MICHIGAN
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INVESTIGATIONAL CONCRETE PAVEMENT

IN

MICHIGAN

By

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MICHIGAN TEST ROAD

Conclusions obtained by theoretical formulae on concrete pavement design according to many contemporary authors are not completely substantiated by practical observations in certain localities or under varying conditions. If it be true that there is a disparagement between these conclusions and practical observations of certain localities - then before any locality can accept such conclusions it is necessary to determine the causes for such differences and, where necessary, determine the proper conclusions for the given conditions. This status and the desire to improve practices impelled the Michigan State Highway Department to construct an experimental concrete pavement which would embody certain modern theories of design and methods of construction. The decision to build such a road was made prior to the submission by the Public Roads Administration of plans and procedure for construction of experimental roads to various state highway organizations. For this reason the set up is not entirely in agreement with the aforementioned plans. However, the plans of the Michigan Test Road coincided in a general way with the Public Roads Administration outlined procedure and necessitated only a few changes to correspond with other similar studies.

The road was constructed on M-115 in the north central part of Michigan's lower peninsula and entails a length of approximately 10.7 miles. This is of sufficient length to reduce the variables of construction to a minimum for each feature investigated. With the exception of a few thousand feet of clay underlying a one-foot sand cushion, the entire project was placed on a uniform sand subgrade constructed in 1937. This subgrade condition insured a uniformity in density and friction which will introduce few variables in the final analysis. The location of this project is ideal from the standpoint of grade, alignment and average weather conditions of Michigan. The maximum grade is 0.65 per cent, the maximum curvature 0°45' with an approximate length of 3.500 feet. The experimental project was constructed as a 22-foot width road under regular contract and construction procedure using the Michigan State Highway Department's 1940 plans and specifications with a few supplements. The concrete aggregate was supplied from a local gravel pit of glacial origin common to Michigan.

For the purpose of this report, the planning and construction of the experimental road may be divided into three groups namely, features of design, methods of measurement and incidental studies.

Features of Design

The structural adequacy of a concrete pavement slab from the standpoint of strength and permanency is influenced by the features of design which determine its continuity and dimensions. The features which were given study in the Michigan Test Road were joints, cross section dimensions and reinforcing.

Joints: The most desirable concrete pavement would eliminate all transverse joints both expansion and contraction, but because of the nature of concrete, joints are a necessary evil. Joints have been one of the most controversial subjects in the design of concrete pavements. Therefore, considerable attention was given to this subject in the Michigan Test Road.

Emphasis was placed upon joint spacing, expansion space, and joint construction.

Spacing: The primary end in the design of joint spacing should be the minimum use of joints particularly for expansion. As each joint breaks the continuity of the concrete pavement and incorporates a new weakness, the maximum slab length should be used. Because of the necessity of transverse joints the pavement requires a design to approach a contiguous slab resistant to static and natural stresses.

Expansion Joints: In the Michigan Test Road, expansion joints were spaced to give sections of 120 foot, 360 foot, 480 foot, 600 foot, 900 foot, 1800 foot and 2700 foot lengths for various cross sections and various amounts of reinforcing steel. In addition, 300 foot sections were constructed on 7 inch and 8 inch uniform pavement without reinforcement steel. Since the project is built over a uniform subgrade, the findings should enable us to determine a selection of proper slab lengths for the various pavement designs.

Closely associated with expansion joint spacing is the requirement of expansion space. A one-inch joint width was maintained for the various lengths of slabs. Tests on joint width movement will be a primary factor in determining the necessary expansion opening. In the case of long expansion joint intervals, relief sections are placed between each slab section and will relieve any movement in excess of amount provided for in the expansion joint opening. It is not expected that the required expansion space will be a direct function of the unit length of slab but no arbitrary opinion will be made at this time. Rather the results of the investigation on the project will determine the relative slab movement versus slab length.

<u>Contraction Joints</u>: As in the case of expansion joints, contraction joints are essential in concrete pavement construction to relieve the slab of excessive stresses. The spacing of the contraction joints is determined by the maximum length of slabs that eliminates the possibility of transverse crack occurrence intermediately between contraction joints due to temperature, moisture and subgrade reactionary stresses. Determination of proper contraction joint spacing will be obtained from the analysis of the varying slab lengths which have been constructed at 10, 15, 20, 30 and 60 foot intervals. These varying spacings have been included with the construction of the various cross sections and expansion joint spacings as described above and shown in detail on composite chart.

Weakened plane "dummy" joints also are included in some of the sections and are placed at 15 and 30 foot spacings for 8" -6" -8" and 9" -7" -9" cross section pavement using 37 and 60 pounds per 100 square feet reinforcing steel. This type of joint is used in Michigan construction as standard practice and an opportunity is afforded to evaluate weakened plane joints with contraction joints at close spacings.

The proper spacing of joints will be determined by permissible maximum stress intensities induced by linear frictional restraint and flexural weight restraint; whereas the detailed design features of the joint itself are determined by the desired structural interaction between jointed slab units.

<u>Design</u>: The design of joints necessitates consideration of structural features which will enable the joint to perform the function for which it is intended. Among which are freedom of movement for expansion or contraction, flexibility and load transfer where necessary. Together with

these functions, consideration must be given in the joint design so that in construction adequate seal can be affected to prevent infiltration of water and foreign matter. Although these phases were not of major importance in this project, several units of various types of expansion and contraction joints were installed. These installations were made with the intent of determining their design weaknesses in order that a more perfect joint might be developed.

In connection with the study on expansion joints, the efficiency of dowel bars and other load transfer devices will be compared with thickened edge joints for balanced design of pavement.

In conjunction with the contraction joint spacing investigation, various load transfer devices were installed together with dummy contraction joints having no feature for transference of load. Four major types will be studied, first, aggregate interlock with load transfer which involves the use of coated 3/4 inch round bars 15 inches in length at 15 inch spacing transversely. Either a groove or ribbon type weakened plane 2-1/2 inches deep is used to control crack development. The aggregate interlock which results from the crack formed below the weakened plane aids in the transference of load when the joint is in a closed condition. With the joint in an open position, the slip dowel bars function independently in the distribution of load stresses.

The second type of contraction joint is essentially the same as the first with the elimination of slip dowel bars. In this type of construction, the transfer of load is dependent entirely upon aggregate interlock. In effect, the ends of abutting slabs act as free units when the joint is open, and perform no load transfer across the joint. Load transfer is obtained only when the joint is in a closed condition.

The third type of contraction joint makes use of the 3/4 inch dowel bars without any assistance from aggregate interlock. This was accomplished by installing joints with a metal divider plate to insure a vertical division of the slabs with load transfer through slip dowel bars only.

The fourth type consists of a continuous plate dowel with a metal dividing strip. This type is intended to provide more uniform distribution of load transfer.

In some cases, both in expansion and contraction joints, corner bars 1 inch in diameter by 18 inches in length were used to maintain mutual elevation of the slabs.

These installations should enable us to evaluate load transfer and preservation of mutual elevation when using aggregate interlock, aggregate interlock plus load transfer devices and independent load transfer devices.

CROSS SECTION

In the design of a pavement slab on the basis of stress analysis many factors must be considered. The complex manner in which these factors are inter-related and the value of the factors has provided a very controversial field.

It was believed, by the planners of the Michigan Test Road, that on certain types of subgrades providing better than average support, reduced thickness of pavement might be used. Also, it has been argued that equivalent uniform thickness pavements are perhaps more satisfactory and economical than the balanced cross sections; for example, a uniform thickness pavement designed to resist transverse edge stresses requires no joint strengthening whereas the thickened edge type cross section demands strengthening for a balanced section. It was hoped, in the planning of the Michigan Test Road, that some of these factors could be measured and some of the complex relations studied and simplified. Therefore, four different types of cross sections were set up in the study of this project namely, 9"-7"-9", Michigan State Highway Department standard cross section; 8" uniform, the approximate equivalent of 9"-7"-9"; 8"-6"-8" a reduced cross section which might be used on subgrades of sufficient supporting value; and 7" uniform, the approximate equivalent of the preceding cross section.

REINFORCEMENTS

Elaborate surveys have been made upon concrete pavements to determine the value of steel reinforcing in concrete pavements. The results from such surveys have again opened up a controversial field in regards to the design of concrete pavements. Although the proponents of plain concrete pavements can present many plausible arguments, there are many unanswered questions. Among these unanswered questions are:

(1) Relation of plain uniform cross section to reinforced "balanced" cross section.

(2) Economics of reinforced cross sections of both types versus plain cross sections with adequate jointing.

(3) What is an adequate amount of reinforcing steel?

It was felt in planning the Michigan Test Road that inasmuch as the length of the project allowed for comparatively long stretches of both types of pavements to be constructed and observations could be made under identical conditions, perhaps some of the questions might be answered. To this end, sections were constructed using 9"-7"-9"; 8"-6"-8"; 8" and 7" uniform cross section using plain concrete, and reinforced concrete with 60 pounds per hundred square feet and 37 pounds per hundred square feet. Joints were spaced in the manner as described under 'Joint Spacings'.

METHODS OF MEASUREMENT

For proper appraisal of the structural efficiency of the elements of design considered in this project, periodic visual examinations together with measurement of displacements and physical conditions must be made. The program of observations as set up by the Public Roads Administration will be adhered to. Therefore, only the methods of measurement used on the Michigan Test Road will be discussed.

DISPLACEMENTS

The displacements which occur in the various design sections are affected by volume change of concrete, superimposed loads and subgrade differentials. These displacements are determined by change in joint width and slab movement horizontally and vertically.

Joint Width Change: Joint opening and closing is measured on reference points which are holes drilled in heads of galvanized roofing nails. A Starrett micrometer caliper reading to 1/1000 inch was adapted for taking measurements. The initial readings were taken the morning following the placing of the concrete pavement and subsequent readings for daily, seasonal and permanent joint width determinations will be made as per schedule similar insofar as possible to the Public Roads Administration outline. To insure accuracy of the readings and avoid any criticism of the results in the use of roofing nails as reference points, in one section consisting of a days pour, a series of comparative brass plugs were installed, held in place with sulphur. Coincident readings will be taken at these points and if variations develop that have been caused by corrosion of the nail heads, the entire project will be replaced with brass plugs set in sulphur. In this manner, the accuracy of the results will not be affected and initial readings will have been determined that exclude the possibility of an unrecorded early joint width movement. Thus, a definite permanent deformation of the concrete pavement is established whereas the placing of plugs a day or two following the placing of the concrete pavement would not include the early movement of the concrete slabs.

Slab Movement: Practically all of the joints being studied for width movement have precise level reference points consisting of 5/16 inch by 2-1/2 inch carriage bolts, set in the concrete at the time of the construction of the pavement to determine the vertical movement at the joints. Intermediate reference points were set in a number of slabs. The day following placing of the concrete, the initial elevations of all points were established by precise level measurements. During this coming winter, preferably a uniformly cold period, a complete set of levels will be run. This will be repeated during the summer of 1941, selecting a uniformly high temperature period. In this manner, the extremes in temperature variation and their effect on the concrete pavement will be established. Three years following the construction of the design project, a third set of levels will be run for observations on permanent vertical slab movement.

The relative horizontal movement of various concrete pavement slabs will be measured in conjunction with the vertical displacement and at such other times as may be necessary. To obtain the accurate measurement of pavement movement, an 8 inch pipe casing was set in the subgrade to a depth of 6 feet, the interior of which is excavated. Centered in the casing is a 2 inch pipe to a depth of 12 feet below the concrete pavement on top of which is placed a chrome plated pipe cap having reference cross hairs etched in the surface. In this manner the shifting of subgrade soil due to frost action or slab movement will not affect the original position of the reference pipe. A specially designed monument box, containing a machined brass bushing to hold a glass plate having etched cross hairs, set in a brass ring, is cast in the concrete immediately over the 8 inch casing. With a telescopic instrument so constructed to permit adjustments both longitudinally and transversely in respect to the concrete pavement, the increments between sight on reference pipe and reference plate can be measured to 0.1 mm. A line of sight is established at initial reading parallel to center line of pavement at location of monument box and the instrument attached on a tripod which can be repeatedly set up with a positive assurance of accuracy as to position and alignment. This feature of the design study incorporates observations on seventy-nine of the described installations.

PHYSICAL CONDITIONS

Physical conditions which must be measured may be classified as those which affect slab movements and those which are the result of slab movement. These conditions which are being measured in the Michigan Test Road are; temperature of concrete, moisture content of concrete and subgrade, strain in concrete, subgrade bearing capacity and meteorological conditions.

Temperature of Concrete: The temperatures of the concrete pavement and subgrade are determined by the use of thermocouples embedded in the concrete and subgrade. For the pavement slab they are placed every inch through its depth beginning one inch from the surface. Subgrade temperatures are made at the following depths below concrete pavement, 1, 3, 7, and 13 inches. Four such layouts were installed 5 feet 6 inches from the edge of the pavement at critical points in the design project. At one of these locations two additional thermocouple assemblies were embedded as described above with the exception that the distance from the edge of pavement was 1 inch and 10 feet 6 inches respectively in order to obtain temperatures at extreme edge and center of slab. All the thermocouple junctions were cast in lead after twisting and brazing and the point of entrance of wire leads into lead plug taped and sealed with asphalt. This was done to insure true temperature readings without being affected by moisture leaks. All the thermocouple wires were entered through a common conduit into an electrical outlet box at the edge of the slab. The iron wire leads are connected to one pole and constantin wire leads to individual poles of a plug-in type. The 32°F. constant temperature cold junction method is used to ascertain resistances. Rapidity in the reading of the temperature resistance is obtained by this assembly as the iron connecting lead is plugged into the common pole and requires only the change on the constantin wire lead for each reading.

Moisture Content: At the same locations of thermocouples, moisture cell assemblies were also installed in the concrete pavement and subgrade to accurately measure moisture content. The moisture is determined, coincident with the temperature at similar adjacent positions in the slab and subgrade. The cells used for measuring moisture content consisted of two exposed wires separated one inch and cast in chemically pure plaster of Paris to form blocks 1/2 inch by 1-1/2 inches by 2-1/2 inches approximately. The moisture bridge measures the resistance in ohms of potential from one pole to the other and the moisture content of the cell being inversely proportional to the resistance. Extensive laboratory tests show that accurate determinations of the moisture in concrete can be made in direct relationship to moisture content of the measuring cell. The temperature and age of the concrete create variables in recording the moisture but a nomograph has been constructed for adjusting the resistance readings for such variations to obtain the true moisture content of the concrete pavement. In the subgrade a correction curve designed for temperature differentials only is necessary.

Both the thermocouple and moisture cell assemblies are so spaced in the design project as to eliminate large time losses when making other observations.

Strain in Concrete: The measurement of strain in the concrete is being made both at the neutral axis and at the surface of the slab. These measurements are being made at special locations to determine differences in tensile, compressive and warping stresses for various spacings of expansion and contraction joints.

The interior strains are being measured with the Carlson electric strain meter. Strains and temperatures of concrete are determined by the use of this device. This meter consists of very fine elastic music wire threaded on small porcelain spools that are rigidly secured to steel bars connected one to each end of the meter. One coil is immediately within the other but not touching it. The elastic wire is placed in position under tension and when the meter is under compression, the outer coil is released and the tension of the inner coil is increased, or vice versa for tension. The wire coils are at equal temperatures which is important as a 1/40° change introduces considerable error. Due to the linear relationship between resistance and tension, the resistance ratio is changed in direct proportion to the change in gage length. The coils are connected to a portable testing set, forming a Wheatstone bridge circuit. The strain meter is covered with a metal shield to protect it against moisture leaks and is embedded in the concrete in this manner. Twenty-six such meters have been placed at the desired locations in the design project to determine strains and temperatures in the various concrete pavement sections.

Immediately over the Carlson strain meters and at a few additional locations surface strain measurements are being determined by use of the Berry strain gage. In this manner, stress differentials between the surface and interior of concrete pavement can be analyzed for temperature and moisture changes in the concrete.

Subgrade Bearing Capacity: During construction of the project, subgrade tests of density and moisture content were conducted. Subgrade bearing capacity tests were conducted prior to placing of the pavement and check tests are contemplated through openings cored in the concrete pavement at the locations of the original tests. In these determinations, 10, 50 and 100 square inch area circular plates are used. The static load was applied through a hydraulic jack from a loaded truck. The resisting load was recorded by a dynamometer ring with a dial sensitive to 1/10,000 inch deflection of the ring. The penetration of the plate was measured with three 1/1,000 inch dials equally spaced around the edge of the plate. Bearing values are established for each size plate with and without a superimposed load surrounding the plate equivalent to the weight of the concrete slab over an area affected by slab weight in respect to area of plate being loaded.

It is hoped that the results of these tests will assist in the development of a simple method for determining subgrade modulus.

Meteorological Date: Throughout the construction of the project meteorological data was obtained including temperature, relative humidity, precipitation, evaporation, wind direction and velocity. The weather observation station has been permanently established and the gathering of this information will be continued for the entire period of the design project investigation predetermined as approximately five years.

INCIDENTAL STUDIES

In the construction of an experimental road certain incidental studies may be added which will not interfere with the plans and observations of the major items. A few incidental studies were introduced into the Michigan Test Road which were of interest to the Michigan State Highway Department and pertinent to the improvement of concrete slab construction. These sub-investigations comprised a study of various construction methods including; the stress curing of concrete, mechanical spreading of concrete and the use of various joint sealers.

Stress Curing: Eighteen hundred feet of concrete pavement was placed by the stress curing method of construction which eliminates steel reinforcement and transverse joints other than expansion. The slabs were laid in 100 foot lengths and the pre-stressing of the concrete accomplished by use of canvas covered rubber hose pressure cells inserted in the joint openings and expanded to exert pressures based on results of tests on representative specimens 7 by 9 by 14 inches cast throughout the period of construction of the stress curing section. The pressures were increased at a rate controlled by determinations of strength increase of specimens up to a maximum of

200 pounds per square inch. This pressure was maintained until the standard modulus of rupture beam tests reached the 7 day specification strength requirement of 550 pounds per square inch. After this period, one slab was utilized to determine the subgrade friction factor by making use of the pressure cells to actuate sliding and record exerted pressure necessary. The pressures were applied in increments of 25 pounds per square inch with a 10 minute time interval between each increase in pressure. In the first test no movement of slab resulted until pressure reached 187 pounds per square inch and then released with a resultant movement totaling 0.264 inch. There was a small amount of residual movement after release of the pressure. In the second run, definite movement of the slab occurred at 50 pounds per square inch with a resultant of 0.507 inch following application of 200 pounds per square inch load. A third test was run with very little change in values and the indicated subgrade value for sand was found to be about 1.75.

Mechanical Concrete Spreader: With the exception of 600 lineal feet, the concrete for the design project was placed and consolidated by means of a mechanical concrete spreader. Observations were made on the uniformity of distribution and placing of the concrete compared with and without spreader. Flexural strength tests on beams cast on the subgrade with and without concrete spreader and beams vibrated with internal vibrator will be reported for 7 and 28 day tests to determine characteristics of strength for each type of concrete placement. Preliminary conclusions relative to the concrete spreader indicate that the spreader is a valuable construction aid. Its use should allow much lower water content and requires less working of the concrete in finishing operations.

The study of the effectiveness of the concrete spreader was supplemented by the analysis of the fresh concrete. This analysis was made by the Dunagan method of "Determining Constituents of Fresh Concrete". Essentially, it is known that continued manipulation of a fresh concrete surface tends to displace the ingredients from a well graded mixture with the percentage of fines increasing toward the surface of the concrete. By taking three samples immediately following the transverse finisher at top, center and bottom of slab respectively where the spreader was used and comparing the results with analgous tests on standard construction, the distribution and aid in proper placement of concrete by use of the mechanical spreader can be determined.

Since a mechanical longitudinal finisher was used on construction of this project, similar test samples were taken immediately before and after to determine the effect of this method of finishing.

Joint Sealers: The finishing and spreading operations in the construction of a concrete pavement are very important in the development of the strength and durability of concrete slabs, yet there remains one other construction and design detail which may be of greater importance, namely, adequate and proper sealing of the joints. Probably many of our problems of pavement design would be simplified if more attention were given to thie important item. Over a period of successive temperature changes causing repeated joint opening and closing cycles the possibility and occurrence of infiltration of foreign matter will be multiplied. When this partial filling of joint openings takes place the primary purpose of the joints will be defeated and the entrance of foreign matter at transverse joints will reduce the effective width of the expansion joints, particularly in lengthy slabs, and subsequently high compression stresses will result which may not have been considered in the design. Equally important is the sealing of surface water from the subgrade.

Considerable attention has been given to this matter by the Michigan State Highway Department to the end that a seal of the asphalt oil latex type has been developed which shows promise of providing an adequate seal.

In this project all of the expansion joints were sealed with this material except a few in which other types of fillers were used. These types included poured rubber, premolded rubber and tar. A new type of expansion joint was also used which employs the poured filler of asphalt oil latex as a seal, completely sealing top, sides and bottom of joint. The contraction joints were sealed with premolded bituminous strip and asphalt oil latex seal. Periodic observations will be made to determine the effectiveness of the various types of seals.

CONCLUSIONS

A review of the details described herein leaves the reader to wonder whether the project may be too comprehensive for one research project. But, fortunately, the Michigan State Highway Department authorities recognized the value of such research and have provided an adequate staff of 18 members in its Research Division which should be capable of analyzing and evaluating the various phases of this research project.

The design section has included the consideration of the pertinent features of design in concrete pavements and methods have been developed for the measurement of factors important to the evaluation of these features. Further incidental studies are being made which supplement the major problems.

The design section has included the consideration of proper spacing of transverse joints, the amount of expansion space required per unit length, the efficacy of reinforcing steel in pavement slabs, the relation of the amount of reinforcing steel to joint spacing, the relation of thickened edge cross section versus uniform thickness, the efficiency of various types of joint design and seals and the value of various methods of construction.

It is hoped that the facts and relationships obtained will assist in the classification of many controversial issues and will serve in the development and improvement of the design and construction of concrete pavements.

COMPARISON OF MICHIGAN STATE HIGHWAY DEPARTMENT JOINT STUDY SCHEDULE WITH PUBLIC ROADS ADMINISTRATION SUGGESTED SCHEDULE

Section			Expansion		Contraction		Weakened Plane Dummy	Reinf. lbs. per hundred sq. ft.	Cross Section	Remarks
No.	Sched.	Length	Spacing	Load Trans.	Spacing	Load Trans.	Spacing			
1	PRA	5280'			15'-20'-25'	None	None	None	9"-7"-9"	Contraction spacing depends on type agg.
3F	MSHD	2700'	2700'		20'	D.B.	None	None	"	See 3F & 4F adjacent 1 joint in 1 mile
4F	MSHD	2700'	2700'		10'	D.B.	None	None	"	
3E	MSHD	1800'	1800'		20'	None	None	None	"	
4E	MSHD	1800'	1800'		10'	None	None	None	"	
2	PRA	2640'	800'	D.B.*	15'-20'-25'	None	None	None	"	*Approved load trans.
3-D-1	MSHD	900'	900'	D.B.*	20'	D.B.	None	None	"	
4-D-1	MSHD	900'	900'	D.B.	10'	D.B.	None	None	"	
3-D-2	MSHD	900'	900'	D.B.	20'	D.B.	None	None	"	
4-D-2	MSHD	900'	900'	D.B.	10'	D.B.	None	None	"	
3	PRA	2640'	400'	D.B.	15'-20'-25'	None	None	None	"	
3C	MSHD	1440'	480'	D.B.	20'	D.B.	None	None	"	
4C	MSHD	1440'	480'	D.B.	10'	D.B.	None	None	" "	
4	PRA	1320'	120'-125'	D.B.	15'-20'-25'	None	None	None	"	
10-B-1	MSHD	1080'	120'	D.B.	20'	None	None	None	"	
10-B-2	MSHD	1080'	120'	D.B.	15'	None	None	None	"	
5	PRA	1320'	120'-125'	D.B.	15'-20'-25'	D.B.	None	None	"	
3A	MSHD	360'	120'	D.B.	20'	D.B.	None	None	"	
4A	MSHD	360'	120'	D.B.	10'	D.B.	None	None	"	
10-A-1	MSHD	1080'	120'	D.B.	20'	D.B.	None	None	"	
10-A-2	MSHD	1080'	120'	D.B.	15'	D.B.	None	None	"	

6	PRA	1320'	120'	D.B.	60'	D.B.	None	70	9"-7"-9"
S	MSHD	600'	120'	D.B.	60'	D.B.	30	60	9"-7"-9"
1A	MSHD	360'	120'	D.B.	60'	D.B.	30	60	"
2A	MSHD	360'	120'	D.B.	30'	D.B.	15	37	"
5A to G	MSHD	2520'	120'	D.B.	30'	L.T.	None	37	"
7	PRA	1320'	120'	None	15'-20'-25'	None	None	None	8" unif.
6A	MSHD	600'	120'	D.B.	30'	None	None	None	8" unif.
6B	MSHD	600'	120'	None	20'	None	None	None	8" unif.
6C	MSHD	600'	300'	None	15'	None	None	None	8" unif.
6D	MSHD	600'	300'	None	10'	None	None	None	8" unif.
8A	MSHD	600'	120'	D.B.	30'	None	None	None	7" unif.
8B	MSHD	600'	120'	None	20'	None	None	None	7" unif.
8C	MSHD	600'	300'	None	15'	None	None	None	7" unif.
8D	MSHD	600'	300'	None	10'	None	None	None	7" unif.
1B	MSHD	720'	240'	D.B.	60'	D.B.	30'	60	9"-7"-9"
1C	MSHD	1440'	480'	D.B.	60'	D.B.	30'	60	"
1D	MSHD	1800'	900'	D.B.	60'	D.B.	30'	60	"
1E	MSHD	1800'	1800'	D.B.	60'	D.B.	30'	60	"
1F	MSHD	2700'	2700'	D.B.	60'	D.B.	30'	60	"
2B	MSHD	720'	240'	D.B.	30'	D.B.	15'	37	"
2C	MSHD	1440'	480'	D.B.	30'	D.B.	15'	37	"
2D	MSHD	1800'	900'	D.B.	30'	D.B.	15'	37	"
2E	MSHD	1800'	1800'	D.B.	30'	D.B.	15'	37	"
2F	MSHD	2700'	2700'	D.B.	30'	D.B.	15'	37	"
3B	MSHD	720'	240'	D.B.	20'	D.B.	None	None	"
4B	MSHD	720'	240'	D.B.	10'	D.B.	None	None	"
7A	MSHD	600'	120'	D.B.	60'	D.B.	30'	60	8"-6"-8"
7B	MSHD	600'	120'	D.B.	30'	D.B.	15'	60	"
7C	MSHD	600'	120'	D.B.	20'	D.B.	None	None	"
7D	MSHD	600'	120'	D.B.	10'	D.B.	None	None	"
9A	MSHD	1800'	100'	L.T.	None	None	None	None	9"-7"-9"