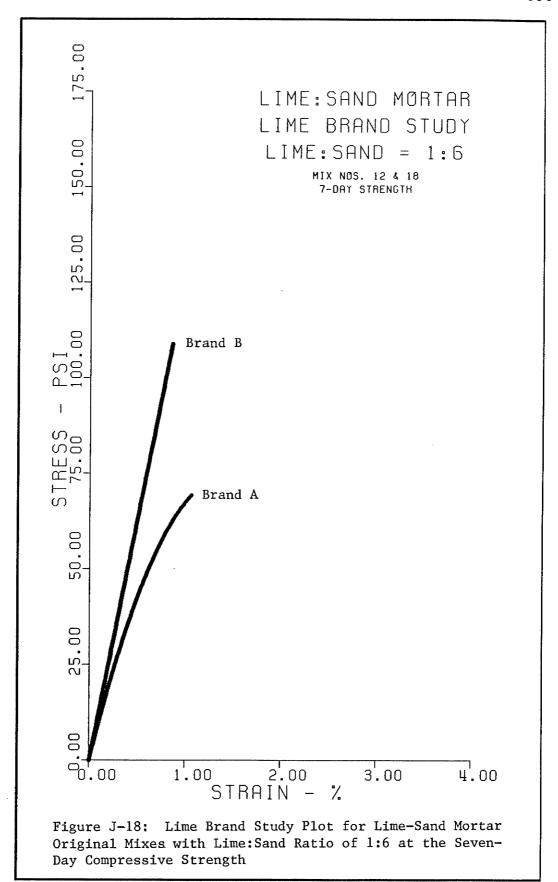


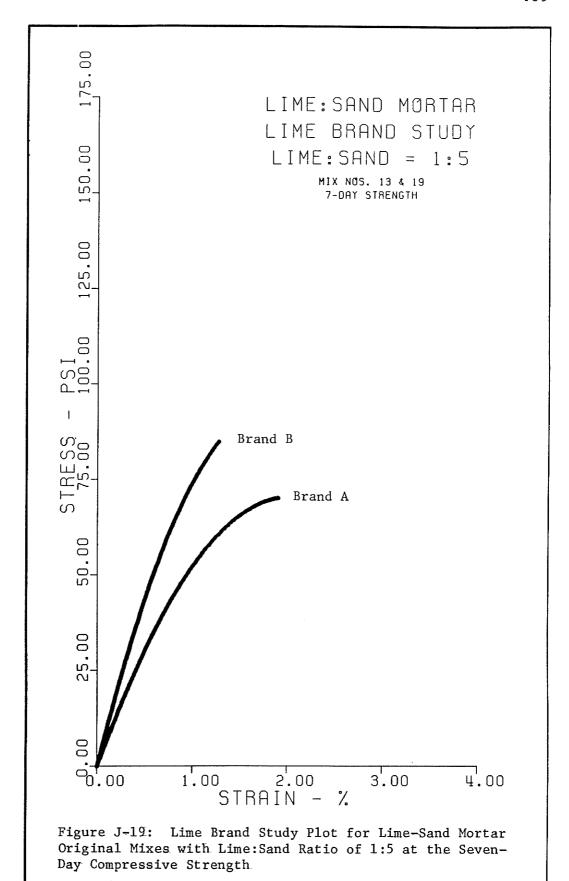


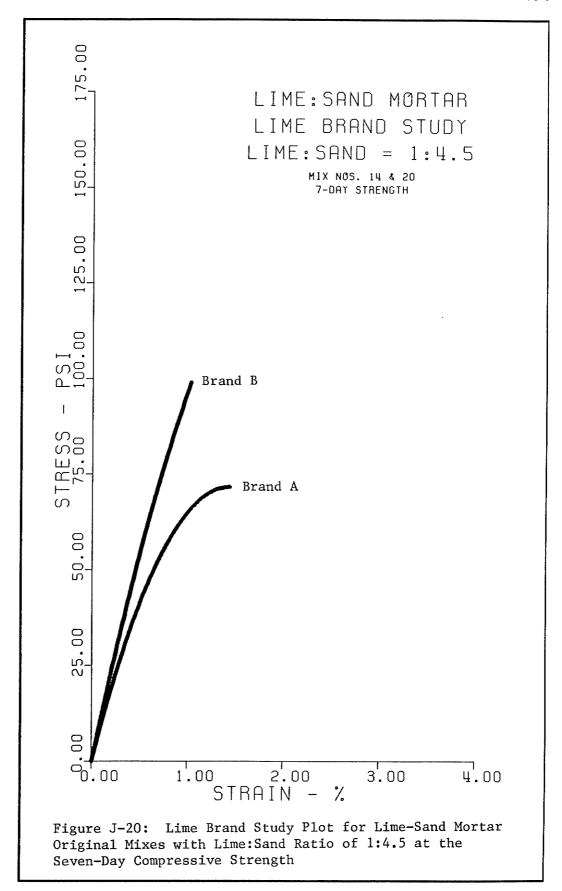


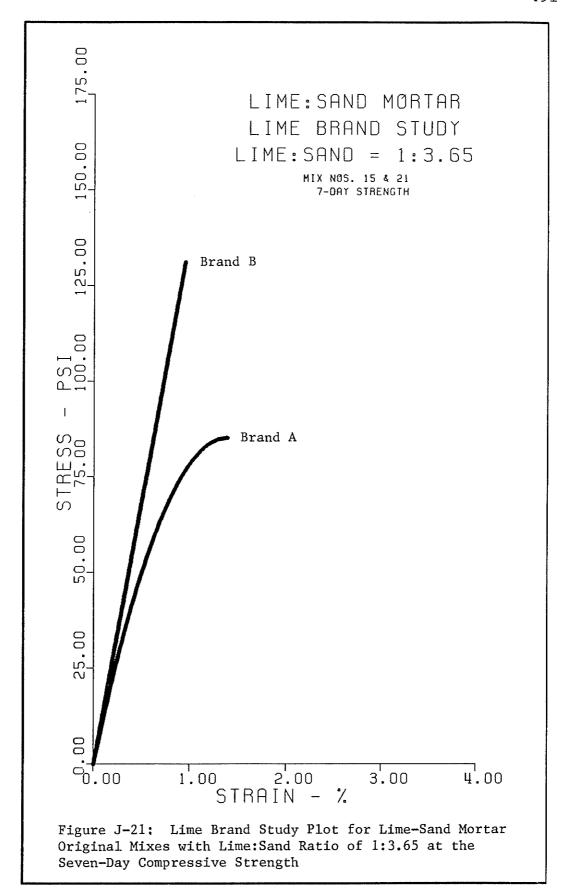


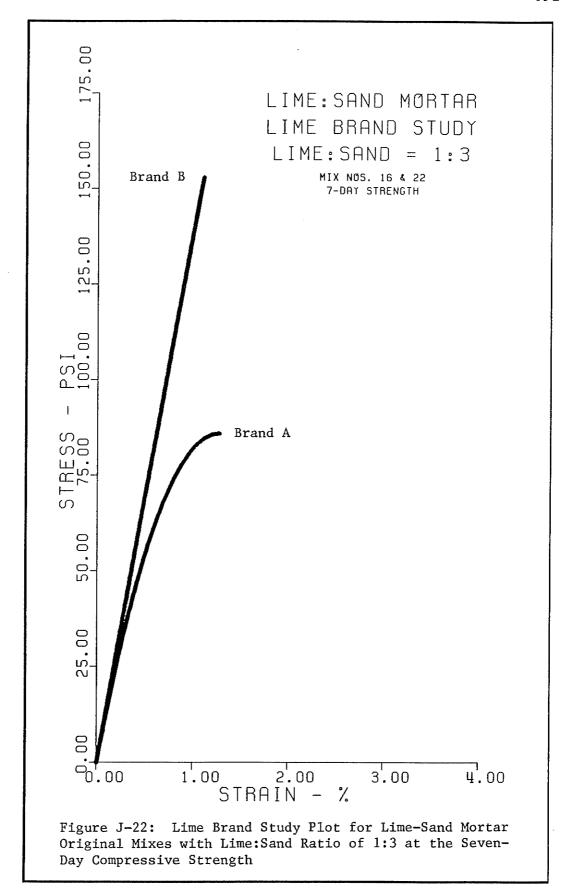


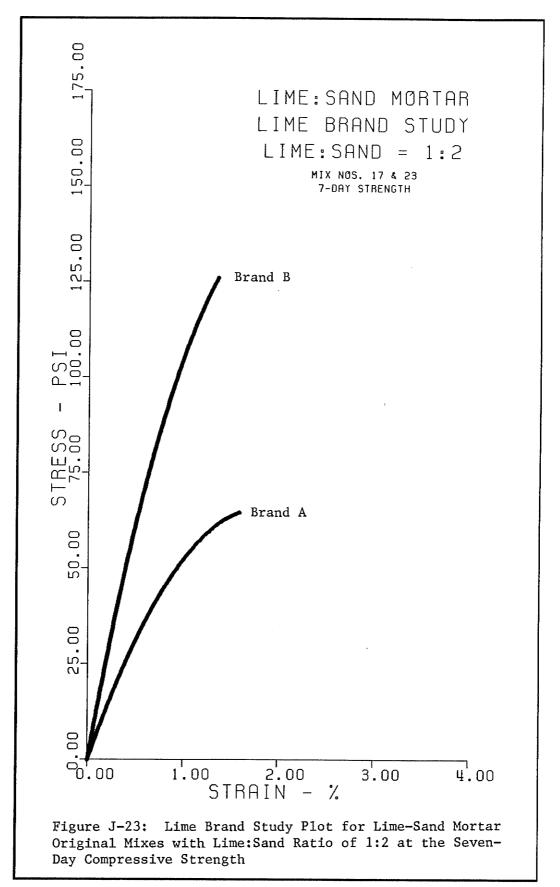


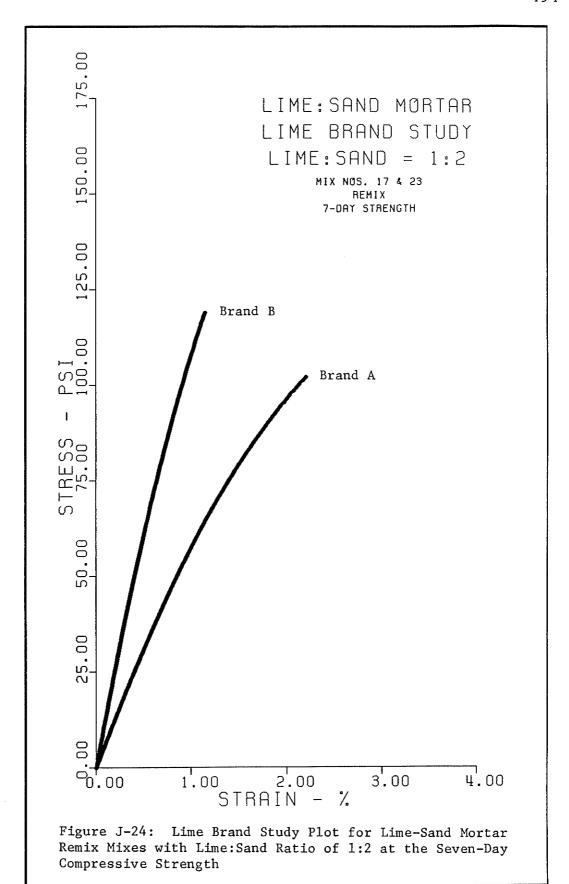


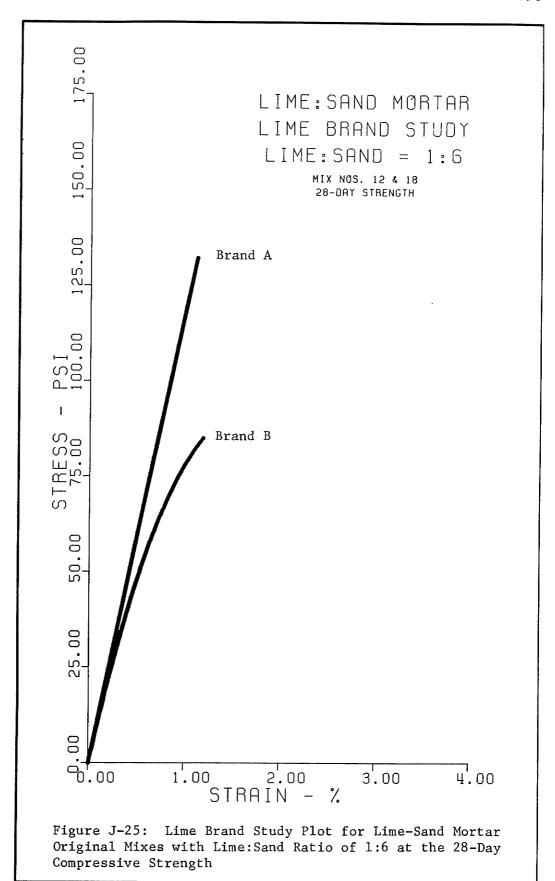


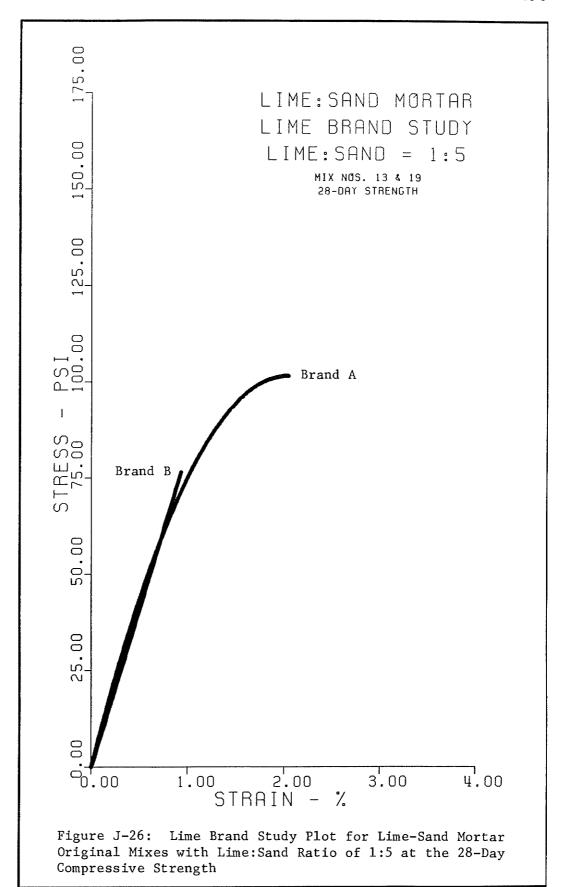


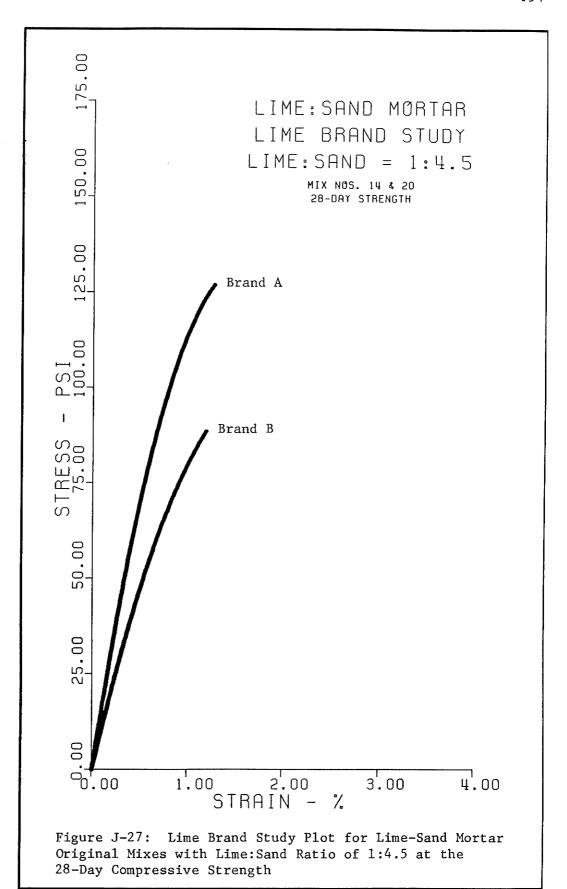


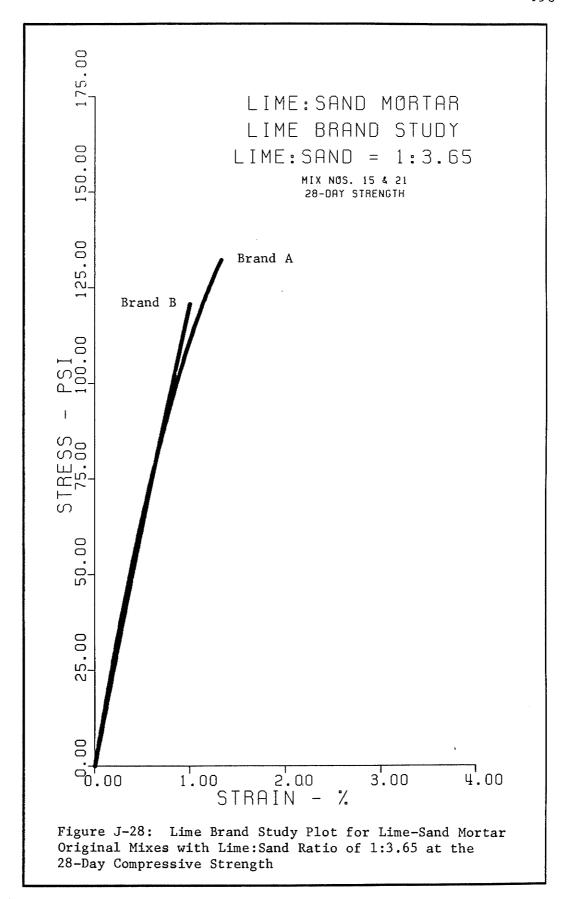


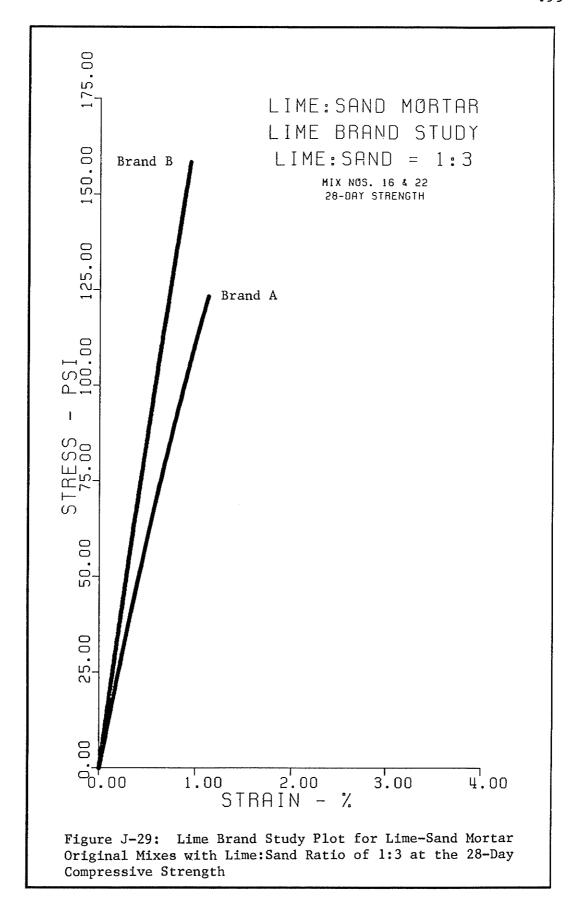


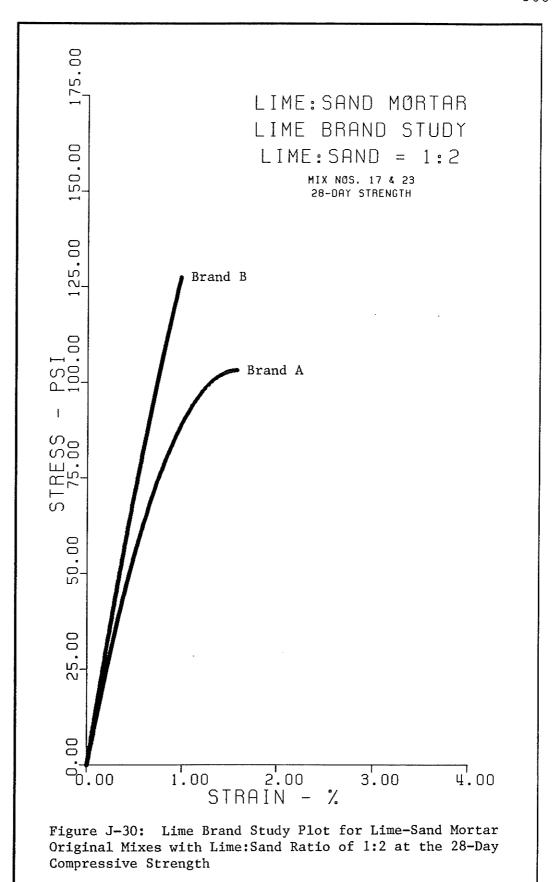


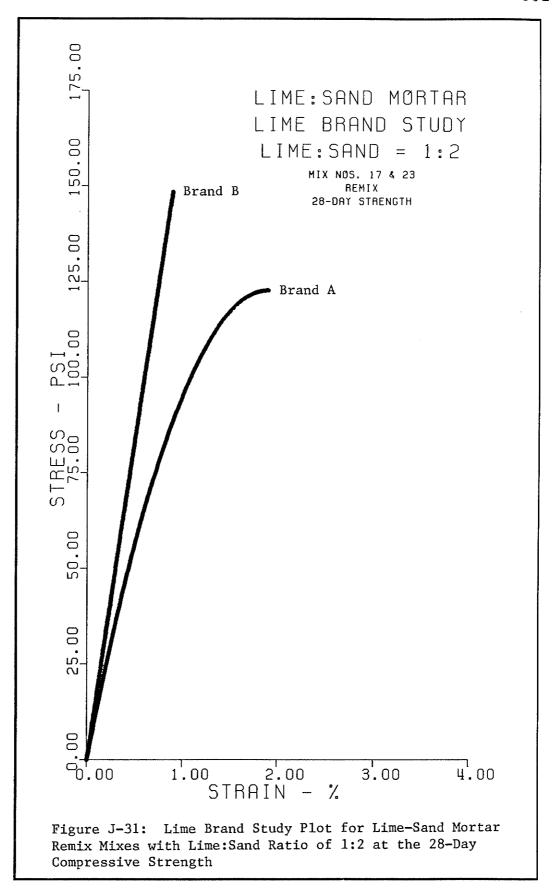












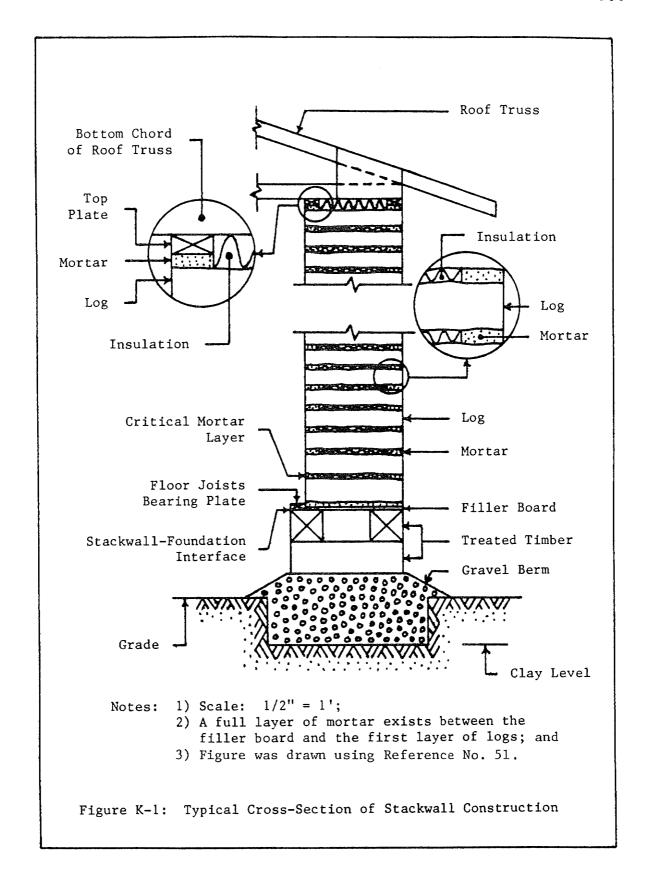
Appendix K

MORTAR STRENGTH REQUIRED FOR STACKWALL CONSTRUCTION

In the laboratory, the mortar was tested in the form of twoinch cube specimens while the mortar in a stackwall structure is in a different form. What is the laboratory mortar
strength required that would correlate to the mortar
strength required for stackwall construction? Sought for
was an <u>adequate</u> strength (see Appendix A) with a generous
safety factor rather than high strength.

Figure K-1 shows a typical cross-section of stackwall construction. The Northern Housing Committee of the University of Manitoba [51] evaluates the load for a one- and two-storey stackwall house to be respectively one and two kips per linear foot of wall; these figures represent the loading at the stackwall-foundation interface. This loading is assumed to be uniaxial with no eccentricity thereby creating a pure compressive state of stress.

Intermittent lateral forces such as that due to wind are assumed to be non-governing since stackwall construction consists of a wall that can be described as being stubby relative to conventional masonry (see Definitions). In addition to the compressive strength, an analysis of lateral



forces would involve the bond strength of mortar; the bond strength of the mortars examined in this investigation was not measured.

Reference 51 [p. 44] states that the mortar joint of stackwall construction should have a width of three to four inches. In practice, the width used is usually three and one-half to four inches [51]. In calculating the compressive stress on the mortar, a width of three inches will be used; this will represent a higher stress situation than usually met in practice.

As indicated in Figure K-1, page 503, due to a lower bedding area, the critical mortar layer will be taken on top of the first layer of logs instead of the stackwall-foundation interface. The total area of mortar at this point per linear foot is:

- = No. of mortar joints x (width of joint x length of joint)
- $= 2 (3" \times 12")$
- $= 72 in.^{2}$.

Assuming that the full load is present on this area, the maximum compressive stress of the mortar for a one storey stackwall house is:

- $\sigma = load/area$
 - $= 1,000 lbs./72 in.^{2}$
 - = 14 psi.

At this point, it does not mean that the strength of a two-inch cube mortar specimen, tested in the laboratory, requires a compressive strength of 14 psi. to be satisfactory for stackwall construction. The two different conditions of stress must first be correlated before any comparison can be made.

In the laboratory, the height-diameter ratio of the cube specimen is one (2/2 = 1); in stackwall construction, assuming a maximum of one inch thickness for the mortar [51, pp. 40, 43], the height-diameter ratio is 1/3 (height of mortar joint/width of mortar joint). The literature indicates that as the height (length for a cylinder) of the specimen in compression is reduced, the effect of the frictional restraint at the ends become relatively important [28, p. 139]. If the specimen is so short that a normal failure plane cannot develop within the length of the specimen (i.e. diagonal planes intersect the base), then the apparent strength is appreciably increased and other types of failure, such as crushing, may occur [28, pp. 139, 146]. The literature also indicates that as the ratio of joint thickness to the height of a building block decreases, the masonry strength increases [30, p. 32].

The effects of size and shape of the test specimen are noted in the testing of concrete -- a non-homogeneous, brittle material. To standardize tests, correction factors, to take into account the length-diameter ratio of the specimen, are set up for concrete testing [28, pp. 147 to 148].

It is suggested that for a homogeneous material, the unit compressive strength varies with the shape of the specimen, being dependent upon the ratio between the least horizontal dimension and height [12]. The mortars examined in this study as well as the conventional mortars (see Definitions) are assumed to be homogeneous materials. For a laboratory mortar cube, the above ratio is one. A mortar joint in a stackwall wall has a minimum width of three inches [51, p. 44] and a maximum of one inch thickness [51, p. 40]. In the stackwall joint, the above ratio is 3/1 = 3. The strength required of the mortar used for a one storey stackwall house should then theoretically be

$$14/3 = 4.7 \text{ psi.}$$
 [12].

If the joint's width is increased and/or height decreased, this theoretical figure would become even lower. For example, if the mortar was given the width of four inches and a height of three-quarters of an inch, the above ratio would become 4/0.75 = 5.3. The theoretical strength required would then become

$$14/5.3 = 2.6 \text{ psi.}$$
 [12].

The required strength can be lowered further if one closely examines the true state of stress of the mortar in the wall. In conventional masonry (see Definitions) subjected to uniaxial compression, the mortar is put into a

state of triaxial compression and the masonry unit is put into a state of uniaxial compression (in the direction of loading) and lateral biaxial tension [40, pp. 34 to 35; 60, pp. 103, 128]. The biaxial tension of the masonry unit is due to the mortar having a tendency to spread out laterally under load. In response, the unit reacts in the opposite direction so as to maintain equilibrium creating lateral biaxial compressive stress on the confined mortar.

If the mortar in stackwall construction is in a state of triaxial compressive stress, as in conventional masonry (see Definitions), the strength of that mortar would be appreciably higher than the mortar tested in the laboratory which is in an unconfined and uniaxial compressive state of stress. If a correlation between these two different states of stress were known, the required laboratory strength of mortar could be reduced further. One way of getting a better indication of how the mortar and building units react together is by assemblage and wall panel type of tests.

Assemblage and wall panel type of tests is a more valuable laboratory strength test than mortar cubes, since in good masonry work, mortar becomes an integral part of the wall, even though it may occupy a small percentage of wall area. Mortar cubes do not remotely emulate masonry wall conditions such as effect of absorption by masonry units, consolidated weight of wall and particularly the profound influence of the strength of the units [12].

In masonry work, safety factors of five to 15 are completely adequate [12]. If assemblage and/or wall panel (built and seasoned as it would be in the field) tests are performed for tensile bond strength, shear strength and compressive strength, load factors between four and five may be sufficient for masonry construction; otherwise load factors of 10 or higher have to be used [30, pp. 35 to 36]. Since only mortar cubes were used in this study, a safety factor of 10 will be used.

Previously it was calculated that a theoretical mortar compressive strength of 4.7 psi. was required for a one-storey stackwall house. With the safety factor applied, the theoretical strength required becomes

$$4.7 \times 10 = 47 \text{ psi.}$$

It must be remembered that this figure assumes the highest stress situation with the mortar, having the minimum width of three inches and a maximum thickness of one inch; if the width were increased and/or the height decreased, this figure would be lower.

The loading for a two-storey stackwall house was previously found to be twice that for a one-storey house [51]; this means that the theoretical mortar strength required for a two-storey stackwall house is

$$47 \times 2 = 94 \text{ psi.}$$

Before finalizing the required mortar strength for stackwall construction, a comparison check should be performed with respect to the building unit. There is considerable support to the theory that mortar should never be stronger than the masonry unit since under settlement or deflective stresses, the unit, rather than the mortar is more likely to crack [12]. In conventional masonry (see Definitions), the primary comparison check between the mortar and the unit is simply the laboratory compressive strength of the two.

If the wood in stackwall construction experiences the same state of stress as conventional masonry (see Definitions) subjected to uniaxial compression, the wood would be in uniaxial compression (in the direction of loading) and lateral biaxial tension. Due to wood being an anisotropic material, three different types of stresses would be experienced. Figure K-2 demonstrates these stresses on a stackwall unit (log) at one of the two mortar joints which exist on a unit (see Figure K-1, page 503). The stresses are: 1) compression perpendicular to the grain, f_{cl} ; 2) tension parallel to the grain, f_{tl} .

All of the above three stresses are important in determining the strength of stackwall construction. However, using the primary comparison check used in conventional masonry (see Definitions), only the compressive stress per-

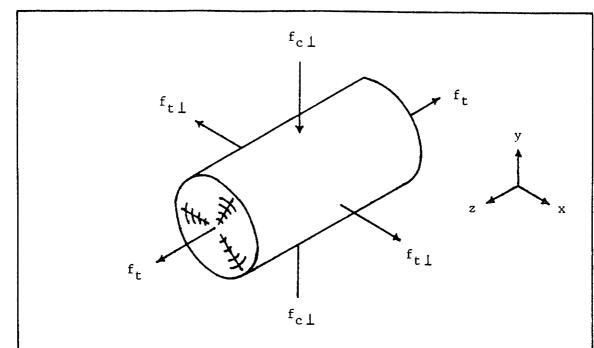


Figure K-2: Theoretical Stresses on a Stackwall Unit (Log) at One of the Two Existent Mortar Joints

pendicular to the grain of wood will be checked against the required compressive strength of the mortar. The Canadian Wood Council (CWC) Datafile WP-3 [22] tabulates the allowable stresses for different grade categories of wood. Wood in the walls of stackwall construction would fit the grade category of Post and Timbers 5" x 5" and Larger. For this grade category, the allowable compressive stress perpendicular to the grain ranges from 180 to 460 psi. The value within this range is determined by the species of wood used as given by Table K-I. Stress modification factors must be applied as follows:

$$F_{CL}' = F_{CL}K_{SCL}K_{F}K_{D}$$
 [43, p. 164]

where:

 $F_{C\perp}$ = modified allowable compressive stress perpendicular to the grain of wood;

 $F_{C\perp}$ = allowable compressive stress perpendicular to the grain of wood;

 κ_{F} = treatment modification factor for wood; and

 K_D = load duration modification factor for wood.

An examination of $K_{\rm Scl}$, $K_{\rm F}$ and $K_{\rm D}$ [43] with respect to stackwall construction all prove to have the value of 1.00, thereby having no effect on the above mentioned figures.

Hence, depending upon the wood species used in stack-wall construction, the laboratory compressive strength of mortar used should theoretically not exceed 180 to 460 psi. (see Table K-I).

From the calculated compressive stress requirements of mortar and the compressive strength perpendicular to the grain of wood as used in stackwall construction, a minimum and maximum range of laboratory mortar compressive strength $(f_m^{'})$ is attained.

Table K-I

Allowable Compressive Stress Perpendicular to Grain (F_C1) of Wood for the Grade of Posts and Timbers 5" x 5" and Larger1

Commercial Species Group Designation	Species in Combination	
Douglas Fir-Larch (North)	Douglas Fir, Western Larch.	460
Hem-Fir (North)	Pacific Coast Hemlock, Amabilis Fir, Grand Fir.	235
Eastern Hemlock Tamarack (North)	Eastern Hemlock, Tamarack.	405
Coast Species	Douglas Fir, Western Larch, Pacific Coast Hemlock, Amabilis Fir, Grand Fir, Coast Sitka Spruce.	235
Spruce-Pine-Fir	Spruce (all species except Coast Sitka Spruce), Ponderosa Pine, Lodgepole Pine, Jack Pine, Alpine Fir, Balsam Fir.	245
Western Cedars (North)	Western Red Cedar, Pacific Coast Yellow Cedar.	280
Northern Species	All species above plus: Red Pine, Western White Pine, Eastern White Pine.	235
Northern Aspen	Trembling Aspen, Largetooth Aspen, Balsam Poplar.	180

 $^{^{1}\}mathrm{As}$ published by the Canadian Wood Council [22].

For a one-storey stackwall house:

47 psi.
$$\leq$$
 f_{m}^{\prime} \leq 180 to 460 psi.

For a two-storey stackwall house:

94 psi.
$$\leq$$
 f_{m}^{\prime} \leq 180 to 460 psi.

The upper limit (180 to 460 psi.) is determined from the species of wood used in stackwall construction as given by Table K-I, page 512. These values will be assumed to be the 28-day compressive strength requirements as tested on two-inch cube specimens in the laboratory.

Appendix L

INITIAL UNIT COST OF MORTARS

Calculated in this appendix is the initial unit cost of three different type of mortars. Initial cost is defined as the cost to obtain the mortar components. The mortar types looked at are: 1) conventional mortar (see Definitions); 2) clay mortar; and 3) lime-sand mortar. The Portland cement:hydrated lime:sand (P.C.:L:S) volumetric ratio used for the conventional mortar (see Definitions) calculations is 2:1:6. This is the same mortar that is suggested for stackwall construction by the Northern Housing Committee [51, p. 20]. Mix No. 2 is used for the clay mortar calculations. For the lime-sand mortar, the initial cost is given for the lime:sand (L:S) volumetric ratios of 1:2, 1:3 and 1:3.5. An example calculation is performed for the ratio of 1:3.

Following are the assumptions made in the calculations:

1. Portland cement, hydrated lime and sand measured volumetrically with gentle shaking have the following weight per cubic foot [45, p. 361]:

Portland cement = 85 lbs./ft.3

hydrated lime = 35 "

sand (dry) = 100 "

- When necessary, it is assumed that the volume of Portland cement and/or lime contribute very little to the total volume of a mortar; this assumption is based on the fact that Portland cement and lime are very fine materials that fill the gaps between the coarser materials. This implies that the volume of mortar, if needed, will be determined by the volume of the coarser dry materials.
- 3. Although in somewhat different quantities, the cost of water for each type of mortar is assumed to be very low and not worthwhile to include as part of the initial cost calculations. This implies that the cost calculations are based only on the dry materials.
- 4. The cost of obtaining clay for clay mortar is assumed to be negligible. This assumption is made on the basis that clay is usually available at or near most stackwall construction sites; this is the primary reason why clay mortar was examined.
- 5. Clay mortar Mix No. 2 is assumed to have a density of 85 pcf. This is the average density of Mix Nos. 7 to 11 (see Table VIII, page 97). The density measurement of Mix Nos. 1 to 6 was not performed.

Accuracy of Assumption No. 2 is checked for a lime-sand mortar mix with a lime:sand volumetric proportion of 1:3.65.

One cubic foot of lime and 3.65 cubic feet of sand are used

in the calculations. Using the density weights defined in Assumption No. 1, the weight of the materials in the mix should be:

Using Assumption No. 2, the dried volume of this mixture will be taken as 3.65 cubic feet, the volume of the coarser dry material, namely the sand. Therefore, the density of the mix should be:

$$\frac{400 \text{ lbs.}}{3.65 \text{ ft.}^3} = 110 \frac{\text{lbs.}}{\text{ft.}^3}$$

Checking with Table XXI, page 149, Mix No. 21, which has a lime:sand ratio of 1:3.65, was measured as having a density of 110 pcf. This figure agrees with the above theoretical figure. If the volume of the lime were included in the total volume, the density would become:

$$\frac{400}{(3.65 + 1) \text{ ft.}^3} = 86 \text{ lbs.}$$

This figure differs significantly from the measured density of 110 pcf. From the above, it is concluded that Assumption No. 2 has validity.

Similar checks with the other mixes also show that Assumption No. 2 is reasonable.

The cost of the individual mortar components can differ from area to area, within an area, and with time. Quoted in Table L-I are the prices of the various mortar components in Winnipeg, Canada as of June, 1987. In this table, a price range exists for Portland cement and lime due to the various prices found among 11 different suppliers. These prices

Table L-I Prices of Various Mortar Components in Winnipeg, Canada June, 1987			
Material	Price		
Portland Cement	\$(6.99 to 8.89) ¹ per 40 kg.		
Normal Hydrated Lime	\$(5.55 to 9.99) ¹ per 25 kg.		
Mortar Sand	\$12.05 per yd.3		
Clay	Assumed Negligible		
Flax Straw	\$0.50 per Bale (about 28 lbs.)		
Water	Assumed Negligible		
$^{ m 1}$ Price range found among 11 different suppliers.			

will be used in the initial unit cost calculations.

L.1 CONVENTIONAL MORTAR

The conventional mortar (see Definitions) suggested for stackwall construction by the Northern Housing Committee [51, p. 20] is:

Portland cement: lime: sand volumetric ratio = 2:1:6.

In the calculations, volumes of one cubic foot and Assumption Nos. 1 through 3 is used. First the theoretical density is determined.

Weights:

Portland cement = $2 \times 85 = 170 \text{ lbs.}$ hydrated lime = $1 \times 35 = 35$ "

mortar sand = $6 \times 100 = 600$ "

total weight = 805 lbs.

theoretical density =
$$\frac{805 \text{ lbs.}}{6 \text{ ft.}^3}$$
 = $\frac{134 \text{ lbs.}}{6 \text{ ft.}^3}$

Amount of individual materials per cubic foot:

Portland cement = $(170/805) \times 134 = 28.3 \text{ lbs.}$ hydrated lime = $(35/805) \times 134 = 5.8 \text{ "}$ mortar sand = $(600/805) \times 134 = 99.9 \text{ "}$ total weight = 134.0 lbs. (check) Cost of materials per cubic foot of mortar:

Portland cement

28.3 lbs. x kg. x
$$\frac{(6.99 \text{ to } 8.89)}{2.2046 \text{ lbs.}}$$
 = \$(2.24 to 2.85)

hydrated lime

5.8 lbs. x kg. x
$$(5.55 \text{ to } 9.99) = (0.58 \text{ to } 1.05)$$

2.2046 lbs. 25 kg.

mortar sand

The total cost of one cubic foot of conventional mortar (see Definitions) (P.C.:L:S = 2:1:6) is:

$$= ($2.24 + 0.58 + 0.45)$$
 to $$(2.85 + 1.05 + 0.45)$
 $= $(3.27 \text{ to } 4.35).$

L.2 CLAY MORTAR

Mix No. 2 is used for the calculations. In these calculations volumes of one cubic foot and Assumption Nos. 1 through 5 are used. Referring to the proportion of materials of Mix No. 2 (see Chapter VI, Conclusions, page 268), and arbitrarily starting off with 100 pounds of clay, the weight of the materials used for calculation purposes is first determined.

Weights:

$$clay = 100 lbs.$$

$$mortar sand = 33.3 "$$

$$flax straw (fibres) = 1.75 "$$

$$hydrated lime = 3.0 "$$

$$total weight = 138.05 lbs.$$

Density: assumed 85 pcf. (see Assumption No. 5)

Amount of individual materials per cubic foot:

clay =
$$(100/138.05) \times 85 = 61.6 \text{ lbs.}$$

mortar sand = $(33.3/138.05) \times 85 = 20.5$ "

flax straw (fibres) = $(1.75/138.05) \times 85 = 1.1$ "

hydrated lime = $(3.0/138.05) \times 85 = 1.8$ "

total weight = 85.0 lbs. (check)

Cost of materials per cubic foot of mortar:

clay

\$0. (see Assumption No. 4)

mortar sand

20.5 lbs. x ft.³ x yd.³ x
$$\frac{\text{yd.}^3}{100 \text{ lbs.}}$$
 x $\frac{\text{yd.}^3}{27 \text{ ft.}^3}$ x $\frac{\$12.05}{\text{yd.}^3}$ = \$0.09

flax straw (fibres)

1.1 lbs. x
$$\$0.50 = \$0.02$$

28 lbs.

hydrated lime

1.8 lbs. x kg. x
$$(5.55 \text{ to } 9.99) = (0.18 \text{ to } 0.33)$$

2.2046 lbs. 25 kg .

The total cost of one cubic foot of clay mortar Mix No. 2 is:

$$= $(0.09 + 0.02 + 0.18) \text{ to } $(0.09 + 0.02 + 0.33)$$
$$= $(0.29 \text{ to } 0.44).$$

L.3 <u>LIME-SAND MORTAR</u>

The lime-sand mortar used for an example calculation is:

lime:sand volumetric ratio = 1:3

In the calculations, volumes of one cubic foot and Assumption Nos. 1 through 3 are used. First the theoretical density is determined.

Weights:

hydrated lime = 1 x
$$35 = 35$$
 lbs.
mortar sand = 3 x $100 = 300$ "
total weight = 335 lbs.

theoretical density =
$$\frac{335 \text{ lbs.}}{3 \text{ ft.}^3}$$
 = $\frac{112 \text{ lbs.}}{\text{ft.}^3}$

Amount of individual materials per cubic foot:

hydrated lime =
$$(35/335) \times 112 = 11.7 \text{ lbs.}$$

mortar sand = $(300/335) \times 112 = 100.3$ "
total weight = 112.0 lbs. (check)

Cost of materials per cubic foot of mortar:

hydrated lime

11.7 lbs. x kg. x
$$\frac{(5.55 \text{ to } 9.99)}{2.2046 \text{ lbs.}}$$
 = \$(1.18 to 2.12)

mortar sand

The total cost of one cubic foot of lime-sand mortar (L:S = 1:3) is:

=
$$\$(1.18 + 0.45)$$
 to $\$(2.12 + 0.45)$
= $\$(1.63 \text{ to } 2.57)$.

Table L-II collectively shows the initial unit cost of the three different types of mortars studied in this appendix. Included as the last column of this table is a comparative cost analysis with respect to the conventional mortar (see Definitions) [P.C.:L:S = 2:1:6 as recommended for stackwall construction by the Northern Housing Committee -- Reference 51, p. 20]. The cost of clay mortar Mix No. 2 is 0.09 to 0.10 times that of the conventional mortar (see Def-

initions). For lime-sand mortars with lime:sand volumetric proportions of 1:2, 1:3 and 1:3.5, the cost is correspondingly 0.68 to 0.84, 0.50 to 0.59 and 0.45 to 0.52 times that

Table L-II Initial Cost Analysis of Various Mortar Types			
Mortar Type	initial Cost Per Cubic Foot1	Cost Relative to Conventional Mortar ²	
Conventional3 (P.C.:L:S = 2:1:6)	\$(3.27 to 4.35)	1.0 to 1.0	
Clay (Mix No. 2)	\$(0.29 to 0.44)	0.09 to 0.10	
Lime-Sand (L:S = 1:2)	\$(2.22 to 3.64)	0.68 to 0.84	
Lime-Sand (L:S = 1:3)	\$(1.63 to 2.57)	0.50 to 0.59	
Lime-Sand (L:S = 1:3.5)	\$(1.46 to 2.26)	0.45 to 0.52	

 $^{^{1}\}mathrm{Based}$ on assumptions listed at the beginning of this appendix and Table L-I, pages 514 to 515 and 517 respectively.

of the conventional mortar (see Definitions).

 $^{^2\}mathrm{Lower}$ and higher values are comparative to the respective lower and higher costs.

 $^{^3}$ Mortar presently recommended for stackwall construction by the Northern Housing Committee [51, p. 20].