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No. RW/PL-17(8)/81-OR *Dated the 24th October, 1985*

To,

All State/Union Territories, Chief Engineers dealing with Roads; Director General Border Roads; Director General, CPWD.

Subject: Criteria for the choice of the type of bituminous surface courses for flexible pavements under different traffic and climatic conditions (R-8) — Findings and Recommendations in respect of bituminous wearing courses on WBM base course in high rainfall area (over 250 cm per annum) and heavy traffic (F curve).

With the objective to collect data for choice of appropriate type of bituminous wearing course which would be economical and durable for given condition of traffic, rainfall, aggregate quality and type of base course, Ministry launched Road Research Scheme No. 8 in 1978-79, brief particulars of which are enunciated in the Annexure.

2. The Central Road Research Institute, which is the Central Agency for R-8, has prepared a detailed report on the relative performance of different bituminous wearing courses laid on WBM base course on NH-8 (Bombay-Ahmedabad section) in Maharashtra with high rainfall (more than 250 cm per annum) and 'F' category of traffic (1500 to 4500 commercial vehicles per day). The findings were discussed in the P&I Group of R-8 meeting held on 17.7.85 and it was recommended by the Group that the findings with the following recommendations may be circulated amongst the Engineers incharge of roads in the country for adoption under identical conditions in the profession. (summary of the report is enclosed as Annexure to this letter for reference and guidance).

Recommendations of P&I Group of R-8.

(i) It is preferable to lay wearing course of 20 mm premix carpet with liquid seal coat/25 mm semi dense carpet/mix seal surfacing with aggregates of AIV upto 30 on WBM Base Course.

(ii) Asphaltic wearing course directly over WBM base course is not recommended.

(iii) Liquid seal coat is preferable to sand seal coat on premix carpet.

(iv) Sand seal coat on premix carpet should be avoided.

(v) Crusher dust will be preferable to sand for seal coat but whenever sand has to be used it shall be used with caution. Rounded fine sand of single size shall not be used.

(vi) Mix seal surfacing with rounded aggregate should not be used.

3. It is suggested that the findings and recommendations of P&I Group of R-8, spelt out in para 2 above, may be adopted in actual practice and feed-back with your suggestions/recommendations, if any, forwarded to the Ministry in due course to be utilised while publishing the final report of R-8.

Encl. to letter No. RW/PL-17(8)/81-OR

ANNEXURE

Dated the 24th October, 1985

ROAD RESEARCH SCHEME R-8 — CRITERIA FOR THE CHOICE OF THE TYPE OF BITUMINOUS SURFACE COURSES FOR FLEXIBLE PAVEMENTS UNDER DIFFERENT TRAFFIC AND CLIMATIC CONDITIONS — FINDINGS AND RECOMMENDATIONS IN RESPECT OF BITUMINOUS WEARING COURSES ON WBM BASE COURSE IN HIGH RAINFALL AREA (OVER 250 CM PER ANNUM) AND HEAVY TRAFFIC ('F' CURVE).

This scheme was envisaged in the Ministry in 1978-79. The objective of this research was to collect the data for the choice of appropriate bituminous surfacing type which is economical and durable for given condition of traffic, rainfall, aggregate quality and type of base course. Thus the appropriate choice of the desired type of bituminous surfacing will help highway engineers for deciding optimum utilisation of scarce resources and construction materials.

2. Following variables were considered for studying the relative performance of the bituminous surfacings:

(i) Four categories of traffic — C, D, E and F

(ii) Three categories of rainfall areas — low (less than 130 cm), medium (130 to 250 cm) and high (more than 250 cm).

(iii) Four types of stone aggregates — aggregates of per cent aggregate impact values of 10 to 20, 20 to 30 and 35 to 45, and rounded aggregates.

(iv) Two types of base courses — water-bound macadam and bituminous macadam.

The different types of bituminous surfacings proposed to be evaluated were as follows:

(i) 20 mm premix carpet with liquid seal coat

(ii) 20 mm premix carpet with sand seal coat

(iii) mix seal surfacing

(iv) 25 mm semi-dense asphaltic concrete

(v) 40 mm semi-dense asphaltic concrete

(vi) 25 mm asphaltic concrete

(vii) 40 mm asphaltic concrete

The aggregates for bituminous mixes used were of A-IV of 10-20, 20-30, 35-45 and rounded aggregates conforming to Ministry of Transport Specifications for Road and Bridge Works.

3. Test sections on BM base and WBM base were identified in different parts of the country covering the stipulated rainfall and traffic conditions. Two of the test tracks in the high rainfall area i.e. more than 250 cm per year and 'F' category of traffic over BM and WBM base course were located on NH 8 (Bombay-Ahmedabad section) in Maharashtra. These experimental test-sections comprising different types of bituminous surfacing laid in 1979 have been under observation since then. Most of the test sections laid on WMB base have failed at the different periods of the service life during the last 5 to 6 years. The test sections on BM base are still under observation. The performance data were evaluated periodically in every 6 months. For this research scheme Central Road Research Institute is the Central agency who have prepared an interim detailed report on the relative performance of different bituminous courses laid on WBM base which was presented before the P&I Group for this research scheme. The group accepted the interim findings for the purpose of adoption in practice.

4. The test sections were located where the traffic intensity was 'F' category and rainfall intensity greater than 250 cm per year. The selected stretch was free from sharp curves and there were no large variations in soil properties of the sub-grade and terrain conditons. The adequacy of the pavement thickness was ascertained by CBR method and to eliminate the effects of extraneous factors on the performance of surfacing, the pavement crust was over designed to some extent. The WBM base course overlay was constructed over the existing black topped surface by cutting furrows of 50 mm × 50 mm @ 1 m interval in the existing surface. 23 test sections as listed below in all each of 100 m length were constructed to cover the variables of 7 different types of surfacings and 4 types of aggregates. The details of specifications for the test-sections are listed below:

S.No.	Specification details
1.	PMC + LSC (AIV 10-20)
2.	PMC + SSC (AIV 10-20)
3.	MSS (AIV 10-20)
4.	25 SDAC (AIV 10-20)
5.	25 AC (AIV 10-20)
6.	40 SDAC (AIV 10-20)
7.	40 AC (AIV 10-20)
8.	PMC + LSC (AIV 20-30)
9.	PMC + SSC (AIV 20-30)
10.	MSS (AIV 20-30)
11.	25 SDAC (AIV 20-30)
12.	25 AC (AIV 20-30)
13.	40 SDAC (AIV 20-30)
14.	40 AC (AIV 20-30)

15. MSS — rounded aggregates
16. 25 SDAC (AIV 10-20) repeated for S. No. 4.
17. PMC + LSC (AIV 35-45)
18. PMC + SSS (AIV 35-45)*
19. MSS (AIV 35-45)
20. 25 SDAC (AIV 35-45)
21. 25 AC (AIV 35-45)
22. 40 SDAC (AIV 35-45)
23. 40 AC (AIV 35-45)

Note: PMC — Premix carpet
LSC — Liquid seal coat
SSC — Sand seal coat
MSS — Mix seal surfacing
SDAC — Semi-dense asphaltic concrete
AC — Asphaltic concrete
Figures outside brackets — Thickness of layer in mm
Figures inside brackets — Range of per cent aggregate impact values.

The standard specifications for construction of bitiminous surfacings as laid down by Roads Wing, Ministry of Shipping and Transport were followed. The mixes for semi-dense and dense asphaltic concrete were designed in the laboratory. Proper quality control was exercised during the construction of bituminous surfacings regarding the quality of materials used and of mixes manufactured and laid. The test track was constructed during the years 1979 and 1980.

5. The performance of the test sections was periodically evaluated by the following methods:

(i) Serviceability rating by visual observation of distress on road surface

(ii) Serviceability index by physical measurements of distress on road surface

(iii) Benklemen Beam Deflection

All these observations were taken on 6 monthly periodicity. The timings of these observations were generally kept during March/April and September/October every year so as to account for the worst condition likely to occur during the year. Under serviceability rating based on visual observation the procedure consisted of noting the total distress appearing on the bituminous surfacing in the following seven different components:

(i) Appearance in terms of binder content

(ii) Cracking

(iii) Pot-holes

(iv) Surface texture

(v) Ravelling

(vi) Surface unevenness

(vii) Loss of seal coat (wherever applicable)

As regards serviceability index based on physical measurements, areas of distresses shown in the form of ravelling, pot-holes, cracking and patchig were measured periodically with instruments for each of the test-section with progress of time. Regarding Benklemen beam deflection measurements these were taken as per the method given in IRC : 81-1981.

6. From the analysis of data on performance of various test-sections, the following inferences could be drawn regarding relative performance of seven different surfacing types using four different aggregate types:

6.1 Performance evaluation based on serviceability rating from visual observations.

6.1.1 Performance of each of seven types of surfacings using four different types of aggregates.

*Crusher stone dust was used instead of sand.

6.1.1.1 **Premix carpet with liquid seal coat**

(i) There is no difference between performance of test-sections using 10-20 and 20-30 AIV aggregates whereas 35-45 AIV aggregates proved to be less durable.

(ii) The distress generally appeared in the form of ravelling followed by formation of pot-holes.

6.1.1.2 **Premix carpet with sand seal coat.**

(i) Test sections using 10-20 and 20-30 AIV aggregates premix carpet and natural sand for seal coat failed during the rainy season following the construction after a very short service life (i.e. 9 months only). However, the test section with 35-45 AIV aggregates laid with crusher stone dust with seal coat instead of sand performed for better with a longer service life (i.e. 41 months).

(ii) The distress generally appeared in the form of loss of seal coat followed by ravelling of premix carpet and formation of pot holes.

6.1.1.3 **Mix seal surfacing**

A(i) The test section with 20-30 AIV aggregates gave a service life of 47 months whereas 10-20 AIV aggregates gave a service life of 30 months only. The 35-45 AIV aggregates gave an intermediatory performance.

(ii) The failure pattern was predominantly in the form of ravelling with limited cracking followed by formation of pot-holes.

B **Mix Seal surfacing with rounded aggregate:** The only test section constructed with rounded aggregates, AIV 20-30, failed soon after the beginning of the rainy season following the construction.

6.1.1.4 **25 mm thick semi-dense asphaltic concrete**

(i) The service life with 10-20 AIV aggregate was 64 months and that with 20-30 AIV 52 months and that for 35-45 AIV 56 months.

(ii) The failure pattern of test section was in the form of ravelling with little cracking followed by formation of pot-holes.

6.1.1.5 **40 mm thick semi dense asphaltic concrete**

(i) The test section with 10-20 AIV aggregate gave a service life of 68 months, that with 20-30 and 35-45 AIV 56 and 44 months respectively.

(ii) The failure of the test sections occurred mainly in the form of cracking leading to ravelling and formation of pot-holes.

6.1.1.6 **25 mm thick asphaltic concrete**

(i) The test section with 20-30 AIV aggregates gave a service life of 60 months and that with 10-20 and 35-45 AIV 68 and 58 respectively.

(ii) The failure pattern in the test-sections consisted of appearance of cracks followed by ravelling and formation of pot-holes.

6.1.1.7 **40 mm thick asphaltic concrete**

(i) The test section with 10-20 AIV aggregates gave the service life of 73 months followed by 71 months for 20-30 AIV aggregate and 68 months for 35-45 AIV.

6.1.2 **Performance of all seven types of surfacings with all three types of aggregates**

6.1.2.1 Considering the best service life values for each of the surfacing type using three different types of aggregates, the following order of performance has emerged:

	Type of surfacing	*Service Life months*	*AIV*
(i)	40 mm asphaltic concrete	73	10-20
(ii)	25 mm asphaltic concrete	68	20-30
(iii)	40 mm semi-dense asphaltic concrete	68	10-20
(iv)	25 mm semi-dense asphaltic concrete	64	10-20
(v)	Premix carpet with liquid seal coat	58	10-20
			20-30
(vi)	Mix seal surfacing	47	20-30
(vii)	Premix carpet with crusher stone dust (in place of sand) seal coat	41	35-45

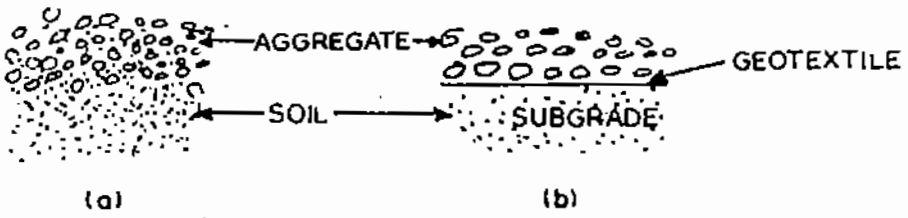

FIG. 1 - SEPARATION OF SUBGRADE AND BASE BY GEOTEXTILE
(GEOTEXTILE PREVENTS PUMPING OF FINES AND INTRUSION OF AGGREGATES)

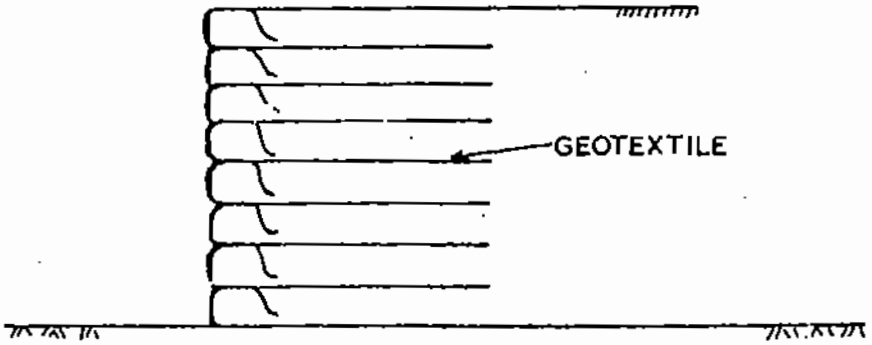

FIG. 2 - GEOTEXTILE REINFORCED RETAINING WALL

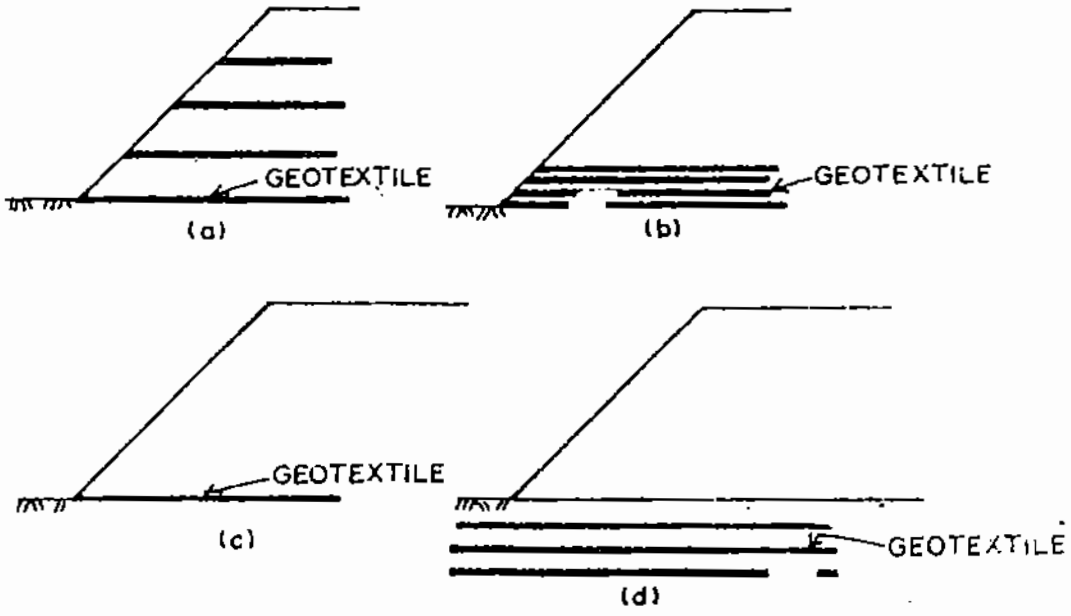

FIG. 3 - GEOTEXTILE USED TO STABILIZE EMBANKME

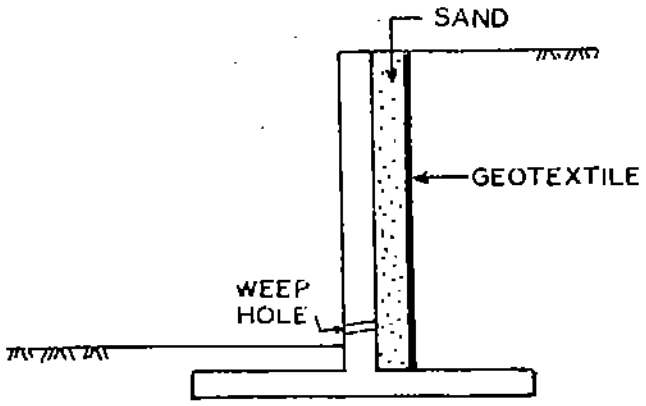

FIG. 4 - USE OF FABRIC BEHIND THE RETAINING WALL

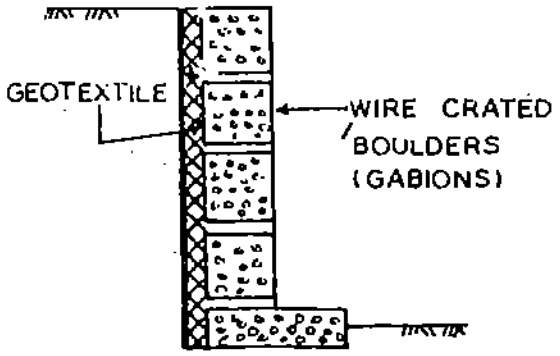

FIG. 5 - FABRIC BEHIND THE GABIONS

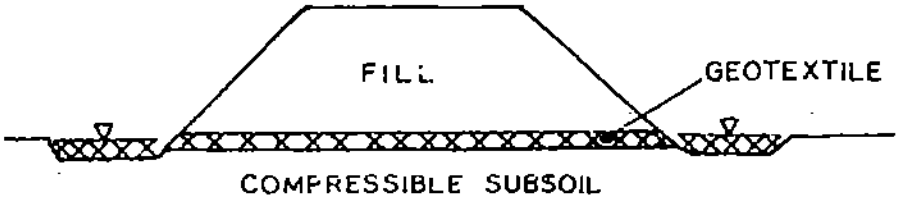

FIG. 6 - DRAINAGE THROUGH GEOTEXTILE AT THE BASE OF FILL ON COMPRESSIBLE SUBSOIL

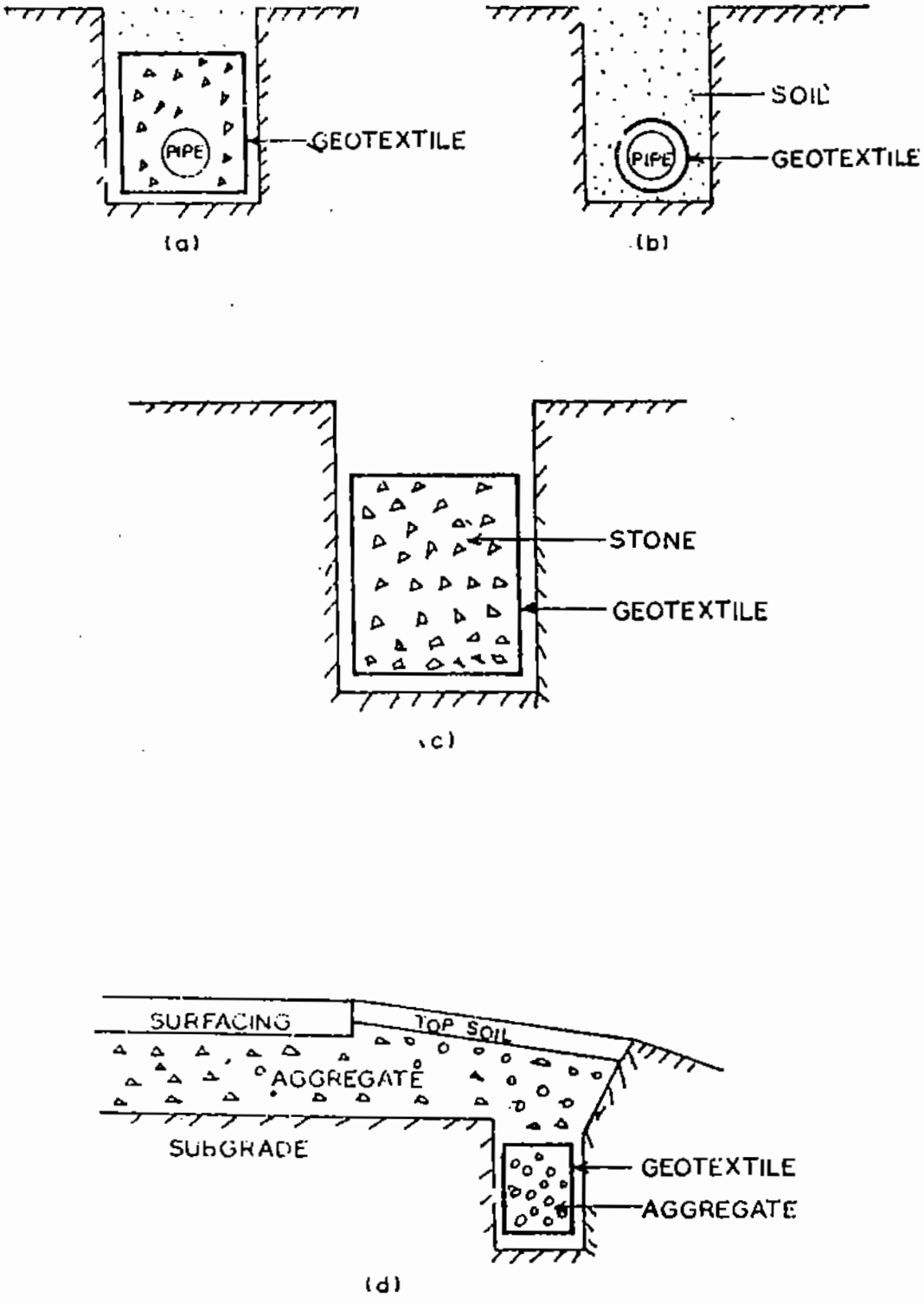

FIG. 7- USE OF GEOTEXTILE IN UNDER-DRAINS

6.1.2.2 There has been in general, a reduction in service life values of test section with 35-45 AIV aggregates as compared to service life values of test sections with 10-20 or 20-30 AIV aggregates.

6.1.2.3 The test section with premix carpet with liquid seal coat has generally proved to be superior to that with mix seal surfacing and that with premix carpet with sand seal coat (or crushed stone dust).

6.1.3 Comparative cost economics of various surfacing types

6.1.3.1 The comparative cost of seven surfacings was worked out in terms of cost index for cost of 10 sq. m. per year of life for sake of comparison. These may not be exact representation as the actual cost shall depend upon the leads and other local factors. However, the cost worked out on the basis of rates prevailing in Delhi and comparative life in years for these surfacings are given in the table below:

S. No.	*Surfacing type*	*Cost per 10 sq.m. Rs*	*Service life in months*	*Cost index Col 3-Col 4 (life in years)*
1	2	3	4	5
1.	40 mm asphaltic concrete	356	73	58.5
2.	25 mm asphaltic concrete	222	68	39.3
3.	40 mm semi-dense asphaltic concrete	310	68	54.7
4.	25 mm semi-dense asphaltic concrete	194	64	36.3
5.	20 mm premix carpet with liquid seal coat	205	58	42.2
6.	Mix seal surfacings	178	47	45.4
7.	20 mm premix carpet with stone crusher dust seal coat	192	41	56.2

6.1.3.2 From cost index 25 mm semi-dense asphaltic concrete, 25 mm asphaltic concrete, 20 mm premix carpet with liquid seal coat and mix seal surfacings are in order of economy.

6.2 **Performance evaluation based on serviceability index from physical measurements**

The data on physical measurements of distress cannot be utilized to arrive at serviceability index values by standard formula because of certain limitations like insignificant rut depth due to even nature of Lateral placement of vehicular traffic, low weightage to cracked and patched area in the formulae though in study they formed major manifestation of distress, no weightage to ravelling.

6.3 **Performance evaluation based on Benkleman beam deflection values**

6.3.1 The Benkleman beam deflection observation did not produce any co-relationship between the observed deflection and variations in the quality of aggregates, and also no definite pattern of change of deflection value with the passage of time.

6.3.2 The deflection value can serve only as an index of retention of structural adequacy of the test-sections over their periods of service life.

7. The performance of bituminous surfacings on bituminous macadam base course for the same rainfall and traffic conditions has been found to be very much superior than the surfacings on WBM base. None of surfacings on bituminous macadam base courses have failed even after 5 to 6 years service and are still under observation. The data on balance test sections is under collection and a comprehensive report shall then become available after completion of field work.

8. **The Findings of the Study are**

(i) It will be preferable to lay wearing course of 20 mm premix carpet with liquid seal coat/25 mm semi-dense carpet/mix seal surfacing with aggregates of AIV upto 30.

(ii) Asphaltic concrete surfacing directly on WBM base is not recommended.

(iii) Liquid seal coat is preferable to sand seal coat.

(iv) Sand seal coat on premix carpet should be avoided.

(v) Crusher dust will be preferable to sand for seal coat but whenever natural sand has to be used, it shall be used with caution. Rounded fine sand of single size shall not be used.

(vi) Mix seal surfacing with rounded aggregates should not be used.