pilot research catchments and experimental urban catchments, a state-of-the-art report is to be prepared reviewing current research on urban hydrology based on case studies. The report will include descriptions of laboratory and field studies, instrumentation, methods of processing and analysing information from experiments, development of models on urban water systems, etc.

In addition, a report is to be made on mathematical models applied to urban catchment areas and dealing with, for example, rainfall-runoff relationships both for sewage and storm drainage systems.

The concentration of wastes in urban complexes produces significant effects on groundwater quality. A report is to be prepared on changes in groundwater quality produced by contaminants resulting from urban and industrial development.

A workshop is to be held in 1977 to examine the social, economic and ecological aspects of urban hydrology and the effects of urbanization on the planning and management of water resources at the national and regional levels.

*Project No. 8: Long-term prediction of groundwater régime taking into account human activities* The increasing use of groundwater over the last decade has led hydrologists to become more and more concerned with the response of aquifers to heavy pumping and exploitation and with the long-term prediction of the reserves available.

A number of models have been produced representing unsteady groundwater flow. Thanks to multi-layer techniques it is possible to make models of large complexes consisting of superposed, permeable or semi-permeable layers representing entire basins.

A technical report is to be prepared concerning long-term predictions of changes in groundwater resources, both natural and man-induced, as an aid to the determination of the limits of rational exploitation. The report will examine the capabilities of models for the prediction of quantitative and qualitative changes in the groundwater regime.

Similarly, a report is to be prepared on the state-of-the-art of artificial recharge of aquifers from surface basins and water spreading. It will discuss the improvement of water quality through natural filtration, the recharging of aquifers to form a barrier to saline water encroachment or to infiltration from polluted rivers.

A review will be made of the present state of knowledge concerning changes in groundwater quality produced by contaminants under urban, industrial and agricultural development conditions.

The increasing exploitation of groundwater, in particular in basins partly filled with unconsolidated alluvial deposits often leads to subsidence of the land surface. A small working group is to prepare a casebook on subsidence due to groundwater exploitation giving details of measures used to control and arrest subsidence, in particular by means of artificial recharge and repressuring of aquifers.

Special attention is to be paid to the study of crystalline rock aquifers which could be an important source of water in many areas of India, Africa and South

America and could make an important contribution to the solution of many problems of water scarcity during periods of drought.

An outline report is also to be prepared on the development of new techniques and instruments for observation of groundwater regimes, including the zone of aeration, for consideration at the next session of the Council.

**IHP Diary**

*September-October*

29-4 Conference on hydrological forecasting in the Danube Basin countries : Regensburg.

*October*

Second regional meeting of IHP National Committees and water services experts of the countries of the Maghreb and Mauritania.

*November*

Working group meeting on the assessment of qualitative changes in the hydrological regime due to human activities : Unesco.

Working group meeting on the dispersion and self-purification processes of pollutants in rivers, lakes, reservoirs and estuaries : Unesco.

# Buildings Bridges and Highways Section

# A Study of Structural Design Evaluation and Performance of in- Service Bitumenous Surfaced Roads in Pakistan

*BY*

**S. FAYYAZ ALI SHAH***

## 1. INTRODUCTION :

Pakistan covers an area of 310,000 square miles with a population of over sixty-five millions. Except for the hilly areas where the population intensity is sparse, the majority of the terrain consists of alluvial plains in arid and semi-arid regions. The annual rainfall varies from 5 to 40 in. and the distribution is shown in the Annexure. The rain is mostly concentrated in the summer months of July, August and September and January, February in winter. Predominantly, the subgrade soils are sandy and silty clays. Experience has shown that if adequate drainage is provided, the subgrade conditions remain comparatively dry throughout the year and the higher soil strength (CBR Value) can be adopted for economical pavement design.

Out of a total paved mileage of approximately 15,000 about 50% carries upto 500 motor vehicles per day and the remaining 50% carries upto 2000 or more motor vehicles per day. The pereentage of commercial vehicles is over 60%. Most of these roads were built at a time when the traffic volume was nominal and the pavement designs were adopted arbitrarily with a layer of 3-4½" brick soling under 3-4" crushed stone with triple surface treatment. With the increasing pace of economic development during the last ten to fifteen years, there has been a phenomenal increase in the traffic and coupled with it the incidence of over-loading is on the increase. The 2-axled commercial vehicles commonly carry a pay load of over 20 tons which gives rise to an axle load of about 13 tons ( 13,000 Kg. ) .

Where there is a need of providing a vast road communication system in the country provide due facilities to the developing areas, there is a strongly felt need of cutting down the cost of construction. To cope with the increasing volume of traffic, there is also a need of improving the existing road system.

In view of these circumstances, the Highway Departments in our country have been

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constantly engaging their attention in finding out pavement design techniques suitable to our conditions so as to give most economical designs. The publications of the Road Reasearch Laboratory, U. K. particularly Road Note No. 31, has been considered of great assistance in finalizing our design techniques. The suggested improvements which are the subject matter of the seminar are also considered in the right direction.

In support of our contention that, provided the subgrade conditions remain comparatively dry as in tropical sub-tropical climate predominantly available in our country, a higher subgrade strength (CBR Value) can be adopted for pavement designs, a study of the structural design, evaluation and per formance trends of three in-service bituminous surfaced roads has been carried out on the parametees discussed in the following report.

### 1.1 Subgrade Conditions

The subgrade conditions include the type and nature of the subgrade soil, depth of sub-soil water table and general drainage conditions.

The subgrade soils, in these cases, include A-2-4 (O), A-3(O) and A-4 (8) groups of the A.A S.H.O. Soil Classification System. Their equivalents, in the extended Casagrande system, may be termed as SF, SP and ML. The depth of sub soil water table varies from 3 to 20 ft. or more. In certain cases, the ground water table controls the moisture content of the sub-grade soil. The subgrade moisture conditions are variable according to the depth of sub-soil water table i.e. 3 ft. for sands, 10 ft. for sandy clays, and 20 ft. for heavy clays. In addition, there are areas wherein the annual rainfall varies in the range of 5-10 in. and 10-20 in. respectively. The ultimate or equilibrium moisture content is being estimated from that in a similar soil under sealed road pavements in the area or from the moisture conditions in the soil below the depth subject to seasonal variations. The general surface and sub-surface drainage conditions have also been studied.

### 1.2 Subgrade Strength :

The subgrade strength has been evaluated in terms of the design CBR value obtained from the moisture-density-CBR (iso-CBR) relationship. The iso-CBR curves are drawn from the laboratory test data and the design CBR value is selected for the required level of relative compaction of the subgrade soil (95% Modified A.A.S.H.O. maximum dry density) and the corresponding ultimate/ equilibrium moisture content. Normally, the equilbirium moisture corresponds to the optimum moisture content of the Standard A.A.S.H.O. moisture-density relationship.

### 1.3 Relative Compaction of Subgrade Soil :

The relative compaction of the subgrade soil is normally below 90% modified A.A.S H.O. maximum dry density but its value is non-uniform in various sections of these roads.

### 1.4 Traffic Conditions :

The relevant traffic data in terms of commercial vehicles per day has been compiled. The data is being converted into standard Axle of 8200 Kgms. (18,000 Lbs.). Since most of the road sections under study are single lane (10-12 ft. width). The vehicular traffic tends to be more channelized than on two lane roads.

### 1.5 Structural Design of Existing Flexible Pavements :

The structural design of the in-service flexible pavements under study through arbitary in nature at the time of execution yet its evaluation at present has made an interesting study. In general, the pavements consist of 4½-6 in. brick soling and 3-4 in. crushed stone covered with a triple surface treatment.

### 1.6 Stage Construction :

These road pavements are being gradually improved i.e. widened and strengthened, with the corresponding increase in vehicular traffic.

### 1.7 Evaluation of Structural Adequacy :

These road pavements have been analysed to evaluate their structural adequacy for the current and future traffic for 10-20 years period of their service life.

## 2. Structural Design And Performance Trends.

The structural design of the existing flexible pavments for these three in-service roads, their evaluation, and performance trends are being further studied in detail. The preliminary investigations have been completed and, therefore, a brief report on the subject is presented as follows :-

### 2.1 GENERAL.

The three in-service roads have been analysed for their structural design of existing fiexible pavments, evaluation for structural adequacy to cater for the current vehicular traffic and their performance trends for the anticipated traffic conditions during the next 10-20 years period of their service life. These roads are given as follows.

a) Mianwali - Muzaffargarh Road.
   i) Section : Mile 116-142.
   ii) Section : Mile 142-173.

b) Jhang - Chiniot Road.

c) Delhi-Multan Road (Multan-Arifwala Section).

The study includes the type and nature of subgrade soil conditions, ground-water conditions, relative compaction of the subgrade soil, climate conditions, traffic data structural design of the existing flexible pavements, performance and condition survey of these pavements. A summary of these preliminary investigations is given as follows :

### 2.2 Mianwali - Muzaffargarh Road.

#### (a) Section Mile 116 - 142

Subgrade soil : A-2-4 (0) group of the A.A.S.H.O. soil classification system.

Depth of sub-soil water table = 4 - 12 ft. below N.S.L.

Annual Rainfall : 5 - 10 in.

**Structural Design of Existing Flexible Pavement**

| | |
|---|---|
| Brick Soling | = 4½ in. |
| Crushed stone + Bitumenous Surfacing | = 3½ in. |
| Total thickness | = 8 in. |

Traffic Data (1973)

| | | |
|---|---|---|
| Passenger busses | = 69 | |
| Trucks | = 150 | |
| Total : | 219 | Commercial vehicles per day. |
| Pavement width | = 18 ft. | |

Originally, the pavement width was 10 ft. at the time of its construction (1950) but it was later on widened to 18 ft. during 1969-70.

**Performance and Condition Survey**

The performance and condition survey of the road pavement shows that the riding quality is quite satisfactory. There is no structural failure of the pavement.

**(b) Section : Mile 142-173**

Subgrade soil : A-2-4 (0) of A.A.S.H.O. Classification.

Depth of sub-soil water : $3\frac{1}{2}$ - 13 ft.

Annual Rainfall : 5 - 10 in.

**Structural Design of Existing Flexible Pavement.**

| | |
|---|---|
| Brick soling | = $4\frac{1}{2}$ in. |
| Crushed stone + Bitumenous surfacing | = 3 in. |
| Total thickness | = $7\frac{1}{2}$ in. |
| Pavement width | = 10 ft. |
| Traffic Data (1973) | = Same as above |

The road (Section a & b) was constructed in early 1950 and the traffic at that time did not exceed 50 CVPD.

The performance and condition survey of the road pavement shows that a permanent pavement distress is observable. Surface cracking, rutting under wheel-paths, deformations and disintegration of pavement are progressive in nature. Due to the single lane width of the pavement, the vehicular traffic tends to be more channelized than on 18 ft. pavement width in Section Mile 116-142 as discussed under (a) above. Edge-breaking is due to heavy vehicular traffic which show that the pavement should be widened to cope with the increasing vehicular traffic. The photographs showing the current condition of the road pavement in both of these sections are given in the end.

For a comparative study of these two sections, it may be mentioned here that the performance of the section Mile 116-142 was similar to the Section Mile 142-173 prior to its widening to 18 ft. during 1967-70 but after its widening, its performance has been quite satisfactory and there is no pavement distress. In other words, it can be easily inferred that if proper geometrical design and maintenance are provided, the existing structural design can yield a satisfactory performance.

2.3 **Jhang - Chiniot Road**

Subgrade soil : A-4 (8) group of the A.A.S.H.O. Classification system.

Depth of sub-soil water table = 20 ft. or more

Annual Rainfall =10 - 20 in.

**Structural Design of Existing Flexible Pavement :**

The structural design consists of two different structural components in different sections of the roads.

These are given as follows :

| | | |
|---|---|---|
| (a) Brick Soling | = | $4\frac{1}{2}$ in |
| Crushed stone + Bitumenous surfacing | = | 3 in |
| Total thickness | = | $7\frac{1}{2}$ in |

The construction tends to be more of Telford type rather than a Macadam one,

**Traffic Data (1973)**

| | | | |
|---|---|---|---|
| Pasenger Busses | = | 95 | |
| Trucks | = | 246 | |
| Total : | = | 341 | Commercial vehicles per day. |
| Pavement width | = | 10 - 12 ft | |

The road was constructed during 1963-64.

**Performance and Condition Survey**

The performance and condition survey of the pavement show that the riding quality is satisfactory. There is no structural failure of the pavement. A slight pavement distress in the form of minor cracking is visible in some sections.

The photographs showing the current condition of the road pavement are given in Appendix.

## 2.4 Delhi-Multan Road (Multan-Arifwala Section)

Subgrade soil : A-4 (8) group of the A.A.S H.O. soil classification system.

Depth of sub-soil water table = 25-35 ft.

Annual Rainfall = 7.05 in.

Mean monthly maximum temperature = 106.6 F°

**Structural Design of Flexible Pavement**

| | |
|---|---|
| Brick soling | = 4½ - 6 in. |
| Crushed stone + Bitumenous surfacing | = 3 - 4½ in. |
| Total thickness | = 7½ - 10½ in. |
| Pavement width | = 12 ft. |
| Relative Compaction of sub-grade (Mod. A.A.S.H.O) | = 84-90% |
| Field C.B R. | = 22-23% |

**TRAFFIC DATA ( 1973 )**

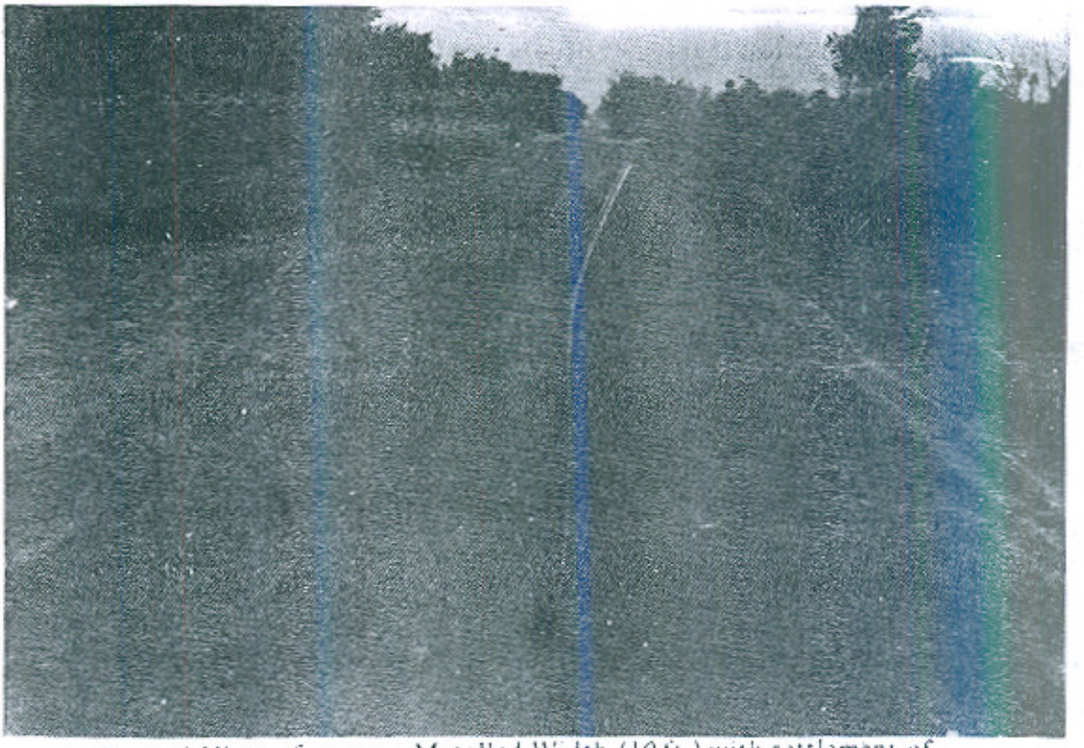
| Road Sections | Passenger Buses | Trucks | Total |
|---|---|---|---|
| Multan-Tibba Sultan Section | 248 | 180 | 428 |
| Tibba Sultan-Vehari Section | 292 | 175 | 467 |
| Vehari-Burewala Section | 269 | 246 | 515 |
| Burewala-Arifwala Section | 207 | 136 | 343 |

The performance and condition survey of the road pavement shows that the pavement has developed minor surface cracking. Edge-breaking is due to heavy vehicular traffic. It shows that if proper geometrical design and maintenance are provided, the existing structural design can yield a satisfactory performance.

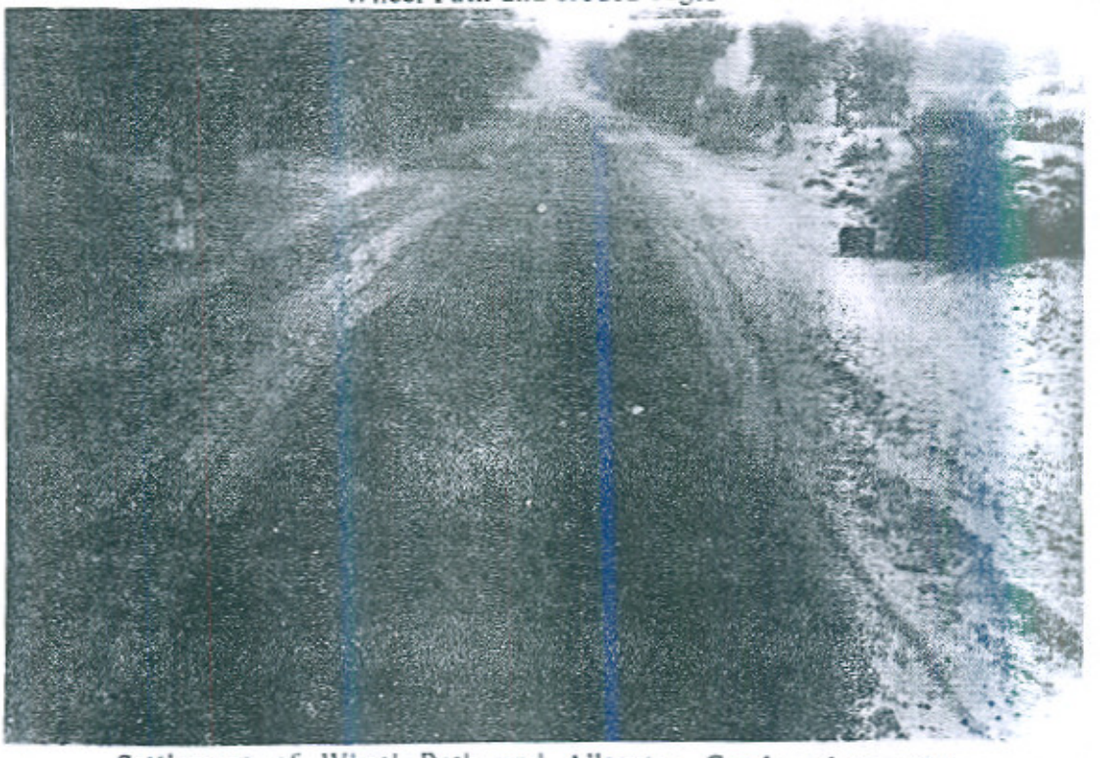
The photographs showing the current condition of road pavement are given in the Appendix.

## CONCLUSION

This study of structural design, evaluation and performance trends of the in-service bitumenous surfaced road pavements in the arid and semi-arid areas of Pakistan, where the annual rainfall is of the order of 10 in. or less, amply substantiates the valuable findings of the Road Note No. 31 (Second Edition). A structural design of 7½ - 10 in. can yield a good performance for a fairly heavy vehicular traffic, even upto 450 commercial vehicles per day, if proper geometrical design and maintenance facilities are available. The design CBR values of the subgrade vary from 8 to 24% which require a minimum sub-base of 4" on the compacted subgrade.

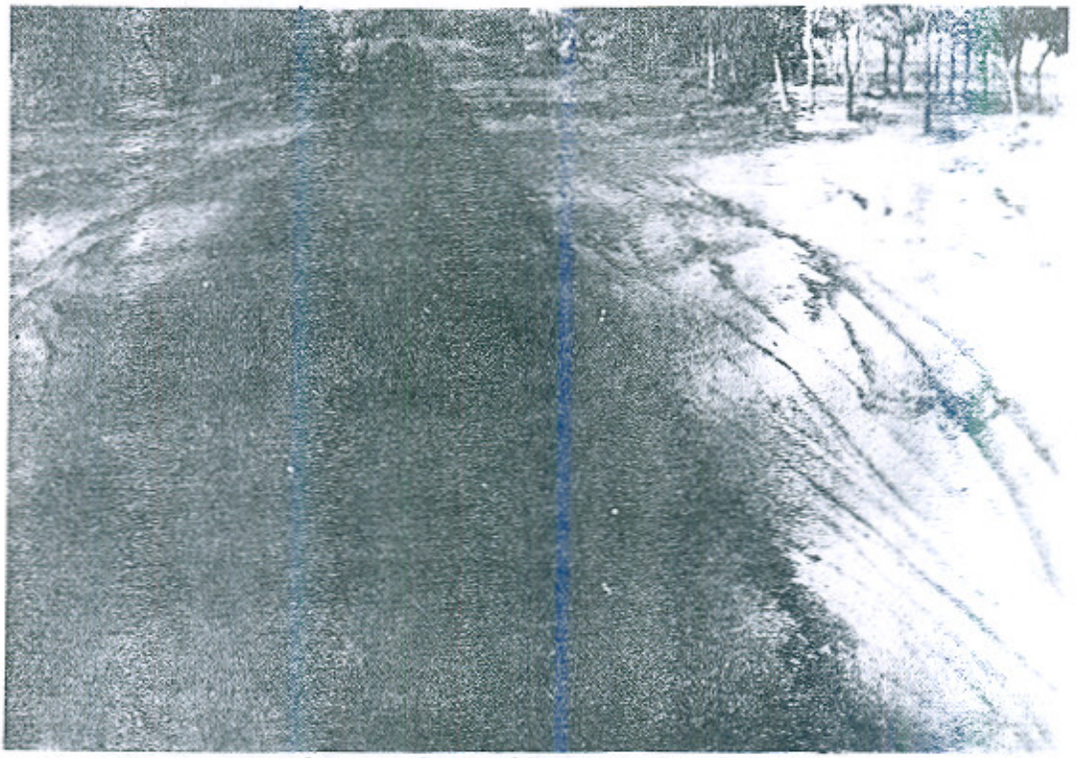


General View of narrow Metalled Width (10 ft.) with settlement of Wheel Path and eroded edges

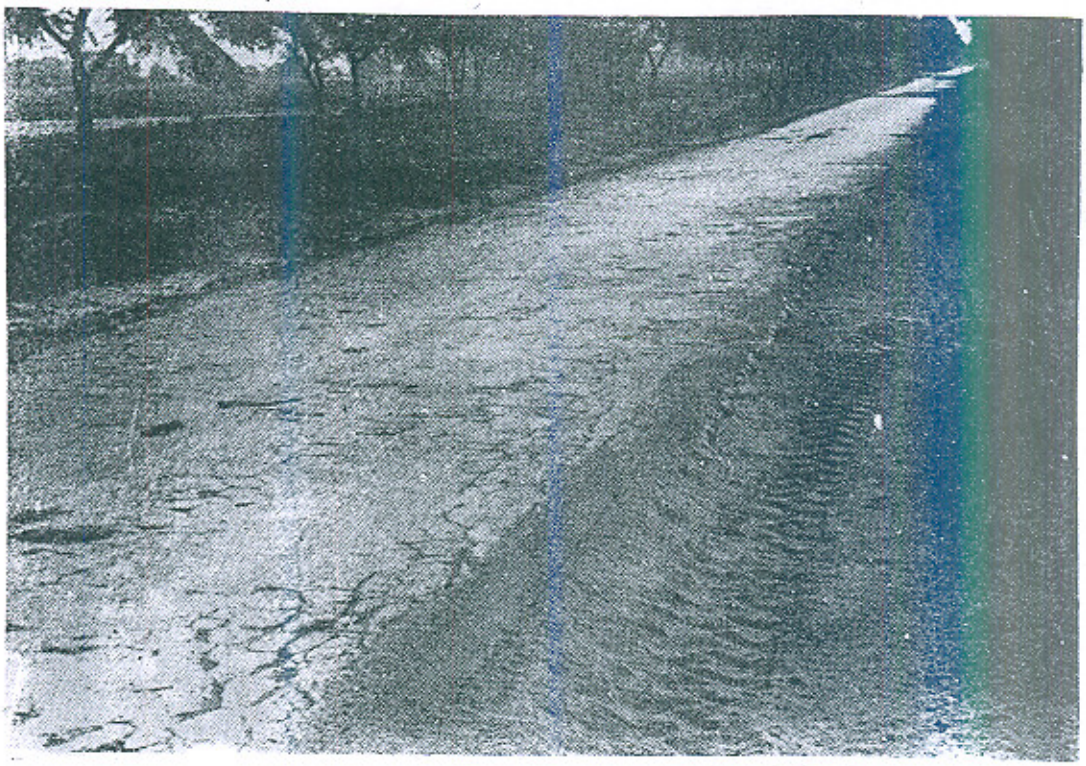


Settlement of Wheel Path and Allegator Cracks along with rutted shoulders

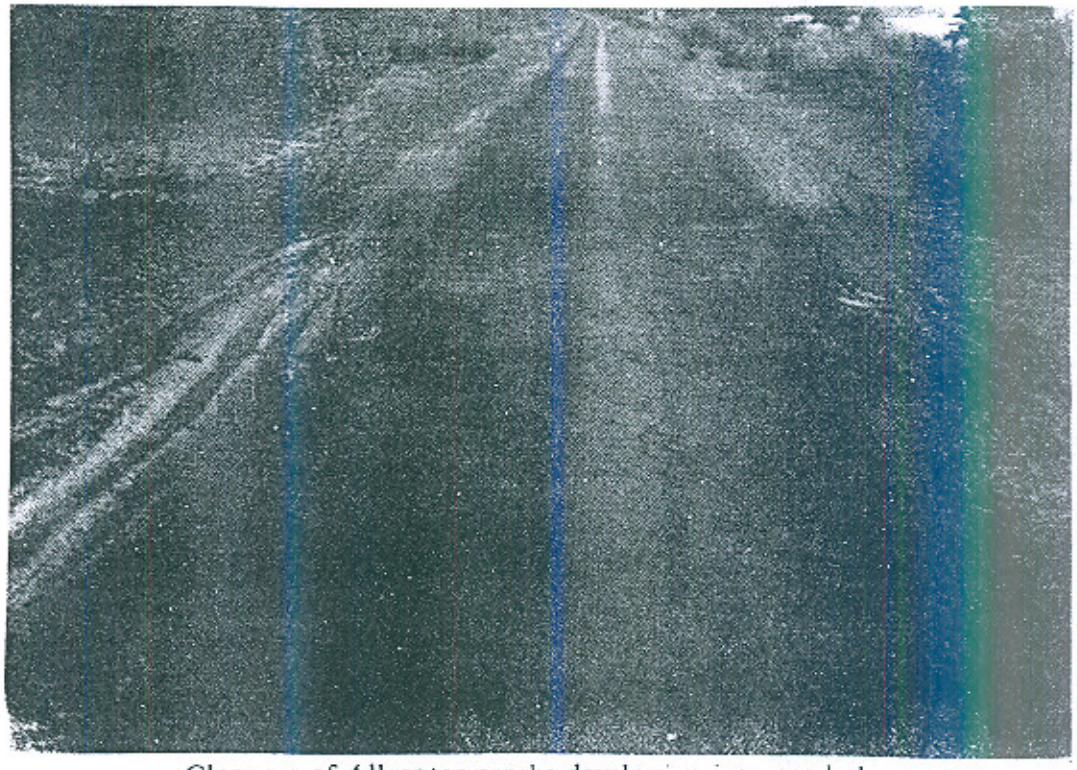
Difficult crossing of two vehicles due to narrow width



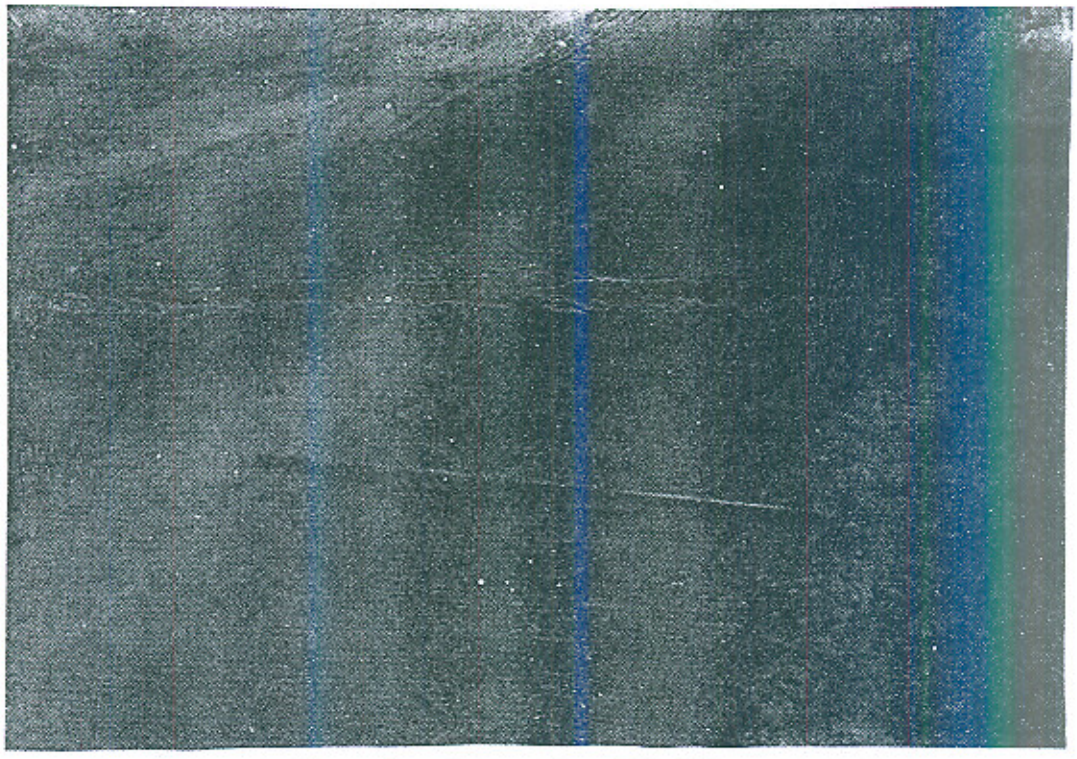
Displacement of dry sandy shoulders causes serious troubles to traffic and accelerates edge dis-integration



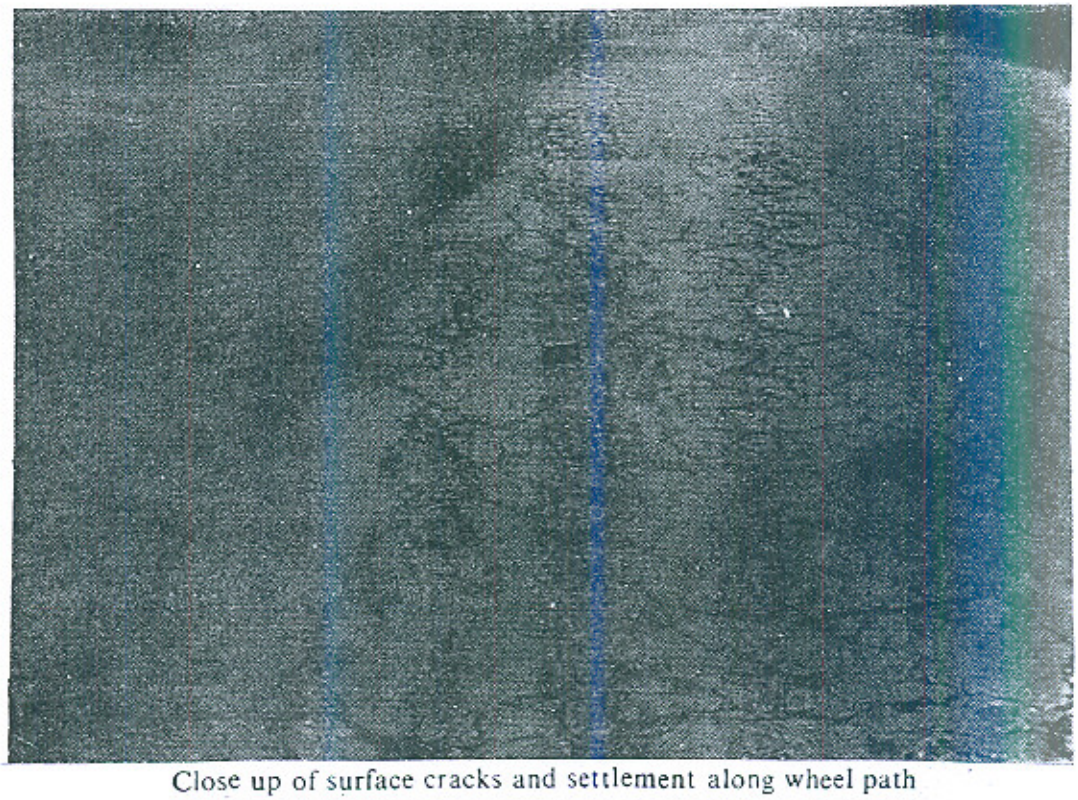
General view of road with pot-holes and eroded dry shoulders



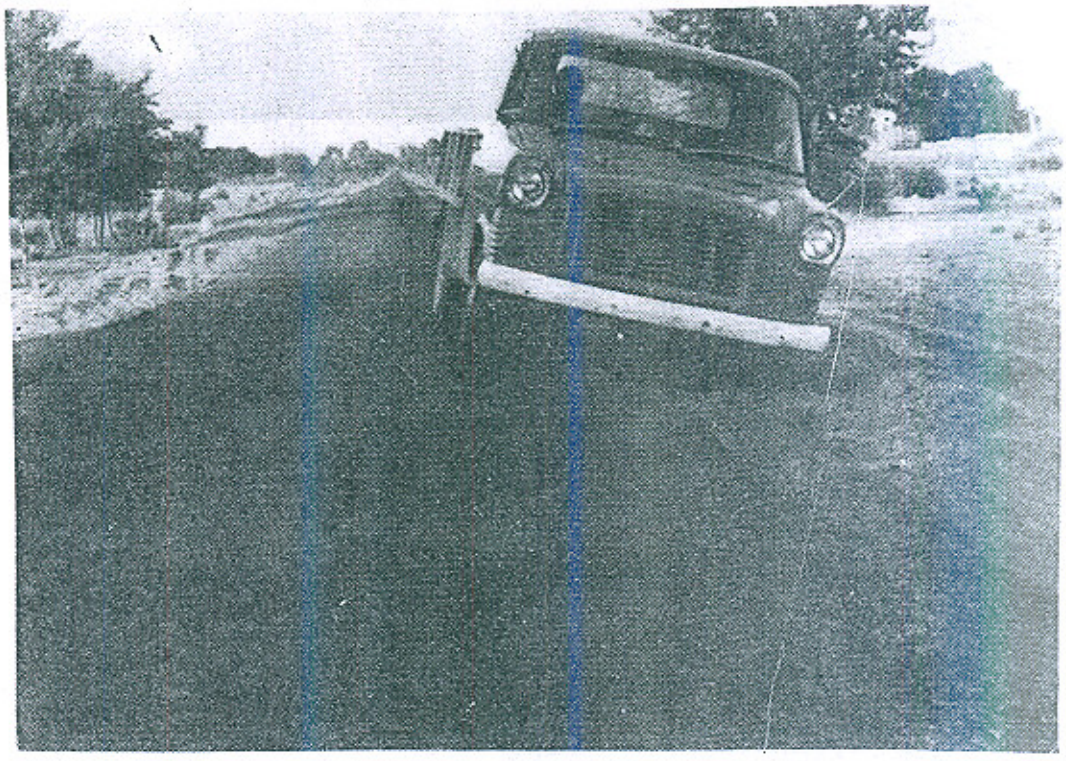
Close-up of Allegator cracks developing into pot-holes



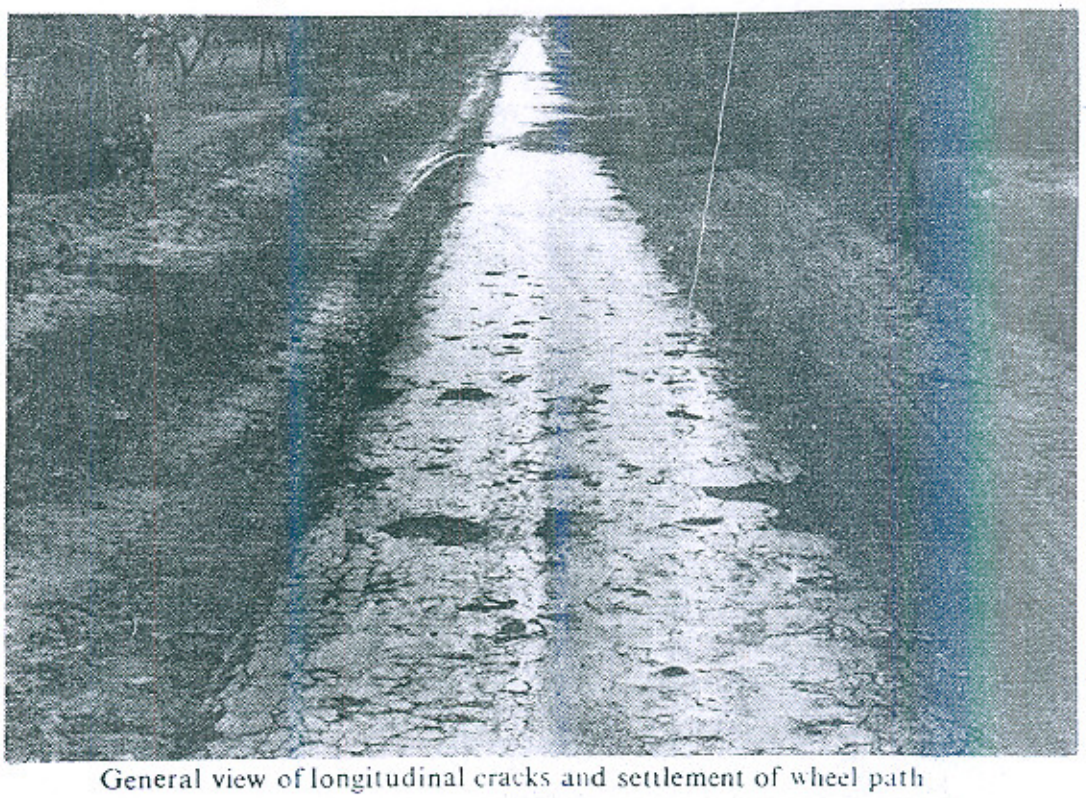
A View of settlement along Wheel Path



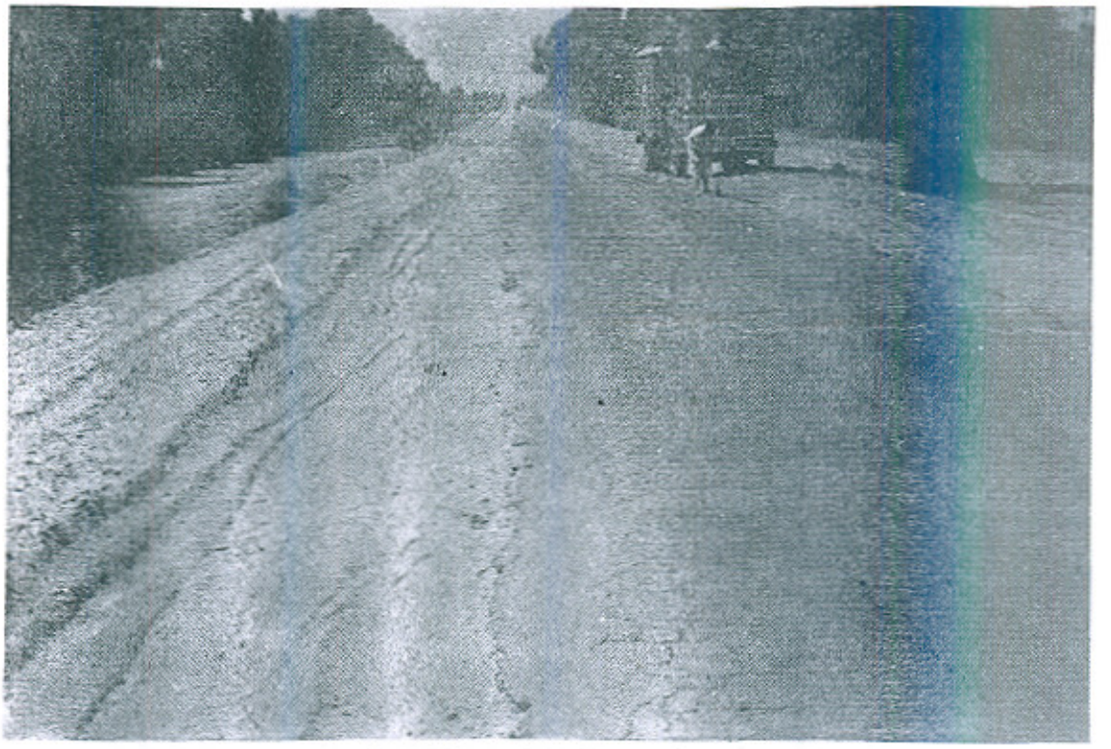
Close up of surface cracks and settlement along wheel path



Probability of vehicle over-turning due to rutted shoulders

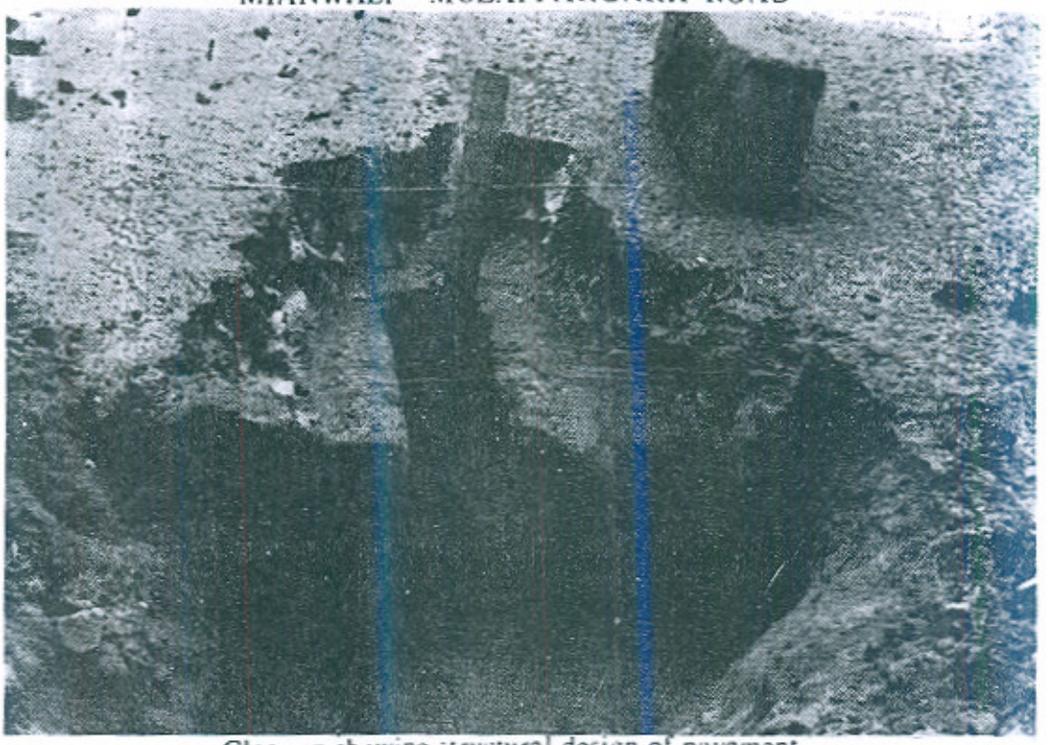


General view of longitudinal cracks and settlement of wheel path



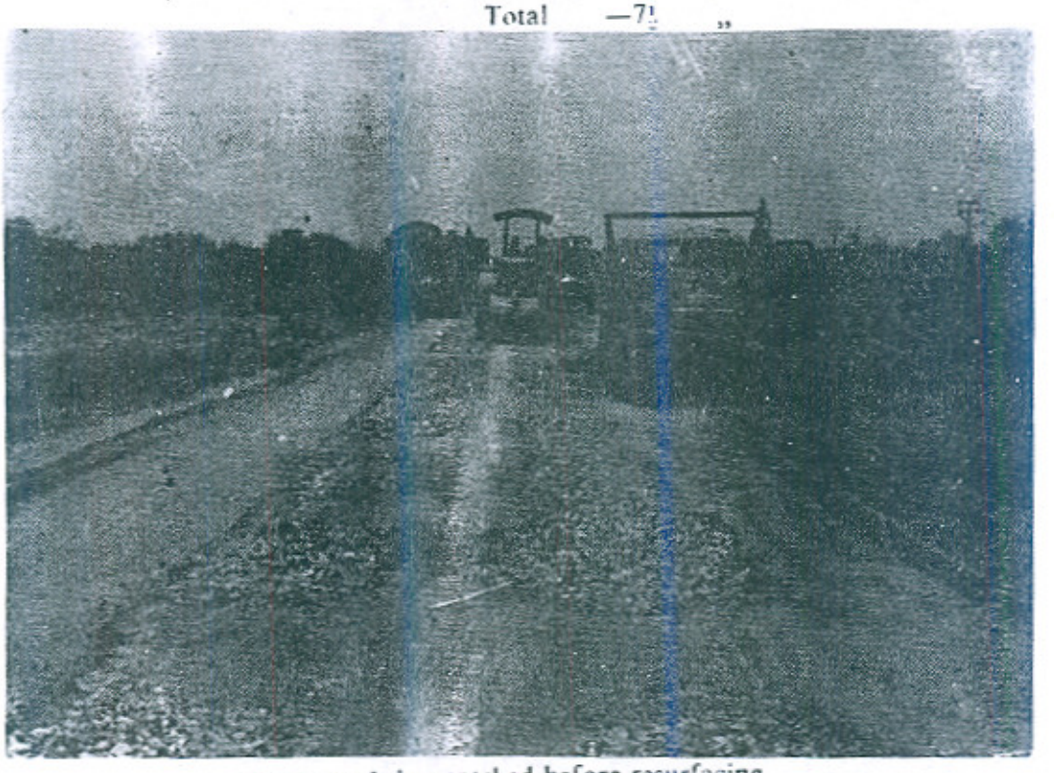
Rapid dis-integration of the edges due to loose dry shoulders

Excellent camber and performance of the road with widening in progress

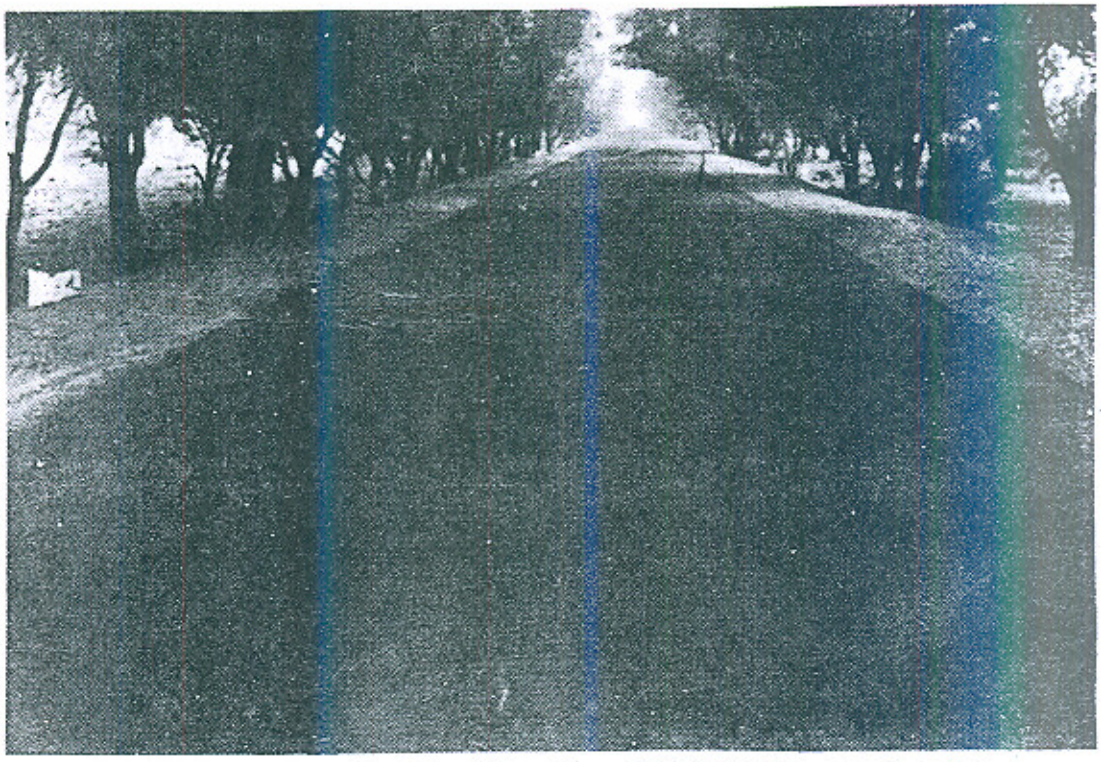


Close up showing structural design of pavement

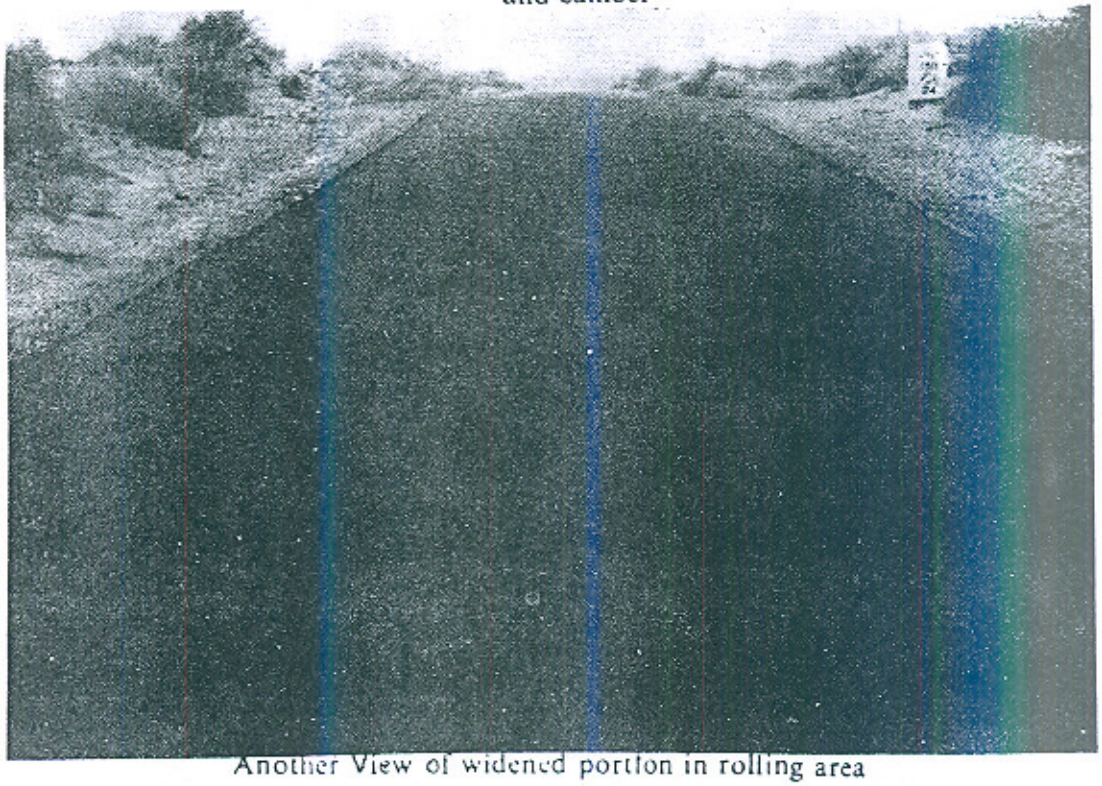
| | | | |
|---|---|---|---|
| Brick soling | — | 4½ | ,, |
| Base course & surfacine | — | 3½ | ,, |
| Total | — | 7½ | ,, |



Deep ruts being patched before resurfacing



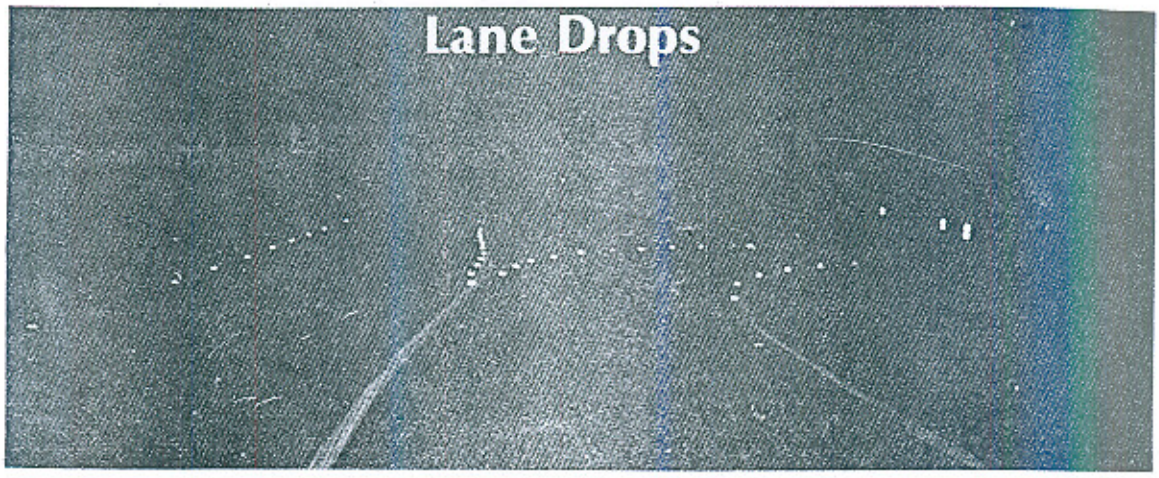
General View of widened portion (18ft.) having good surface and camber



Another View of widened portion in rolling area

# Raised Pavement Markers as a Traffic Control Measure at Lane Drops

--by Jerry G. Pigman and Kenneth R. Agent




**Raised pavement markers are an effective means of reducing erratic movements at lane-drop locations, particularly under nighttime driving conditions. The cost of raised pavement markers and their installation is nominal (approximately $150 per lane-drop location). It is recommended that raised pavement markers be installed at other lane-drop locations. Markers installed at locations described in this article have not been in place for a sufficient time to determine their durability; however, reports from other States indicate their durability is sufficient to render them economical. If raised pavement markers are installed routinely, steps should be taken to insure they are not damaged by snowplow operations. Rubber-tipped blades have been used successfully in areas with slushy snow or where chemicals are used in conjunction with snowplows.**

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## Introduction

A previous study conducted by the Division of Research, Kentucky Department of Transportation, investigated the influence of various traffic control measures on the operational characteristics of lane drops (1). Several standard and experimental traffic control devices were selected for application. No single type of traffic control device was found to be significantly effective in reducing conflicts at all the locations. The purpose of this research was to evalute the effectiveness of raised pavement markers (not used in the previous study) as a traffic control measure at lane-drop sites. One phase of a research study entitled "Evaluation and Application of Roadway Delineation Techniques" (2) is reported in this article. In another phase, an attempt is being made to determine the durability and reflectivity of several types of raised pavement markers over a long period of time. Raised pavement markers have been installed on several test sections and are being monitored by photometer measurements and visual inspection.

## Lane drops

A lane drop is defined as a location where the number of lanes provided for through traffic decreases. The broad category of lane drops has been further subdivided into three more specific classes: lane exits, lane splits, and lane terminations. A lane exit refers to a location where the number of through lanes decreases at an interchange on a multilane roadway. A lane split denotes a major bifurcation of a multilane highway where the level of traffic service provided at the terminus of either fork is approximately equal. A lane termination describes a location where a lane ends.

## Raised pavement markers

Raised pavement markers are in use in some States as an integral part of the roadway delineation system. They are being used to supplement as well as to replace paint stripes. In addition, they are being placed on horizonal curves, merge and diverge areas, turning lanes, no-passing zones, and stop approaches (3). These markers have proved to be particularly effective for wet, nighttime, and other poor visibility conditions.

A major deterrent to the use of raised pavement markers in snow areas has been marker damage and destruction caused by steel snowplow blades. A study conducted by the State of Washington demonstrated that the rubber-tipped snowplow blade was an effective tool for removing freshly fallen or slushy snows and for protecting raised traffic markers (4). The Federal Highway Administration has requested States in areas where snowfall is common to review their snowplowing and deicing procedures and to carefully consider the use of deicers and rubber snowplow blades so that raised pavement markers could be used (5).

Kentucky receives some snowfall each winter and the seasonal amounts are extremely variable. As a rule, the ground remains covered with snow for only a few days at a time. The average seasonal snowfall at the Lexington weather station for the past 39 years has been 18.5 in. (0.47 m), with a high of 41.7 in (1.06 m) for the 1950-51 season and a low of 2.3 in. (0.06 m) for the 1949-50 season. Snowplow use varies from an average of 5 to 10 times a year.

Several different types and brands of raised pavement markers have been developed and used by various States. The markers vary in cost, durability, and reflectivity. In this study, five different

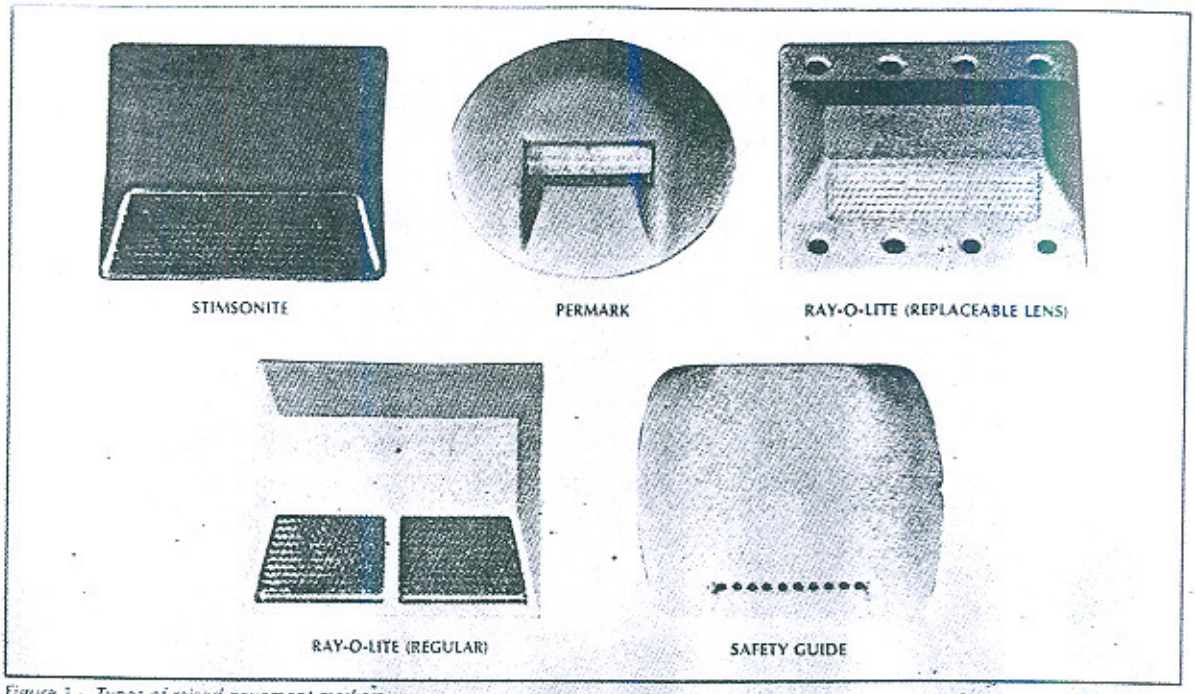



*Figure 1.—Types of raised pavement markers.*

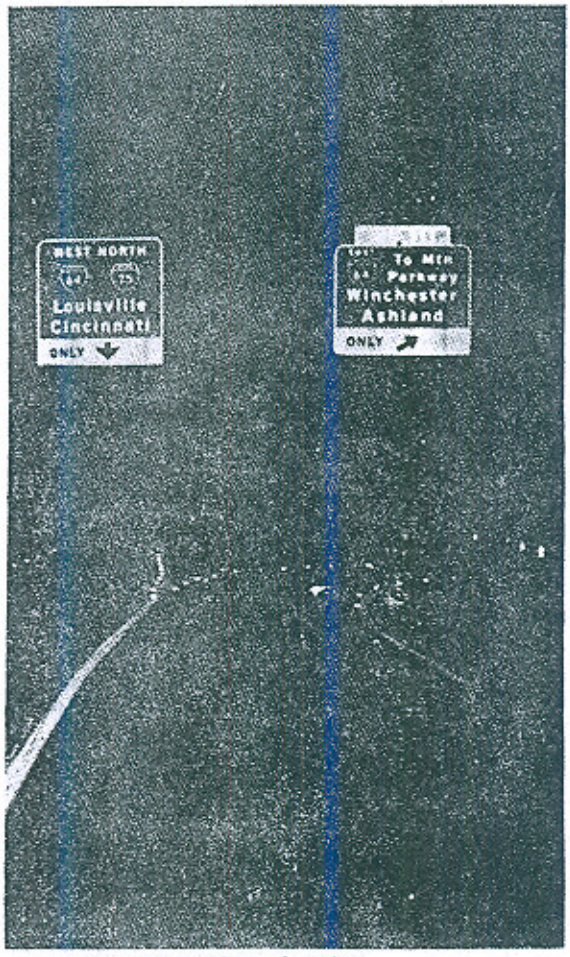



*Figure 2.—I-75 northbound—I-64 eastbound lane split.*

types of raised pavement markers were used (fig. 1).

## PROCEDURE

### Locations

Studies were conducted at five lane-drop locations, each representing one of the three classes of lane drops. The five sites were :

(1) A single-lane split at I-75 northbound—I-64 eastbound located east of Lexington.

(2) A single-lane split at I-75 southbound—I-64 eastbound located east of Lexington.

(3) A single-lane exit without taper on I-75 northbound at the 5th Street exit in Covington.

(4) A single-lane exit with taper at I-75 southbound—I-71 southbound in Boone County.

(5) A lane termination at US 27—68 (Paris Pike) northbound just north of New Circle Road in Lexington.

One of the lane drop locations is shown in figure 2.

### Data Collection

Conflict surveys (consisting of erratic movement and brakelight application counts) and lane volume counts were conducted at each of the lane-drop locations Observations were made before and after installation of the raised pavement markers at all sites for dry pavement conditions. Data were recorded for 6 daylight hours and 3 night-time hours. Erratic movements were grouped into seven categories : (1) cut across gore area, (2) crowded weave, (3) stopped, (4) slowed drastically, (5) swerved, (6) stopped and backed, and (7) multiple error. Brakelight application rates were summarized for the median, middle, and shoulder lanes. The same observer made all conflict surveys in order to eliminate the bias which often results from varying judgements as to what constitutes a conflict.

Wet nighttime data were collected at one of the sites after installation of the markers to illustrate the relative number of conflicts during wet and dry conditions. It would have been preferable to have before wet nighttime data with which to make a comparison, but it was considered to be an infeasible alternative. This was supported by the belief that it is practically impossible to collect data during inclement weather conditions and expect to duplicate these conditions at some time in the future. Visibility would most likely differ between the before and after conditions since the amount and intensity of rainfall would not be identical. By collecting before and after data under dry pavement conditions, the weather variable was eliminated.

### Installations

A different type of raised pavement marker was used at each of the five lane drops. The type of marker and the lane drop at which it was used are as follows :

(1) Ray-O-Lite (regular)—I-75 northbound—I-64 eastbound, east of Lexington.

(2) Ray-O-Lite (replaceable lens)—I-75 southbound—I-64 eastbound, east of Lexington.

(3) Stimsonite—I-75 northbound—5th Street exit in Convington.

(4) Permark—I-75 southbound—I-71 southbound in Boone Count y.

(5) Safety Guide—US 27—68 (Paris Pike) northbound, just north of New Circle Road in Lexington.

The markers were applied using a two-component epoxy. Surfaces were prepared prior to application of the epoxy by scrubbing with a wire brush. Traffic was main-

tained during application, but traffic cones were used to prevent vehicles from touching the markers until the epoxy had hardened.

Markers outlined the gore area as well as the edgelines. The markers started approximately 1,100 ft. (335 m) in advance of the gore and continued approximately 150 ft. (45 m) past the base of the striped gore area. At the Paris Pike location, markers were placed on the right edgeline as well as the left side of the section where the two lanes merged into one. A schematic which provides details of the marker arrangement at one of the study locations where 61 markers were installed is shown in figure 3.

**Data analysis**

Erratic movement and brakelight rates were calculated. Rates before and after installation of the markers were calculated for both daytime and nighttime conditions and for the total study period. Rates were obtained by dividing the number of erratic movements or brakelight applications by the applicable traffic volumes and expressing this quotient as a percentage. Statistical tests were then used to determine whether a significant difference existed between the before and after conflict and brakelight rates (6).

**Results**

Erratic movement rates, brakelight rates, and average hourly volumes for all five lane-drop locations were calculated, and the data before and after installation of the raised markers were summarized by total study period, daytime conditions, and nighttime conditions, respectively.

Results of the statistical analysis of the difference between the before and after conflict and brakelight rates are presented in table 1. The words *increase* and *decrease* mean that the particular erratic movement or brakelight rate difference was found to be statistically significant at the 95-percent confidence level. For more detailed information refer to the research report (2) from which this article was written.

A statistically significant decrease in the total erratic movement rate occurred in nearly all cases. Exceptions were I-75 northbound at the 5th Street exit under daytime conditions and Paris Pike under nighttime conditions. There was not a significant increase in any type of erratic movement at any of the locations. From table 1, it can be seen there was a significant decrease in the total erratic movement rate for daytime, nighttime, and combined conditions. It should be noted that, while the erratic movement rate decreased for all conditions, the nighttime rate showed the greatest decrease. There was a total reduction in the overall erratic movement rate of 27 percent (from 2.07 to 1.52). This resulted from a 20 percent reduction (from 2.15 to 1.71) for daytime conditions and a 44 percent reduction (from 1.78 to 0.99) for nighttime conditions. This indicated the raised pavement markers were particularly effective in reducing the erratic movement rate for nighttime conditions.

A study of brakelight rates produced different results Some locations showed a significant increase while others showed a significant decrease. From table 1, it can be seen that no significant change occurred in the total brakelight rate.

At the I-75 northbound—I-64 eastbound site, wet, nighttime data were collected. A comparison was made of the nighttime data for dry-before, dry-after, and wet-after conditions. Results indicate that the wet-after, nighttime erratic movement rate decreased by 29 percent from the dry-before, nighttime rate and increased by 25 percent from the dry-after, nighttime rate. Neither the reduction nor

Table 1.—Significant erratic movement and brakelight rate differences–summary for all locations

| | Daytime conditions | Nighttime conditions | Total study period |
|---|---|---|---|
| **Erratic Movement** | | | |
| Cut across gore | NSC[1] | Decrease | NSC |
| Crowded weave | Decrease | Decrease | Decrease |
| Swerve | Decrease | NSC | Decrease |
| Slowed drastically | Decrease | NSC | Decrease |
| Stopped | NSC | NSC | NSC |
| Stopped and backed | NSC | NSC | NSC |
| Multiple error | NSC | Decrease | Decrease |
| Total | Decrease | Decrease | Decrease |
| **Brakelight Rate** | | | |
| Median lane | NSC | NSC | NSC |
| Middle lane | Decrease | NSC | Decrease |
| Shoulder lane | Increase | NSC | Increase |
| Total | NSC | NSC | NSC |

1. No Significant change

Table 2.—Materials and installation costs or five lane-drop locations

| Marker type | Makers used | Unit price | Maker cost per lane-drop location |
|---|---|---|---|
| | *Number* | *Dollars* | *Dollars* |
| Ray-O-Lite (regular) | 61 | 1.28 | 78.08 |
| Ray-O-Lite (replaceable lens | 57 | 1.00 | 57.00 |
| Stimsonite | 79 | 1.045 | 82.56 |
| Permark | 63 | 0.45 | 28.35 |
| Safety Guide | 41 | 0.60 | 24.60 |
| Marker costs | ... | ... | 270.59 |
| Labor (site preparation and placement of markers) | ... | ... | 420.00 |
| Epoxy (3 gallons) | ... | ... | 42.00 |
| Total installation costs | ... | ... | 732.59 |

Table 3.—Summary of reflectivity tests

| Type | | Specific reflectivity[1] |
|---|---|---|
| Stimsonite 88 | ... | 1.9 |
| Ray-O-Lite (regular) | ... | 1.8 |
| Ray-O-Lite (replaceable lens) | ... | 2.0 |
| Permark | ... | 0.36 |
| Safety Guide | ... | 0.30 |

[1]Candlepower per foot candle (1.08 lux) per unit reflector (at 0-degree incidence angle).

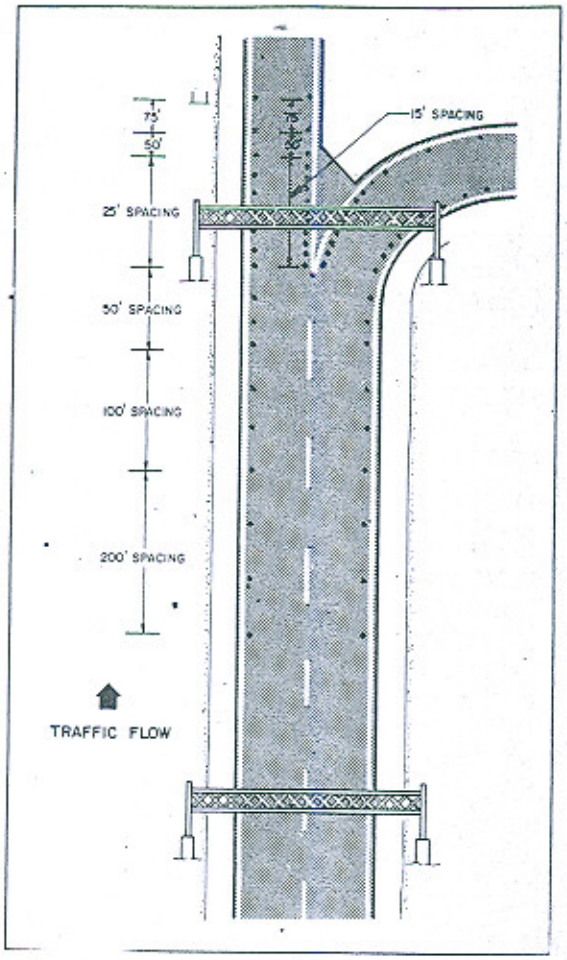
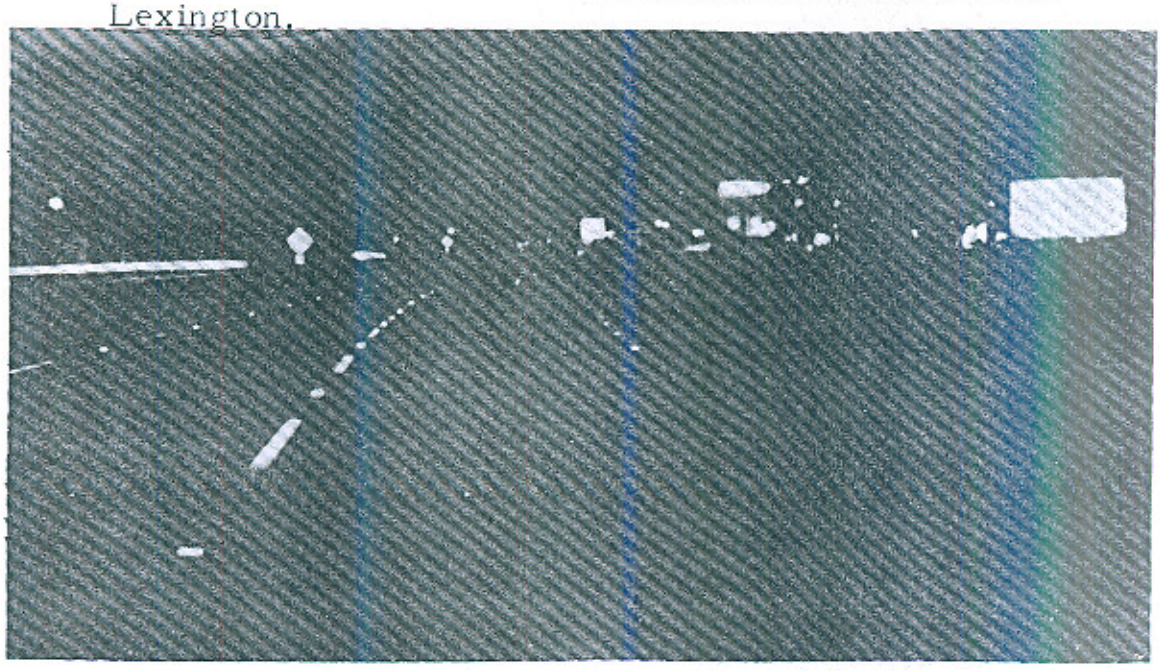



Figure 3. — Arrangement of raised pavement markers at 1-75 northbound— 1-64 eastbound lane split east of Lexington.



ment the increase in erratic movement rates was significant at the 95 percent confidence level,

The increase in erratic movements was somewhat expected due to the larger number of conflicts which occur during wet, nighttime conditions—that is, when visibility is usually impaired.

Cost of the raised pavement markers and their installation was relatively inexpensive compared to their potential benefits (table 2). The average cost was approximately $150 per lane-drop location.

Reflectivity test results at the 0.5-degree divergence angle on the five soft-white markers are summarized in table 3. The comparative reflectivity measurements indicate that two distinct categories of markers were used. All markers used were monodirectional with white reflective lens. The Stimsonite and Ray-O-Lite markers have highly reflective prismatic reflectors which are considerably larger in area than those of the Permark and Safety Guide markers. The Permark and Safety Guide markers have less reflectivity. The Permark marker has an acrylic rod-lens reflector, and the Safety Guide marker has a reflective strip consisting of 10 glass beads. The Stimsonite and Ray-O-Lite markers had a specific reflectivity five or six times greater than Permark and Safety Guide. There were no conclusive results which indicated that the lower reflectivity of the Permark and Safety Guide markers affected their ability to reduce conflicts. Since the five types of markers were installed at different lane-drop locations, a valid comparison of marker types is not available. The markers have not been installed for a sufficient period of time to justify a complete evaluation of their durability. With the exception of the Ray-O-Lite (replaceable lens), all markers appear to have sufficient durability. The Ray-O-Lite (replaceable lens) marker failed to remain intact under traffic and has since been discontinued by the manufacturer.

**Conclusions and Recommendations**

The objective of this study was to determine the effectiveness of raised pavement markers as a traffic control measure at lane drops. Major conclusions, which were drawn from the analyses, and recommendations are as follows :

Raised pavement markers are an effective means of reducing erratic movements at lane-drop locations.

No significant change in brakelight rates resulted from the installation of raised pavement markers.

While the raised pavement markers proved to be generally effective under both daytime and nighttime conditions, the reduction in erratic movements under nighttime conditions was the major benefit derived.

The cost of the raised pavement markers and their installation was nominal, and their use at any lane-drop location is recommended.

Conclusions concerning the longterm durability of the raised pavement markers are not appropriate on the basis of only limited exposure to traffic. However, experience in other States suggests that some markers possess the desired characteristics to make them economically feasible.

Studies have shown that rubbertipped snowplow blades have been used successfully. The potential benefits of raised pavement markers at the types of locations investigated indicate that overall safety provided the driving public would be enhanced by using raised pavement markers. It is recommended that use of steel snowplow blades discontinued on a

trial basis where raised markers have been installed.

Since different marker types were used at each of the lane-drop location it was not possible to compare their relative effectiveness.

**References**


(1) D. Cornette, "Operational Characteristics of Lane Drop," "*Kentucky Burea of Highway Division of Research*, August 1972.

(2) J. G. Pigman and K. R. Agent, "Raised Pavement Makers as a Traffic Control Measure at Lane Drops," "*Kentucky Bureau of Highways, Division of Research*, Research Report No. 384, August 1972.

(3) J. I. Taylor, H. W. McGee, E. L. Sequin and R. S. Hostetter, "Roadway Delineation Systems," National Cooperative Highway Research Program Report 130, *Highway Research Board* 1972.

(4) D. R. Anderson, "Rubber Snowplow Blades and Lightweight Snowplows Used for the Protection of Raised Lane Markers,' Record Number 359, *Highway Research Board*, 1971.

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(6) Experimental Statistics, *National Bureau of Standards* Handbook 91, August, 1, 1963.


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## THEORETICAL AND LABORATORY RESEARCH

# General Section

# Regional Seminar on Curriculum Design in Engineering Education in South and Central Asiac

21-24 December, 1975

*The seminar was convened by UNESCO at the invitation of the Government of Pakistan and jointly hosted by the Pakistan National Commission for Co-operation with UNESCO and the University of Engineering & Technology, Lahore. A part of the final report of the Seminar is being reproduced here for the benefit of our readers.* Ed.

**Background**

The Regional Seminar on Engineering Curriculum Design in South and Central Asia was convened by UNESCO in accordance with Resolution 2.152 adopted by the General Conference of UNESCO at its eighteenth session (1974). The Seminar also conforms to the recommendations of the Second Meeting of the Association for Engineering Education in South and Central Asia (AEESCA) held in Kabul, Afghanistan (March 1974).

Since the Kabul meeting, several countries of the region convened national seminars in engineering curricula which generated sufficient ideas and materials for the Regional Seminar. The main objective of the Regional Seminar was to give the engineering educators in the region an opportunity to exchange ideas, knowledge and experiences and to collect and analyse data on engineering curricula design and to formulate recommendations on ways of solving the problems, both at the national and regional levels, that are relevant to the institutions in the Member States of South and Central Asia.

The Seminar was attended by engineering educators from the Member States of Afghanistan, Burma, India, Nepal, Pakistan and Sri Lanka. UNESCO invited its Chief Technical Adviser at the Engineering Faculty of the Katubedda Campus of the University of Sri Lanka to act as Consultant for the Regional Seminar. In addition observers from the national engineering education and organization attended the meeting

**Inauguration**

The Seminar was inaugurated by Mr. Qudaratullah Shahab, Secretary-General of the Pakistan National Commission for Co-operation with UNESCO on 21 December, 1975. In his inaugural address, Mr. Qudaratullah mentioned that we are struggling to break into the modern technological

age and in few years achieve what the developed world did in decades. He stressed the importance of not only multidisciplined engineers but to train them with the latest and best knowledge available. At this function, speeches were also delivered by Dr. V.G. Podoinitsin, on behalf of the Director-General of UNESCO, and by Dr. M. Islam Sheikh, Vice-Chancellor of the University of Engineering and Technology, Lahore and by Dr. A.H. Qureshi. Director, Directorate of Research, Extension and Advisory Services of the University of Engineering and Technology, Lahore.

**Presentation of Papers**

The Regional Seminar on "Engineering Curriculum Design" discussed the papers presented by the national participants from the Member States of the South and Central Asian Region and a UNESCO consultant.

| | | |
|---|---|---|
| 1. | Some Viewpoints on Engineering Curriculum | Dr. B.A. Josephson |
| 2. | Engineering Curriculum Design | Prof. A. P. Jambulingam India. |
| 3. | Engineering Curriculum Design in Sri Lanka. | Dr. W.P. Jayasekara, Sri Lanka. |
| 4. | A Second Look to Engineering Education via Curriculum Design | Prof. G.N. Natik Afghanistan. |
| 5. | A Step towards Engineering Curriculum Design | Prof. K.R. Tuladhar Nepal. |
| 6. | Engineering Curriculum Design at Rangoon Institute of Technology | Dr. Aung Gyi, Burma. |
| 7. | Principles and Suggestions for Engineering Curricula Design | Prof. A- Wahab Khan, Pakistan |
| 8. | Local Needs Basis for Curriculum Planning in Engineering Education | Dr. Attaullah, Pakistan |
| 9. | Engineering Curriculum Design Pavements for Developing Economics. | Mian Fazal Ahmad, Pakistan |
| 10. | Textile Education in the Societies. | Dr. F.A. Bhatti, Pakistan |
| 11. | Design of Engineering Curricula : A Sociological Analysis of Their Orientations. | A.Z. Butt, Pakistan |
| 12. | Aims and Procedures in Engineering Curriculum Design. | Dr. Kazi Ainuddin Ahmad, Pakistan. |

## Discussions

The discussions centred round the importance of designing a programme of work relevant to the socio-economic conditions prevalent in the countries. Towards this design the participants exchanged views on the several "learning experiences" existing in the countries of South and Central Asia with the traditional 'syllabus examination approach' prevalent in the region. The seminar recognized the importance of an 'Objective Oriented Curriculum' for engineering education pertinent to the stage of industrial and agricultural development and to available resources within the regions. It was felt that optimum utilization of the existing infra-structures of the national system of Engineering Education, has to be borne in mind for any development of an engineering curriculum. The methodology of such a curriculum is a professional exercise involving preparation, development and improvement and has to take into account a variety of parameters such as student input, task analysis, course objectives media and methods, curriculum materials, evaluation procedures and feed back. The need for Staff development involving these processes cannot be overlooked, and a systems approach must be utilized. These tasks have to be performed by a body of professional experts attached to the Curriculum Development Cell. This cell should not only evolve programmes of study but also develop resource materials and set national standards to evaluate faculty and students, physical facilities and economical levels envisage in the curriculum.

The Seminar desired that implementation of any curriculum demands a faculty training programme. Faculty development should therefore play a key role in the systems. It was observed that the faculty in the member countries do possess high academic attainments. Lack of pedagogic skills and industrial exposure amongst the staff have been observed as a common phenomenon in the region. It was therefore felt that a phased programme of staff development has to be drawn by the national systems. Towards this, the Seminar identified the following specific areas for a staff development programme.

**Pedagogic**

1. Methodology and Curriculum Design
2. Educational Technology
3. Programmed Learning
4. Team Teaching
5. Seminar Teaching
6. Evaluation Techniques
7. Communications
8. Principles of Learning & Design of Teaching
9. Project Method

**Industrial Exposure**

1. Familiarisation with the processes and materials of industry.
2. Acquisition of skills.
3. "Research and Development" programmes

The seminar then discussed the inadequacy of practical content in the present engineering curriculum and desired that a mechanism be set up for effective interaction of industry with education. Considering the constraints prevalent in industries, it was felt that at the initial stages the practical content in Engineering Curriculum be

devoted to familiarisation with the practices, processes and materials of the industry. An industrial training board with adequate representation from industry, education and Government be charged with the task of designing, arranging and evaluating training programmes in industry. Towards this, the Seminar desired that adequate funding for this has to be provided by national governments with suitable legislative acts to involve the industries to actively participate in these programmes. The seminar held discussions on laboratory instruction either to supplement theoretical instruction in class-rooms or to verify a law, theory or measurement and physical characteristics. It was decided that sophisticated instruments apparatus and machinery involving huge sum of money have to be replaced by indigenous kits. The use of industrial facilities was suggested as an alternative. The Curriculum Cell should also consider this aspect.

The Seminar discussed the development of software requirements. To disseminate the curriculum materials to a large teaching/ student community, it is desired that the feasibility of a Reprographic Centre at national and regional levels, with all the duplicating mechanisms and supplies needed, primarily for the production of textual materials, be considered.

While discussing the distribution of subjects of study for an engineering curriculum design, the seminar suggested that a common core (or foundation) programme of work be identified for the basic disciplines in the areas of civil, electrical, mechanical and electronic engineering. Mathematics, Sciences, and Humanities and Technical English were identified as common core programmes for the basic disciplines mentioned above.

Based upon the discussions listed above the seminar recommends the following suggestions to evolve relevant engineering programmes of study within the political, social and economic constraints of the countries in the region.

**Recommendations**

1. Establishment of a Curriculum Development Cell at the national level responsible for design and development of Curriculum for Engineering Education.
2. Establishment of a reprographic centre to disseminate the information developed to a wider community of teachers and students of the region.
3. Establishment of an Industrial Training Board to liase the theoretical instructions of educational institution with the training programme with industry.
4. Evolve a "faculty development" programme at national level to meet challenges of a purposeful curriculum.
5. Arrange instructional, state, national and regional seminars to identify and exchange views on common programmes of engineering study.
6. Arrange instructional, state, national & regional workshops to develop a methodology of Engineering Curriculum Design.

Contd: On Page 68

# News and Notes

## Battery System of Pakistan Railway Trains

The "Battery System" of trains operation has been introduced at Karachi-Peshawar main Railway line on Nov. 20, 1975. Under the new system all mail and express trains are running in two groups. One group of trains leaves Karachi and Peshawar station in the morning & the other in the evening simultaneously.

The Grouping of trains, provides gaps of seven hours in the morning & 11½ hours at night, for running goods trains smoothly, specially without interruption by Mail & express trains. Under new system the journey time of Mail & express trains has been reduced by curtailing their stoppages.

Short distance trains would be run to provide Connections with Mail & express trains at Junction stations for the convenience of passengers of less important stations. Battery system would prove immensely beneficial in clearing traffic on the Karachi-Lodhran double line section in particular & would facilitate increasing the speed & number of good's trains and improve utilisation of locomotives & wagons.

## 6 Modern Rice Mills for Punjab

Punjab industrial Development Board (PIDB) is establishing six most modern Rice Mills, at

1. Hafizabad.
2. Faizabad.
3. Mubarakpur.
4. Eminabad.
5. Siranwali.
6. Sheikhupura (Japanese Machinery)

out of these projects, the two mills at Hafizabad and Sheikhupura have been completed and are ready for commercial operation. The program called for PIDB to put up pilot projects of six automatic rice shelling mills with a total milling capacity of 90,000 tons per annum at a cost of Rs 77.8 million and a foreign exchange component of Rs. 15 million. PIDB contracted with Schule of West Germany to provide Machinery for 5 of these mills and with Stake of Japan for the remaining one Mill. Rice is the second most important cash crop in Pakistan after cotton and is competing for the first position. The significa-

nce of this is amply borne out by export figures for rice for the year 1973—74, while Pakistan exported 5,79,728 tons of rice & earned Rs. 209.84 crores in foreign exchange.

### Survey begins for bridge near D.I. Khan

Preliminary survey and investigations for the construction of the Rs. 18 Crore Dash Darya Khan bridge over Indus river near D. I. Khan has been started. The designing of the bridge is in progress & sub soil investigations are being carried out at the Nandipur Research Station. Hydraulic tests are also being undertaken at this station in order to determine the exact location of the bridge. The bridge linking D.I. Khan with the Punjab will shorten the road distance between the two provinces and facilitate the transportation of Consumer goods.

### Lahore—Gujranwala dual carriageway by 1979

A dual carriageway between Lahore Gujranwala and Lahore—Sheikhupura would be completed by 1979. 24 feet wide road being constructed parallel to the existing Lahore—Gujranwala road will cost more than Rs. 12.92 Crores out of which about Rs. 2 Crores would be spent on the Carpetting of the Road. Similarly Lahore—Sheikhupura Road is also scheduled to be completed by 1979.

### Symposium on World Energy

A 2-day seminar on world energy crisis and its implications, with particular reference to the Developing countries was held in Karachi on Nov. 26 & 27, 1.75. Petrolium Institute of Pakistan was holding the 50th oil and gas symposium. Participants were from Iran, Britain, West Germany, U.S.A. and U.A.E.

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Continued from Page 69

7. Arrange regional seminars to identify areas of regional cooperation needed and international assistance towards regional imbalances.

The seminar places on record its appreciation to the Government of Pakistan and all the Governments of the Member countries of A.E.E.S C.A. and UNESCO & participants for organizing and arranging the regional seminar at Lahore which has resulted in fruitful exchange of views and thoughts on engineering curriculum design and brought an awakening towards effecting a change in the engineering curricula of the national system. In recommending the participants of the seminar look forward to early implementation of the recommendations by the member countries of the region. In this task the Seminar feels that A.E.E.S.C A. has to devote all its efforts to pool their expertise and resources. The seminar concluded that the suceess of implementing the recommendations lies in the massive support expected from the International agency such as NESCO.

# Special Feature

# INTRODUCING PAKISTANI CONSULTING ENGINEERS

## 4 ASSOCIATED CONSULTING ENGINEERS (ACE) LTD.

**History and Background**

Associated Consulting Engineers is the oldest and the premier consulting organization of Pakistan engaged in the engineering of major public works and industrial and utility projects. It was founded in 1958 by late Khawaja Azimuddin who withdrew from Government service after a long and distinguished career in engineering service, in order to establish and promote the consulting engineering profession in Pakistan. Since then ACE has steadily grown in size as well as diversity of assignments successfully completed in Pakistan and abroad

**Range of Services**

The services offered cover the full range of activities from conception to commissioning i.e. Surveys and Investigations, pre-feasibility and Feasibility Studies, Detailed Designing, Cost Analysis and Economic Evaluation, Specifications, Tender Documentation, Construction Supervision, Operation and Maintenance Manuals etc.

The principal fields of interest include :

**Dams and Hydraulic Structures**

- Masonry Dams
- Concrete Dams
- Earthfill Dams
- Rockfill Dams
- Barrages
- Other Hydraulic Structures

**Irrigation, Flood Control and Drainage**

- Reservoir Systems
- Irrigation Systems
- Soil & Land Classification
- Irrigation Agronomy
- Water & Soil Conservation Studies
- Irrigation Farming Practices
- Drainage
- River Training Works
- Economic Evaluation

**Agriculture**

- Surveys of Land Use & Potential
- Cadastral Surveys
- Soil Surveys
- Regional Development Planning
- Farm Planning/Management Studies
- Land Reform
- Land Settlement

**Groundwater Development**

- Ground water Investigations
- Tubewells
- Groundwater Development for Irrigation
- Control of Salinity and Water-logging
- Drainage and Reclamation Studies

**Water & Sewerage Systems**

- Municipal Water Supply
- Industrial Water Supply
- Sewage Disposal and Drainage
- Waste Disposal

**Power Stations**

- Hydro-electric
- Thermal
- Power Market Surveys

**Navigations & Coastal Works**

- Docks, Harbours & Jetties
- Navigation Locks
- Coastal Training works
- Terminals & Warehouses

**Highways Roads & Bridges**

- Primary Highway Roads
- Toll Roads
- Secondary Roads
- Farm & Market Roads
- Soil Mechanics
- Traffic Studies
- Highway Crossings
- Road Bridges & Culverts

**Architecture**

- Urban Development
- Landscape Architecture
- Educational Institutions
- Private & Civic Buildings

**Industries & Factories**

- Sugar, Cement, Textile, Cigarette & Paper Factories
- Industrial Estates
- Medium & Small Size Industries
- Civil, Structural & Architectural Works
- Selection of Plant & Equipment
- Management of Operation

**Projects Completed or in Hand**

Its roster enlists more than 450 engineering projects completed in various disciplines and costing approximately 2.5 billion dollars. Only a few important assignments completed or in hand are listed below :—

**Dams & Hydraulic Structures**

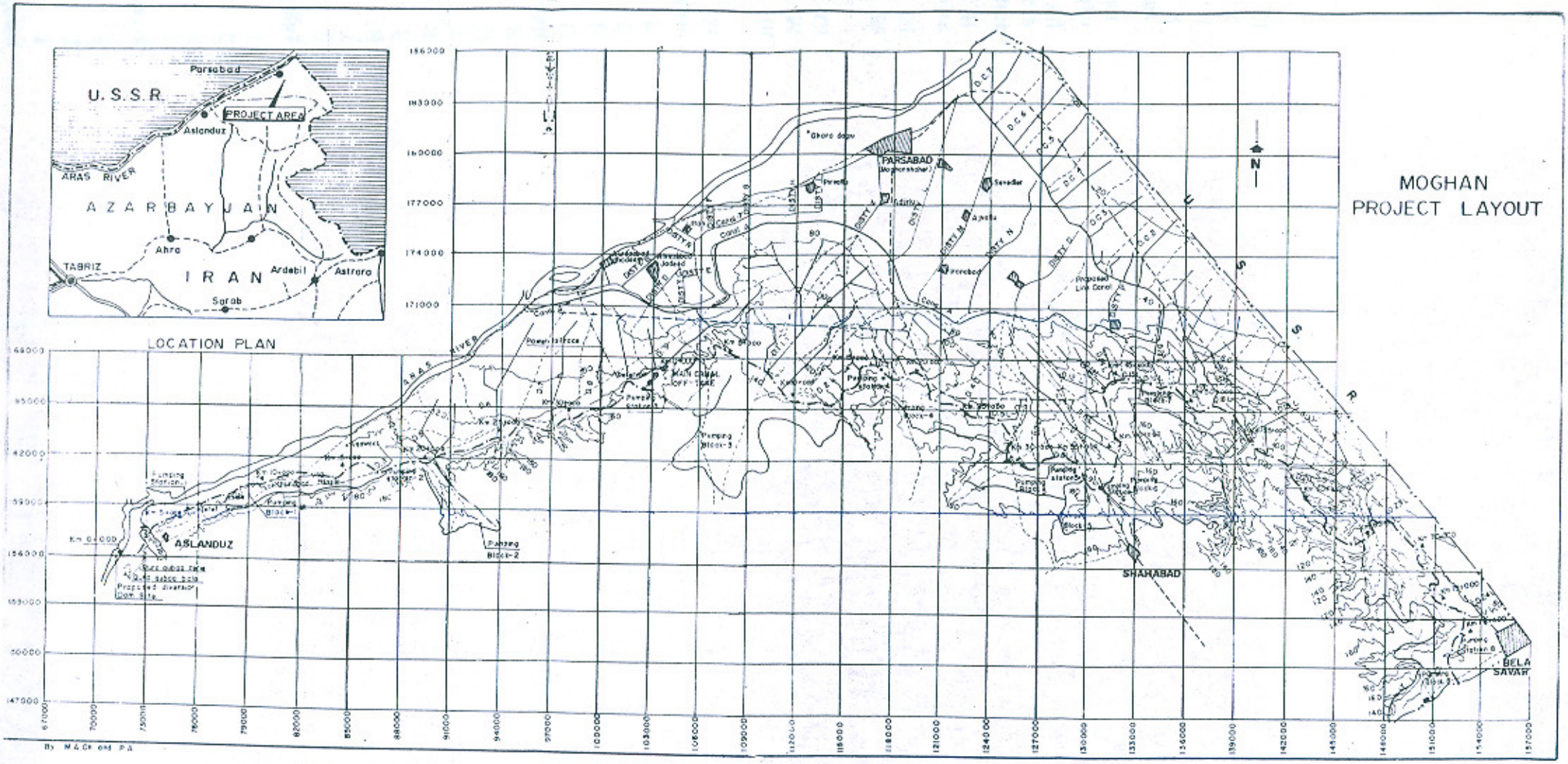
- Rawal Dam
- Hub Dam
- Khanpur Dam
- Chirah Dam Project
- Kalabagh Dam
- Basin Development Appraisals of Soan, Haro and Siran Rivers.
- Old Brahmaputra
- Tippera-Chittagong
- Teesta Barrage
- Gumti River
- Manu River
- Sangu River
- Faridpur-Barisal
- Dacca-Southwest
- Ganges Barrage
- Moghan Irrigation (Iran)
- Gilan Dam (Iran)
- Nampong Irrigation (Thailand)
- TOMAS Irrigation Project (Nigeria)
- Ground Water Irrigation in Kano (Nigeria)

**Water and Sewerage System**

- Greater Karachi Water Supply, Sewerage and Drainage
- Greater Lahore Water Supply, Sewerage and Drainage
- Greater Lyallpur Water Supply, Sewerage and Drainage
- Islamabad and Muree Water Supply
- Majmah, Tabouk, Al-Qurriat etc. (more than a dozen) Water Supply Schemes in Saudi Arabia)
- Azad Kashmir Water Supply
- Soba, Zonkwa, Somanika Water Supply Schemes, (Nigeria)

**Architecture**

- Haram Sharif at Mecca Moazzama
- Madina University
- Madina Secretariat
- Diwanal Amiri, Abu Dhabi
- Campus of Sind University
- Dacca University
- Rajshahi University
- Lyallpur University
- Tandojam Agricultural College
- Urdu College
- Besides Scores of Factories and Com-


MOGHAN
PROJECT LAYOUT
LOCATION PLAN
U.S.S.R.
Parsabad
PROJECT AREA
Aslanduz
ARAS RIVER
A Z A R B A Y J A N
Ahra
TABRIZ
I R A N
Ardabil
Astara
Sarab
ASLANDUZ
PARSABAD
SHAHABAD
BELA SAVAR
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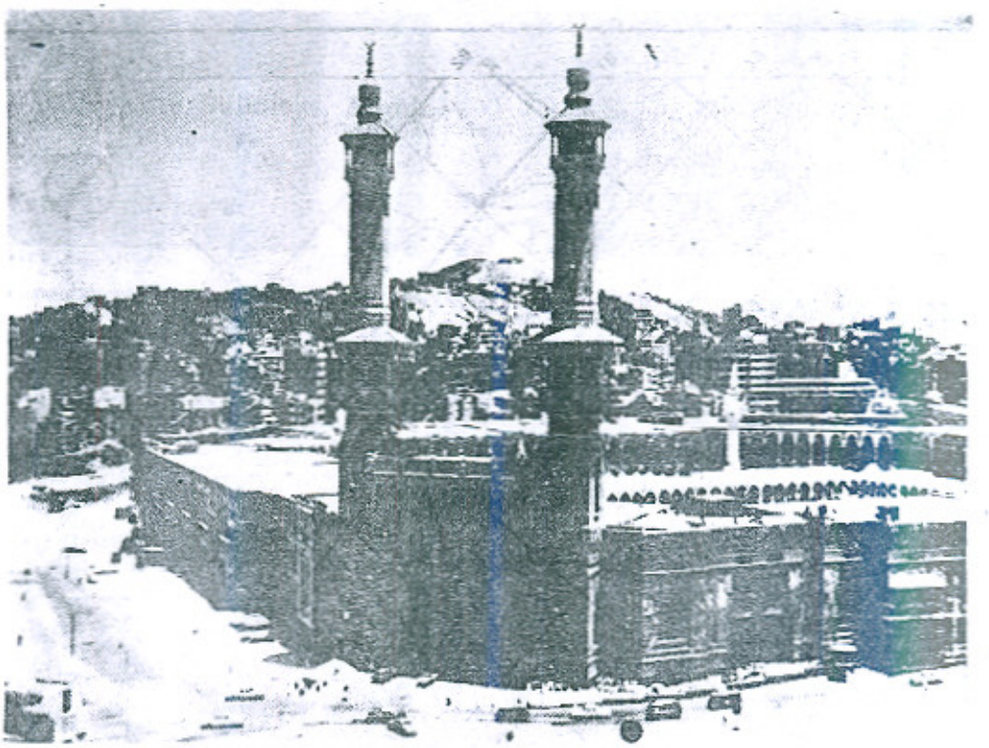
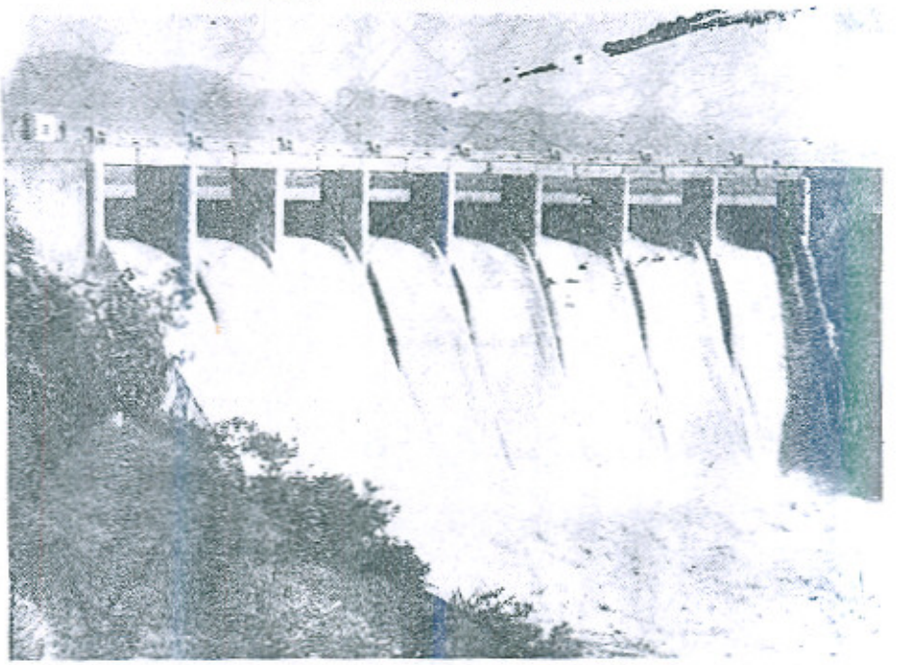


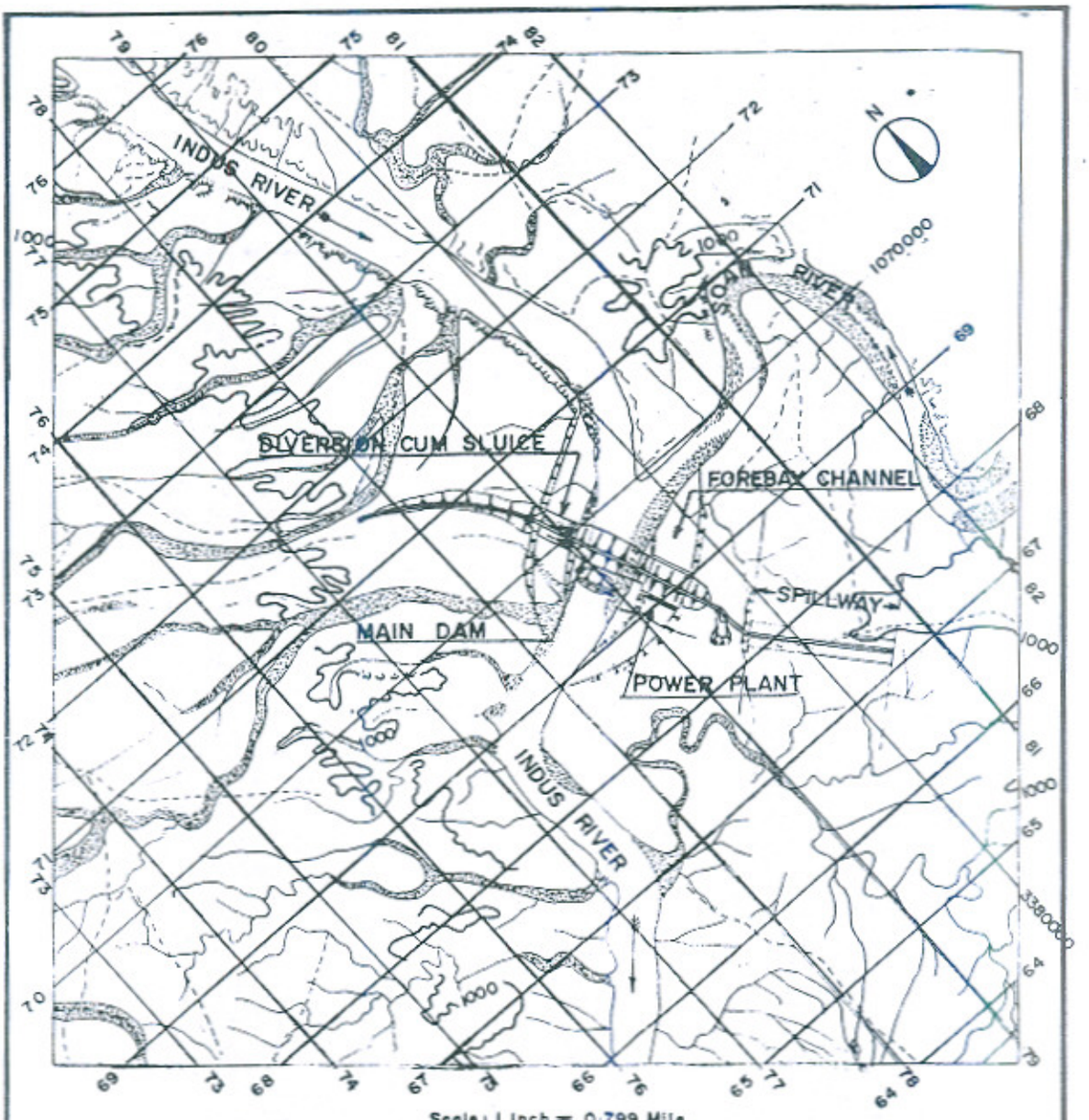
HARAM SHARIF

UNDER CONSTRUCTION



RAWAL DAM

SPILLWAY




KALABAGH DAM PROJECT

LAYOUT PLAN
SALIENT FEATURES

mercial Private Buildings, Mosque etc.

**Ground Water Development**

Salinity Control and Reclamation Project
Saline Area SCARP-II.

**Industries & Factories**

Sugar, Paper, Textile, Cement, Ceramics
Light Engineering, Chipboard, Tobacco, Chemicals
Pharmaceutical, Factories, Cold Storage
Fisheries, Food products, Oil Mills, Printing, Paints etc.

**Highways, Roads & Bridges**

Road and Bridge Projects in Pakistan
Road and Bridge Projects in Malaysia
Road and Bridge Projects in Saudi Arabia

**Navigation and Coastal Works**

Khulna Shipyard
Fenchugani Jetty
Seawall of Clifton
Jet Runway and Facilities of Karachi Airport

**Power Stations**

Hyderabad Thermal Power Station
Ashuganj Thermal Power Station
Karnafuli Hydel 3rd Unit
Small Hydel Schemes, Gilgit
Kalabagh Hydel Station.

**Organization**

ACE is a private limited organization managed by a Board consisting of five Directors. Its key staff includes personnel/ specialists with long experience of Design, Construction and Operation of projects in their respective fields. Its staff includes about 250 professional Engineers, Geologists, Soil Scientists, Agronomists, Architects, Specialists in many fields and the supporting technical personnel.

ACE is registered with international agencies like World Bank (IBRD), WHO, USAID, Asian Development Bank etc. It has worked on several World Bank-Financed Projects.

## SOME OF THE KEY PERSONNEL

| S. No. | Name | Designation | Years Total Exp. | Qualifications |
|---|---|---|---|---|
| **ENGINEERING** | | | | |
| 1. | M.A. Razzack | Managing Director | 25 years | B. E. (Civil), M. S. Struc., Engineering from University of Illinois - USA. |
| 2. | K. Waheeduddin | Dy. Managing Director | 18 ,, | B. Sc. - Degree in Civil Engg. from Manchester College of Science and Technology - U. K. |
| 3. | S. Monawar Ali | Director | 32 ,, | B. Sc. (Civil) - Punjab. |
| 4. | K.J. Murad | Technical Director | 22 ,, | B. E. (Civil), M. S. from University of Minnesota, USA. |
| 5. | Sayyid Hamid | Project Manager | 38 ,, | B.Sc, (Civil), University of South Wales - U.K. |
| 6. | M. Shamsuddin | Chief Engineer | 35 ,, | B.E. (Civil), M.S. from Poly Technic Institute of Brooklyn, USA. |
| 7. | Salahuddin Khan | Chief Engineer | 21 ,, | B.Sc. (Civil) Punjab |
| 8. | M. A. Baig Ghazi | Principal Engineer | 33 ,, | B.E. (Civil) Osmania (Gold Medallist) |
| 9. | S.M.Abdul Wahab | Principal Engineer | 27 ,, | B.E. (Civil) |
| 10. | M. Asaf Hussain | Principal Engineer | 25 ,, | B.E. (Civil) Osmania |
| 11. | A.A. Hameed | Principal Engineer | 22 ,, | B.E. (Civil) Osmania |
| 12. | M.Anwarul Haque | Principal Engineer | 20 ,, | B.E. (Civil) Karachi, M.S. University of Minnesota - USA. |
| 13. | K. A. Sharif | Principal Engineer | 23 ,, | B.Sc. (Civil) - Osmania |

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|---|---|---|---|---|---|
| 14. | S. Manzer Hussain | Principal Engineer | 20 | ,, | B.E. (Civil) - Karachi |
| 15. | K.A. Ansari | Principal Engineer | 17 | years | B.E. (Civil) Karachi. Post Graduate Diploma Course in Soil Mechanics of SEATO Graduate School of Engg. at Karachi. |
| 16. | Asrar M. Ahmed | Principal Engineer | 16 | ,, | B.E. (Civil) Karachi |
| 17. | M.K. Ghauri | Senior Engineer | 18 | ,, | B.E. (Civil) Karachi. Post Graduate Course in Soil Mechanics of SEATO Graduate School of Engg. Karachi. |
| 18. | A.R, Sheikh | Dy. Project Manager | 15 | ,, | M.Sc. (Geological Engg.) from Okhlahoma Vniversity - USA, 1965, B.Sc. (Mining Engg.) from Punjab, 1958. |
| 19. | Obedullah Siddiqui | Senior Engineer | 10 | ,, | M.Sc. (Public Health Engg.) B.E. (Civil) Karachi. |
| 20. | Tehsin Ahmed | Senior Engineer | 26 | ,, | B.E. (Civil) |
| 21. | M.M. Ahmed | Senior Engineer | 12 | ,, | B.E. (Civil) Karachi. |
| 22. | S. Hamid Ali | Senior Engineer | 12 | ,, | B.E. (Civil) Karachi, 1963. Completed Post Graduate Course in Paris under the Technical Assistance Program of the Government of France. |

**ARCHITECTS**

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|---|---|---|---|---|---|
| 1. | Ashiq A. Usmani | Principal Architect | 5 | ,, | B.Sc. 1963, B. Arch. University of Ankara. Turkey. |
| 2. | Jamil Ahmed | Senior Architect | 8 | ,, | B. Arch. (METU) |
| 3. | Mirza Faiz Baig | Senior Architect | 11 | ,, | Diploma in Arch. (G. Q. Arch.) |

# CODE OF ETHICS

## PAKISTAN ENGINEERING CONGRESS

بِسْمِ اللّٰهِ الرَّحْمٰنِ الرَّحِيْمِ

*In the name of God, the Beneficent, the Merciful.*

WHEREAS Allah enjoineth upon his men to faithfully observe their trusts and their covenants ;-

that the practice and profession of engineering is a sacred trust entrusted to those whom Nature in its magnificent bounty has endowed with this skill and knowledge ;

that every member of the profession shall appreciate and shall have knowledge as to what constitutes this trust and covenant, and

that a set of dynamic principles derived from the Holy Quran shall guide his conduct in applying his knowledge for the benefit of society.

Now, therefore, the following Code of Ethics is promulgated. It shall be incumbent upon the members of the Pakistan Engineering Congress to subscribe to it individually and collectively to uphold the honour and dignity of the engineering profession :

١- إِنَّ اللّٰهَ يَأْمُرُكُمْ أَنْ تُؤَدُّوا الْأَمٰنٰتِ
إِلٰى أَهْلِهَا وَإِذَا حَكَمْتُمْ بَيْنَ النَّاسِ
أَنْ تَحْكُمُوا بِالْعَدْلِ إِنَّ اللّٰهَ نِعِمَّا
يَعِظُكُمْ بِهٖ

"Allah commands you to render back your trusts to those to whom they are due, and that when you judge between people, you judge with justice. Allah admonishes you with what is excellent" iv : 58

1. You shall be honest, faithful and just, and shall not act in any manner derogatory to the honour, integrity or dignity of the engineering profession.

٢- أَوْفُوا الْكَيْلَ وَالْمِيْزَانَ بِالْقِسْطِ وَلَا تَبْخَسُوا
النَّاسَ أَشْيَاءَهُمْ وَلَا تَعْثَوْا فِي الْأَرْضِ
مُفْسِدِيْنَ ○

"Give full measure and weight justly and defraud not men of their things, and act not corruptly in the land making mischief". xi : 85

2. You shall use your knowledge and skill of engineering for human welfare, and render professional service and advice which reflects your best professional judgment.

٣- وَلَا يَجْرِمَنَّكُمْ شَنَاٰنُ قَوْمٍ عَلٰى أَلَّا تَعْدِلُوْا
اِعْدِلُوْا هُوَ أَقْرَبُ لِلتَّقْوٰى

"And let not hatred of a people incite you not to act equitably. Be just ; that is nearer to observance of duty". v : 8

3. You shall not injure maliciously, directly or indirectly, the reputation or employment of another Engineer, nor shall you fail to act equitably while performing professional duty.

٤- أَوْفُوا بِالْعُقُوْدِ ○

"Fulfil the obligations" v : 1

4. You shall faithfully observe and fulfil all your obligations.

٥- وَلَا تَأْكُلُوْا أَمْوَالَكُمْ بَيْنَكُمْ بِالْبَاطِلِ وَتُدْلُوْا بِهَا
إِلَى الْحُكَّامِ لِتَأْكُلُوْا فَرِيْقًا مِّنْ أَمْوَالِ النَّاسِ
بِالْإِثْمِ وَأَنْتُمْ تَعْلَمُوْنَ ○

"And swallow not up your property among yourselves by false means, nor seek to gain access thereby to the judges, so that you may swallow up a part of the property of men wrongfully while you know". ii : 188

5. You shall not abuse your position or power, nor accept illegal gratification of any sort.

٦- وَقُوْلُوْا قَوْلًا سَدِيْدًا ○

"And speak straight words." xxxiii : 70

6. You shall express your opinion on engineering or other matters in a frank, open and straightforward manner.

٧- اِجْتَنِبُوْا كَثِيْرًا مِّنَ الظَّنِّ إِنَّ بَعْضَ الظَّنِّ إِثْمٌ
وَلَا تَجَسَّسُوْا وَلَا يَغْتَبْ بَّعْضُكُمْ بَعْضًا

"Avoid most of suspicion for surely suspicion in some cases is sin; and spy not nor let some of you backbite others". xlix : 12

7. You shall not criticise another engineer's work without his knowledge, nor malign, or injure his professional reputation.

٨- وَلَا تَقْفُ مَا لَيْسَ لَكَ بِهٖ عِلْمٌ إِنَّ السَّمْعَ
وَالْبَصَرَ وَالْفُؤَادَ كُلُّ أُولٰئِكَ كَانَ عَنْهُ
مَسْئُوْلًا ○

"And follow not that of which thou hast no knowledge. Surely the hearing and the sight and the heart, of all these it will be asked." xvii : 36

8. Your professional advice shall be based on full knowledge of the facts and honest conviction, and you shall not write articles or advertise in self-laudatory language or in any manner derogatory to the dignity of the profession.

٩- وَتَعَاوَنُوْا عَلَى الْبِرِّ وَالتَّقْوٰى ۖ وَلَا تَعَاوَنُوْا
عَلَى الْإِثْمِ وَالْعُدْوَانِ ۚ وَاتَّقُوا اللّٰهَ

"And help one another in righteousness and piety, and help not one another in sin and aggression and keep your duty to God." v : 2

9. You shall help one another in upholding and doing what is right, and shall not associate with those who transgress and those who indulge in unethical practices.

١٠- وَأَمْرُهُمْ شُوْرٰى بَيْنَهُمْ ۖ

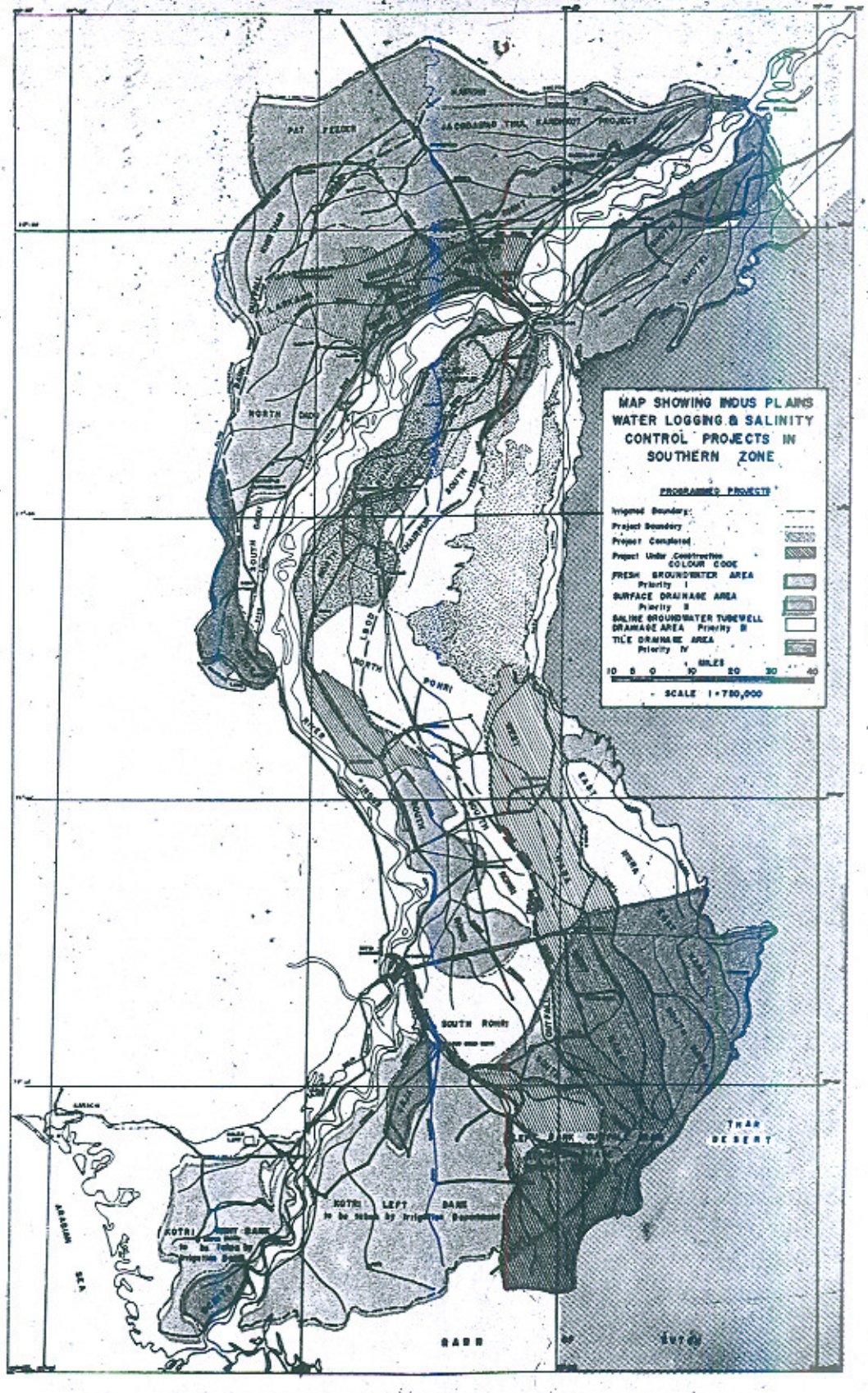
"And whose affairs are decided by counsel among themselves." xlii : 38

10. You shall decide matters of common professional interest by mutual consultation.

١١- وَاعْتَصِمُوْا بِحَبْلِ اللّٰهِ جَمِيْعًا وَّلَا تَفَرَّقُوْا ۚ

"And hold fast by the covenant of God all together and be not disunited." iii : 102

11. You shall strive individually and collectively to enhance the prestige of the engineering profession by ordering your conduct in accordance with this Code of Ethics, and shall not be disunited.


MAP SHOWING INDUS PLAINS
WATER LOGGING & SALINITY
CONTROL PROJECTS IN
SOUTHERN ZONE
PROGRAMMED PROJECTS
Irrigated Boundary
Project Boundary
Project Completed
Project Under Construction
COLOUR CODE
FRESH GROUNDWATER AREA
Priority I
SURFACE DRAINAGE AREA
Priority II
SALINE GROUNDWATER TUBEWELL
DRAINAGE AREA Priority III
TILE DRAINAGE AREA
Priority IV
MILES
10 8 0 10 20 30 40
SCALE 1 = 780,000
KOTRI RIGHT BANK
KOTRI LEFT BANK
SOUTH RONRI
THAR
DESERT
ARABIAN
SEA
BADIN