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NO. PL-10(36)/71 *Dated the 27th May, 1971*

To

The Superintending Engineer, N.E.F.A. Circle II, C.P.W.D., Shillong-3

Sub : Bitumen painting on wet surface

This has reference to your office letter No. SEII/WC-5/A/5107-08 dated the 28th April 1971 regarding advice about the carrying out of bituminous painting works on wet surfaces.

2. It may be informed that in response to a similar reference from the then Adviser to the Governor of Assam

we had forwarded to Superintending Engineer, N.E.F.A., a note entitled 'Black-topping on Roads in Hilly Areas', vide d.o. letter No. PL-10(51)/63, dated the 16th June 1964. A copy of that note is enclosed for ready reference, specific attention being invited to its paras 19-28 where black-topping operations under wet working conditions have been discussed.

3. For this problem a number of solutions could be possible like the use of heated chippings, pre-coated chippings or addition of adhesive agents, depending upon the environmental and working conditions at the site. It is hoped that the details spelt out in the enclosed note will be found useful in dealing with the exact problems being encountered in your area. Still, if any clarifications are required, we will be glad to help.

4. It may be added that we are not aware of the compound for bituminous work on wet surfaces developed by a Chandigarh firm, mentioned in your letter under reference.

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## BLACK-TOPPING ON ROADS IN HILLY AREAS

General

Black-topping is the usual way of referring to all bituminous surfaces, because of their appearance. Under this broad heading would be included a variety of pavements to the types, ranging from the inexpensive, thin surface treatments to the thick dense carpets.

2. Black top pavements consists, essentially, of combinations of mineral aggregates with bituminous binders in various proportions. As with any other construction medium, there can be several combinations of aggregates and binders that will provide a lasting pavement under the given set of conditions. The conditions controlling the design are mostly the external variables of climate and terrain, and to a less extent, the properties of material from which choice is to be made.

The Problems

3. Bituminous pavements have been in vogue for many years in the maintenance and construction of roads in India, both in plains and in the hilly areas. Their more extensive use on hill roads in the recent past has, however, brought forth varied problems. The problems, at times, are created merely through lack of understanding of the interaction of the components of the pavement, and remedial measures lie in the careful selection and control of materials with close supervision at each step of construction.

4. Most problems in hilly areas occur directly on account of the wet and cold climatic conditions obtaining there. In addition to traffic, the newly laid surfacings have to withstand the wear and deformation caused by extremes of temperature, contact with water, and ice, or frost conditions. Water, indeed, is the largest single agent causing deterioration of surfaces in the hilly regions because it has greater affinity than bitumen for stone surfaces. Almost all the corrective measures revolve around elimination of water from the road structure, both at times of actual construction and later during the life of the pavement.

5. Short working seasons are another incidental problem, because of which the working methods have to be suitably adjusted. Questions are also raised frequently in hilly areas as to the timing of black topping operations viz. whether these should commence immediately after the initial formation or wait for 2 or 3 years till the sub-grade gets stabilised.

Timing of Black-topping Operations

6. Considerations as to the timing of black-topping operations are generally the same, be the road located in plains or in a hilly terrain. For roads in fill, it has been usual to let traffic go over it for 2 or 3 seasons if the embankment has not been properly compacted during construction. If, however, the embankment has been compacted fully, layer by layer, to 100% Proctor Density, the pavement can be built straight on completion of the embankment, without risk of failure.

7. Similar considerations apply in the case of a road in cutting. If the sub-grade in the natural stratas compact (i.e. it has 100% Proctor Density) the pavement including the blacktop, could be laid right away. Otherwise the sub-grade must be dug up to a suitable depth and compacted fully before the paving operations are attempted. Same principles have to be kept in mind for the partial cut-fill cross-sections.

8. Mention must also be made here of the measures necessary to avoid wet-weather damage to the newly cut formations in hilly areas when due to short working seasons or other pertinent reasons, laying of pavement has to be deferred till the next season. In this context acohesive soils threw up more foundation problems than the rock subgrades, because wet weather cannot cause any significant damage to the latter.

9. The preservation of a cohesive soil formation under wet conditions becomes impossible if the movement of construction plant cannot be deferred without seriously slowing up progress. The problem may be overcome however by either of the following methods. Either immediately after excavation, a layer of granular stabilised soil, or lean concreteof sufficient thickness to permit the passage of construction traffic without harm to subgrade, should be spread and compacted. Or, alternatively, the desired effect may be achieved by applying a tar or bitumen surface dressing immediately after the formation is prepared. Many of the subsequent black-topping problems can be prevented by these precautionary measures.

10. To ensure trouble free construction, both the key ingredients of black-top, viz., binder and the chippings, must be chosen with care.

Choice of Materials

11. The binder used may be tar, bitumen, a tar-bitumen mixture, or a cut-back bitumen.

12. In selecting the binder, the two important physical properties to be kept in mind are "adhesion" and "viscosity". Important to a less extent are "brittleness" and "tensile" strength. The binder should then applied be sufficiently fluid to wet the surface and the chippings, it must then set so as to keep the chippings firmly in position. For ease in working, lower viscosity binders would be preferable for the colder climates prevailing in hilly areas. On the other hand high-viscosity binders will resist the stripping action of water better than the low-viscosity types. The use of high-viscosity binders, however, involves the risk that initial coverage of the chippings may be too poor. A mean has thus to be struck between the two extreme positions.

13. For surface dressing work, the most desirable grades of straight run bitumen for hilly areas would be with penetration values from 80/100 to 180/200. For premix carpets, or for grouting, cutback bitumens of the rapid-curing type (say H.c. 3) are more suitable. These stipulations apply equally to care with comparable properties.

14. For surface dressings, tar-bitumen mixtures can also be employed with satisfactory results provided the quantity of bitumen is in the neighbourhood of 10-15% of the mixtures.

15. A word about the comparative performance of tars and bitumens. Though both tars and bitumens are suitable as binder, the phenelic constituents of tar lend it better adhesion properties than bitumen in the presence of water. On the other hand, tars tend to be more brittle in frost conditions i.e. at below freezing-point temperatures.

16. Chippings are no less important than the binder. These should generally be of a clean, tough, hard rock or gravel, though the final choice would depend on local availability and economic considerations. For a long effective life the chippings chosen should exhibit a high resistance to crushing and polishing. Some indication of this tendency can be obtained from the results of the aggregate crushing test.

17. Surface texture of chippings is another vital consideration. The displacement of the binder, particularly in the presence of water, is most rapid with chippings having smooth and glassy or coarsely crystalline texture. Chippings of rough coarse texture should be preferred.

18. As for shape and size, best results would be obtained by employing single size "cubical" chippings. The term cubical is used to describe chippings of the most desirable shape i.e. with relatively sharp edges as produced by crushing, but neither elongated nor flaky. Chippings which are too large are more easily torn away from the road surface by traffic. Too small chippings on the other hand become completely embedded and their use may lead to bleeding and fatting up. The choice of the size of chippings should also take into consideration the expected degree of embedment in the road surface as a result of compaction by traffic.

Effect of Water

19. As mentioned earlier, water is the chief cause of deterioration of the black top surfaces in hilly areas. Moisture resulting from wet weather can prevent adhesion of binder to the stone, particularly if the stone is dusty, and can even break down the bond formed in the early stages of a freshly laid surfacings.

20. If the chippings are damp when applied, there is little or no adhesion between the stone and the binder until the film of water has evaporated. Dust on the surface of the stone, particularly if wet, will also greatly delay the adhesion between the stone and the

binder, and for this reason the risk of premature failure by wet weather is accentuated.

21. Remedial measures against water are discussed under two headings: (1) for surface dressings: and (2) for pre-mix surfacings.

(1) *Surface dressings*: The conditions prevailing during surface dressing on hill roads are particularly conducive to water displacement, for the stone is frequently used in a wet condition. This displacement may be obviated in three ways: namely (1) use of heated chippings; (2) use of coated chippings; and (3) use of adhesion agents.

22. With heated chippings, instant adhesion can be obtained with a binder of any viscosity. However the chippings will cool quite rapidly to the road temperature and should therefore be rolled as quickly as possible. One drawback with the heated chippings is that, during the process of drying and heating, there can be possibility of the production of dust which may interfere with the wetting of the chippings by the binder.

23. The alternative method of coating the chippings with a film of binder, overcomes the problem of dust and is generally more convenient. The essential feature of coated chippings is that they should be easily separable. To this end, a very fluid binder, about 0.75 to 1.00% by weight of chippings, is used to coat cold or slightly warmed chippings. In cold weather, coated chippings can with advantage be applied hot, followed soon by rolling operations. Otherwise these should be spread out in a thin layer to cool before being stockpiled for future use.

24. Adhesive agents can possibly be employed in three different ways: namely (1) by incorporation in binder before spraying (about 1%) (2) by sprinkling a solution on the binder film before the application of chipping (4% to 8% solution in creasote oil at the rate of 140/180 sq. yds. per gallon) (3) by pre-treatment of chippings with a solution of the adhesion agent. Of these the last method has been found to be most practical. The procedure is to coat the chippings in a mechanical mixer with about 1-2 gallons of a solution prepared by adding the wetting agent to creasote at a concentration of about 5 to 8% per 25 cft of chippings. 'Adhevia'T manufactured by M/s Imperial Chemical Industries, Daoneon T, Wet fix or Udol are examples of such proprietary wetting agents in the market.

25. It may be added that the adhesion agents have so far not been used in India on any large scale, and it is possible, their use in hilly terrain may not prove economical at but the most problematic locations.

(2) Pre-mix Surfacings

26. Hydrated lime, portland cement, or any other suitable adhesion agent can be used to assist the coating of cold, wet, aggregates with either tar or bitumen. Any of them may also be used in warm mixed bituminous materials to prevent stripping of the binder from previously dried aggregates. Hydrated lime is the most frequently used anti-stripping agent.

27. For this purpose the binder must contain an acidic constituent such as phenol, and it must be of sufficiently low viscosity to flow round the cold stone. Bituminous cut backs being marketted in India are suitable for this job. But since they do not contain phenolic constituents, addition of any external agent like the Turkey Red Oil or any other sulphonated oil is necessary. For Indian conditions, a mixture of 1.5% of Turkey Red Oil by weight of binder with 1.5% lime by weight of stone aggregate (6 to 10 lbs of lime for 100 sq. ft.) has provided both economical and effective in action.

28. Lime to be used should in the form of a dry powder, free from lumps. Quicklime is not recommended, as surfacings made with mixtures containing quick lime are often not durable. Mixing procedure is to add the lime either as the aggregate is fed to the mixer or immediately after it has entered the mixer. Binder should not be addded until the lime is thoroughly dispersed throughout the mix. Projection of hydrated lime could be 1-2% by weight.

Effect of frost

29. Frost conditions may often be experienced at high altitudes when temperatures below the freezing point persist for sufficiently long durations. Low temperatures for only brief periods will not give rise to such conditions normally.

30. Blacktop is not directly affected by the frost, except when considered in relation to the pavement as a whole. Failures from frost occur when there is heaving of the soil due to freezing and thawing of the ground. This heaving leads to loss of bearing strength and

consequential disintegration of the pavement.

31. Remedial measures, as far as the blacktop is concerned, would lie in providing a dense hot-mix carpet which will make the surface impervious to outside water. Keeping the crust thickness at least 9 inches and providing a sub-base of course-grained material are other important measures which can enhance the life of the blacktop surface.

Construction Controls

32. This section describes a few of the familiar construction controls, which can go a long way in the creation of high class blacktop surfaces in the hilly areas.

33. *Preparation of surfaces*: Blacktop obviously cannot restore the riding quality of a surface that thas become mishappen. Before the application of blacktopping, therefore, the pavement should be carefully repaired and re-sectioned. Corrugations should be removed and the local depressions made good with suitable materials so that the resulting surface is nearly as good as that of the reminder of the road surface. It would be advantageous too if the surface is dry and is thoroughly cleaned immediately before applying the blacktopping.

34. *Rate of application of binder* : Binder is the most important single factor affecting the life of a blacktop. Its precise rate of spread is a matter of experience, and much can be gained if records and experience from neighbouring stretches in the region are drawn upon for guidance.

35. The quantity of binder should be so chosen that there is no bleeding because of excess, or scabbing because of deficiency. For deciding on the optimum rate, factors such as the size and shape of chippings the traffic intensity, and the nature of old road surface are important.

36. *Rolling* : The purpose of rolling is to press the stone chippings into good contact with the binder and to flatten the layer of chippings so that it is less prone to disturbance by traffic. With an iron-wheeled roller some crushing of the stone is inevitable but excessive rolling, should be avoided since it can cause harmful degradation of the chippings. For surface dressing work, the roller should normally not exceed about eight tons in weight.

37. *Opening the road to traffic* : No traffic should be allowed over the new work before adhesion between the binder and the chippings has taken place. In particular the fast traffic (over 20 miles/h) should be kept off as long as possible, because it imposes horizontal forces on the road that tend to displace the stone on the surface.

38. A surface dressing is in its most vulnerable position when freshly laid, and efforts in keeping the traffic off during the first few hours, or reducing the speed, to say 15 m.p.h., may mean all the difference between success and failure. At many places in India there is considerable hoofed traffic. This has to be stopped for some time, or allowed carefully on one side for a few hours, so that the newly-laid surfacing does not get disrupted.