

**TENTATIVE SPECIFICATIONS  
FOR  
THE CONSTRUCTION  
OF  
STABILIZED SOIL ROADS WITH  
SOFT AGGREGATE IN AREAS  
OF  
MODERATE AND HIGH  
RAINFALL**



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## TENTATIVE SPECIFICATIONS FOR THE CONSTRUCTION OF STABILIZED SOIL ROADS WITH SOFT AGGREGATE IN AREAS OF MODERATE AND HIGH RAINFALL\*

### INTRODUCTION

The two specifications recommended in this publication were framed by the Soil Research Committee (personnel given below), and approved by the Executive Committee at their meeting held on the 21st & 22nd August, 1967 and by the Council at their meeting held at Nainital on the 30th September, 1967.

B.D. Mathur	...	<i>Convenor</i>
Dr. H.L. Uppal	...	<i>Member-Secretary</i>

### MEMBERS

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Maj. Gen. R.A. Loomba	J.M. Trehan
Dr. I.S. Uppal	

These specifications are intended to indicate what is considered to be a good practice for construction of stabilized soil roads with soft aggregates in areas of moderate and high rainfall laid over compacted embankment of non-expansive soil.

Provisions of these specifications shall apply unless modified by special provision to take into account unusual conditions.

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\*This technique of soil stabilization was evolved and successfully tried on a large scale by Prof. S. R. Mehra of Punjab P.W.D. (B. & R.) and is commonly known as "Mehra's method of stabilization."

I. TENTATIVE SPECIFICATION FOR THE CONSTRUCTION OF STABILIZED SOIL ROADS WITH SOFT AGGREGATE IN AREAS OF MODERATE RAINFALL (NOT EXCEEDING 150 CM PER ANNUM)

1. SCOPE

This specification is recommended for the climatic and traffic conditions given below :

- |  |  |
|--|--|
| (i) Rainfall :                                       | Not exceeding 150 cm per year.                       |
| (ii) Depth of sub-soil water level :                 | More than 2 m below ground level.                    |
| (iii) Traffic intensity and the type of road :       |  |
| (a) About 50 tons per day average of mixed traffic.  | Unsurfaced road.                                     |
| (b) About 200 tons per day average of mixed traffic. | Surface treated stabilized soil road.                |
| (c) About 500 tons per day average of mixed traffic. | Surface treated road having stone grafted base coat. |

2. THICKNESS OF PAVEMENT

Thickness of pavement shall be the same as found satisfactory for the flexible pavement in the area for the traffic required. Thickness of base coat will be kept about 9 cm, and the remaining thickness will be built with base course specification. The above specification presumes that while constructing embankment, the top 30 cm crust of local soil compacted at controlled moisture for minor roads and 45 cm of similar crust for major roads shall be provided.

### 3. DETAILS OF SPECIFICATION

#### 3.1. For Unsurfaced Road having a Traffic Intensity of 50 Tons per day

3.1.1. **Base course** : Soil with Plasticity Index<sup>1</sup> 4 to 7 and sand content<sup>2</sup> not less than 50 per cent shall be laid at optimum moisture and compacted with 6-8 ton power roller\* to a minimum of 95 per cent of laboratory Proctor density. The sodium sulphate content of the soil shall not be more than 0.15 per cent by weight of dry soil. This shall also include the sulphate content in the water to be used for construction.

3.1.2. **Wearing course** : Two parts of soil with Plasticity Index<sup>1</sup> 9 to 11 and sand content<sup>2</sup> not less than 33 per cent shall be mixed with one part by volume of brick aggregate, kankar, moorum or laterite except that about 10 per cent of the aggregate collected for mixing with the soil shall be saved and spread on the layer of soil aggregate mixture, before rolling.

The size of the aggregate shall be such that all of it passes through 31.5 mm sieve and not more than 20 per cent passes 6.3 mm sieve<sup>3</sup>. The aggregate impact value shall not be more than 50 per cent. The soil aggregate mixture shall be brought to optimum moisture and rolled with 6-8 ton power roller till no mark is left on the surface. The limit for sodium sulphate content in the soil shall be the same as that for base course.

#### 3.2. For Traffic Intensity of 200 Tons per day (Stabilized Soil Road with Bituminous Surface Treatment)

3.2.1. **Base course** : Soil with Plasticity Index<sup>1</sup> 4 to 7 and sand content<sup>2</sup> not less than 50 per cent shall be laid at optimum moisture and compacted with 6-8 ton power roller to a minimum of 95 per cent of laboratory Proctor density. The sodium sulphate content of the soil shall not be more than 0.15 per cent by weight

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\*In the absence of a better compacting unit found from experience.

1. Plasticity Index : The lower P.I. to be used where natural soil of the P.I. with the given sand content is available. The higher P.I. to be used when a high plasticity clay is to be used in the mixture.
2. Fraction passing 425 micron and retained on 75 micron *IS sieve*.
3. Ordinary hand broken aggregate satisfies the above grading.

of dry soil. This shall also include the sulphate content in the water to be used for construction.

**3.2.2. Base coat :** Two parts of soil with Plasticity Index<sup>1</sup> 8 to 10 and sand content<sup>2</sup> not less than 33 per cent shall be mixed with one part by volume of brick aggregate, kankar, moorum or laterite except that about 10 per cent of the aggregate collected for mixing with the soil shall be saved and spread on the layer of soil aggregate mixture, before rolling. The size of the aggregate shall be such that all of it passes through 31.5 mm sieve and not more than 20 per cent passes 6.3 mm sieve. The aggregate impact value shall not be more than 50 per cent. The soil aggregate mixture shall be brought to optimum moisture and rolled with 6-8 ton power roller till no mark is left on the surface as per details given in *Annexure*. The limit for sulphate content in the soil shall be the same as that for base course.

**3.2.3. Surface dressing :** The base coat surface, after it has been subjected to controlled traffic for a period of about 10 to 14 days, and dried down preferably to a moisture content of 4 to 6 per cent, shall be sprayed with bituminous primer (a mixture of 30 parts of bitumen 80/100 and 70 parts furnace oil), or cutback SC-0 as per IS : 217-1961 at the rate of 10 kg per 10 m<sup>2</sup>. After the primer has soaked in, it shall be finished with 2 coat surface dressing or with premix carpet and seal coat whichever is preferred. The surface treatment shall be carried out as per relevant I.R.C. Standard Specifications, vide IRC : 23 for surface dressing, and IRC : 14 for premix carpet and seal coat.

### **3.3. For Traffic Intensity of 500 Tons per day**

(Surface treated road having stone grafted base coat)

**3.3.1. Base course :** Soil with Plasticity Index<sup>1</sup> 4 to 7 and sand content<sup>2</sup> not less than 50 per cent shall be laid at optimum moisture and compacted with 6-8 ton power roller to a minimum of 95 per cent of laboratory Proctor density. The sodium sulphate content of the soil shall not be more than 0.15 per cent by weight of dry soil. This shall also include the sulphate content in the water to be used for construction.

**3.3.2. Base coat :** Seven parts of soil with Plasticity Index<sup>1</sup> 8 to 10 and sand content<sup>2</sup> not less than 33 per cent shall be mixed with three parts by volume of brick aggregate, kankar, moorum or



laterite. The size of the aggregate shall be such that all of it passes through 31.5 mm sieve and not more than 20 per cent passes 6.3 mm sieve. The aggregate impact value shall not be more than 50 per cent. The mixture of soil and aggregate shall be brought to optimum moisture and then covered completely with 25 mm size stone metal or overburnt brick aggregate at the rate of 0.20 to 0.23 m<sup>3</sup> per 10 m<sup>2</sup>. The aggregate impact value of the stone or overburnt brick used for grafting shall not be more than 25 per cent. Compaction shall then be carried out with 6-8 ton power roller as per details given in *Annexure*.

3.3.3. **Surface dressing** : This shall consist of two coat surface dressing or premixed carpet whichever is preferred. If premixed carpet is used, care shall be taken that the cutback primer used covers the entire surface to resist penetration of water. The grit used for surfacing shall have an aggregate impact value of not more than 25 per cent and stripping value 15 to 20 as determined vide IS : 6241.

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## II. TENTATIVE SPECIFICATION FOR THE CONSTRUCTION OF STABILIZED SOIL ROADS WITH SOFT AGGREGATE IN AREAS OF HIGH RAINFALL (EXCEEDING 150 CM PER ANNUM) OR AREAS OF HIGH WATER-TABLE

### 1. SCOPE

The specification is recommended for the climatic and traffic conditions given below :

- |                                      |  |
|--------------------------------------|--|
| (i) Rainfall :                       | Exceeding 150 cm per year.                       |
| (ii) Depth of sub-soil water level : | Within 2 m from ground level.                    |
| (iii) Traffic intensity :            | About 500 tons per day average of mixed traffic. |

### 2. INTRODUCTION

The water-table is generally high in areas of high rainfall or areas having poor drainage conditions. The proximity of water-table leads to the absorption of moisture by the subgrade and road bases as a result of rise of moisture through capillarity. The specification for a road pavement, with stone grafted base coat and surface treatment are given below.

### 3. THICKNESS OF PAVEMENT

The exact thickness of road pavement shall be worked out from the soaked CBR of the subgrade and that of the various layers of the road pavement, from the soaked CBR of soil stabilized with binders such as cement or lime. The thickness of the base coat shall be kept about 10 cm and the remaining thickness shall consist of base course and sub-base. No soil layer shall be compacted in loose thickness exceeding 22 cm.

### 4. DETAILS OF SPECIFICATION

#### 4.1. Subgrade

4.1.1. The surface shall be rolled with 6-8 ton power roller and brought to a camber of 1 in 48.

## 4.2. Sub-base

4.2.1. Local soil (barring exceptionally clayey) shall be compacted at optimum moisture as such or after mixing requisite quantity of binder, lime<sup>1</sup> or cement<sup>2</sup>, (added on the basis of the weight of dry soil) if required. It shall be compacted with 6-8 ton power roller to a minimum of 90 per cent of the laboratory Proctor density. This shall be cured for about a week<sup>3</sup> by sprinkling water over it, 3 to 4 times a day. (The sodium sulphate in soil shall not be more than 0.15 per cent).

## 4.3. Base Course

4.3.1. It shall consist of soil with Plasticity Index of 4 to 7 and sand content not less than 50 per cent. The soil shall not contain deleterious salts, such as sodium sulphate, more than 0.15 per cent by weight of dry soil. It shall be brought to optimum moisture content and mixed with requisite quantity of binder (lime<sup>1</sup> or cement<sup>2</sup>) added on the dry weight of soil. This shall be compacted with 6-8 ton power roller to a minimum of 95 per cent of the laboratory Proctor density and cured for about a week<sup>3</sup>, by sprinkling water over it 3 to 4 times a day.

## 4.4. Base Coat

4.4.1. It shall consist of soil with Plasticity Index of 8 to 10 and sand content not less than 33 per cent. The soil shall not contain deleterious salts, such as sodium sulphate, more than 0.15 per cent on the weight of the dry soil. The soil shall be brought to optimum moisture and mixed with requisite quantity of binder (lime<sup>1</sup> or cement<sup>2</sup>) added on the dry weight of soil. Seven parts of soil with binder, shall be mixed with 3 parts of moorum, laterite, kankar, or brickbat or any other similar material. The size of the aggregate shall be such that all of it passes through 31.5 mm IS sieve and not more than 20 per cent passes through 6.3 mm

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1. The percentage purity of lime used shall be determined according to IS : 712-1964. If the percentage purity of lime is less than that specified, the concentration of lime shall be increased proportionately.
  2. Cement as per IS specifications.
  3. The curing can be reduced to two days, if the compacted crust can be covered with the next layer.

IS sieve. The aggregate impact value shall not be more than 50 per cent. The mixture of soil and aggregate shall be brought to optimum moisture and then covered completely with 25 mm size stone metal or overburnt brick aggregate at the rate of 0.20 to 0.23 m<sup>3</sup> per 10m<sup>2</sup> area. The aggregate impact value of the stone or overburnt brick used for grafting shall not be more than 25 per cent. Compaction shall then be carried out with 6-8 ton power roller as per details given in *Annexure*.

#### 4.5. Surface Dressing

4.5.1. This shall consist of two coat surface dressing or premixed carpet whichever is preferred. If premixed carpet is used, care shall be taken that the cutback primer used covers the entire surface to resist penetration of water. The grit used for surfacing shall have an aggregate impact value of not more than 25 per cent and stripping value 15 to 20.

*Note* : It has been found that barring exceptionally clayey soils, a soaked CBR of about 8 can be achieved in a large majority of soils by compaction at optimum moisture to a minimum of 95 per cent of the laboratory Proctor density. It has also been found that mixtures specified in base course and base coat and treated with about 3 per cent cement or lime give laboratory soaked CBR of 35 and 80 respectively.

## CONSTRUCTION PROCEDURE\*

### 1. PRELIMINARY SOIL SURVEY

A visual identification of soils along the entire length of the existing earth road or proposed alignment shall be done keeping in view the behaviour of different lengths under traffic in different weather conditions. Topographical data and figures of rainfall, etc., shall also be collected.

### 2. SOIL SAMPLING

As a certain amount of banking is necessary to keep the road immune from flooding, the soil for stabilizing has normally to be borrowed from areas outside the formation width of the road.

In the alluvial plains of India, the characteristics of the soil deposits change at short intervals. Therefore, soil samples shall be taken from fixed points which can be located at the time of borrowing soil for road construction.

Soil samples shall be taken 30 cm or more deep depending upon the practice of borrowing soil and 20 m away from the centre line of the road and at points approximately 50 m apart or longer distance depending upon the variation in the texture of soil keeping in view the borrow area available. After removing the top 3 to 5 cm of foreign matter, which may be in the form of grass or any other loose matter, a representative sample about 2.5 kg in weight shall be obtained by the method of quartering, after mixing the entire quantity of soil dug out from 30 cm cubical pit. For locating the spot for subsequent borrowing of soil, a numbered peg shall be driven.

In addition to sampling at regular intervals, a few more samples of admixtures like fat clay and sand, available at economic distance from the road shall be taken to facilitate blending.

Samples of local aggregate such as brickbats, or any other local deposits of kankar, laterite, or coarse moorum shall be also

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\*The procedure specified relates to work carried out by manual labour. The use of machinery for pulverising, mixing and watering has been successfully adopted recently in a few cases. The procedure for the use of machinery will be evolved in due course as a result of actual experience.

collected. Samples of water to be used for construction shall be collected in glass bottle.

### 3. DESPATCH OF SAMPLES

Each sample shall be put in paper bag to avoid loss of fine material. This, in turn, shall be enclosed in a cloth bag to which a tag shall be tied describing the exact location. Similar information written on paper shall also be enclosed in the bag itself. The samples shall be despatched to the laboratory for testing.

### 4. TESTING OF SAMPLES

The following routine tests shall be carried out :

<b>Soils :</b>	(i) Sieve analysis through No 2 mm, 425 micron, 75 micron IS sieve
	(ii) Liquid Limit
	(iii) Plastic Limit
	(iv) Sulphate content
<b>Water :</b>	Sulphate content
<b>Soft Aggregates :</b>	Aggregate impact value

### 5. SUBGRADE FORMATION

If the formation is already existing, then top 15 cm of the subgrade shall be raked, pulverised and rolled back with 6 to 8 ton power roller at near optimum moisture. In case of a new formation of minor and major roads, the top 30 cm and 45 cm respectively of the embankment shall be compacted in loose layers of not more than 22 cm in the same manner as mentioned above. The desired moisture may be attained by flooding the borrow area.

### 6. COLLECTION OF SOILS

Soils, as specified in the designed mixtures, shall be dug out and collected in stacks in required quantities every 50 m.

## 7. PULVERISING OF SOILS

The soil shall then be pulverised separately with the backs of spades to such a state of fineness that about 80 per cent of the soil is under 8 mm size.

In the case of fat hard clays (P.I. over 20), the pulverisation can be carried out more conveniently if the clods are wetted a day or two in advance.

## 8. DRY MIXING AND STACKING

The different soils for base course and soils with aggregate for base coat shall then be mixed in the dry state by turning them over with spades and shovels. After thorough mixing, stacks about 38 cm in height shall be prepared and the top of stacks levelled carefully.

## 9. CHECKING OF MIXED STACKS

A representative sample shall be taken from the mixed stack and checked in the field laboratory, for correctness of the required P.I. and sand content. Any serious departure shall be set right by adjusting proportions of its constituents to make sure that requisite quantity of admixture is added.

## 10. ADDITION OF MOISTURE

Quantity of water required for optimum moisture is determined on weight basis. It will, therefore, be necessary to determine the average weight of soil per cubic metre. This generally varies from 1100 to 1300 kg per m<sup>3</sup>. Quantity of water for optimum moisture, determined by the field laboratory shall be poured carefully towards evening over the stacks, small earth sides having been provided to retain the water, earmarked for laying next morning and allowed to soak down overnight. To ensure uniform distribution of water, the top of the stacks shall be divided with raised earth sides into a number of sub-stacks. Necessary allowance shall be made for evaporation losses and absorption by brick aggregate as determined by actual experiments from time to time.

## 11. LAYING AND ROLLING

After remaining in contact with moisture for several hours, the wet mixture of the base course shall be sliced off from the stacks in

small lots, mixed as required and laid on the prepared subgrade to template with cross slope of 1 in 48 for the roads with bituminous treated surface and 1 in 24 for other roads. (The mixing can also be done mechanically with equipment such as rotavator). The rolling shall then be done with 6-8 ton power roller, to attain a minimum of 95 per cent of the laboratory Proctor density.

The wearing coat shall also be laid and rolled as described above. Rolling shall be continued till the wheels of the roller make no appreciable impression on the surface. A heavy sprinkling of water shall then be given to the road and left overnight. Next morning, the surface shall again be rolled to finish.

When stone grafting is specified, the following procedure shall be adopted.

On the first day, the uncompacted base coat together with the layer of stone, 2.5 cm gauge, spread on the surface at the rate of 0.20 to 0.23 m<sup>3</sup> per 10 m<sup>2</sup> shall be rolled with two to three passes of the roller over the whole length, and then the surface shall be sprinkled thoroughly with water and left over for the night.

On the following day, without adding any more water, the surface of the road shall be rolled thoroughly with at least 6 passes of the roller. The surface shall again be thoroughly sprinkled with water and left for the rest of the day.

On the third day again, the surface of the road shall be rolled (after spreading wet soil to blind the surface and without any addition of water) and rolling continued till the road is thoroughly compacted. Of these 3 days, the rolling on the second day shall be the heaviest.

## 12. CURING

The ungrafted road surface shall be kept closed to traffic for 4 to 5 days and all the time kept damp by heavy sprinkling of water. After this, light sprinkling of water shall be continued for another 1 to 14 days and controlled traffic allowed to run over the road, beginning with motor traffic only and gradually extending to all kinds of traffic. In case it is not possible to subject the road to controlled traffic, the crust shall only be allowed to dry before surfacing. However, in the case of the grafted surface, the crust shall be allowed to dry without subjecting it to any traffic.



### 13. SURFACE TREATMENT

The crust shall be allowed to dry to a moisture of about 4 to 6 per cent. For a traffic intensity of 200 tons a day, the surface shall be painted with primer (30 parts bitumen 80/100 and 70 parts furnace oil) or cutback SC-0 at the rate of 10 kg per 10 sq. metre before bituminous surfacing is given.

### 14. MAINTENANCE OF UNSURFACED STABILIZED SOIL ROAD

The maintenance of this type of stabilized soil road is different from ~~the~~ of the conventional gravel road in that, it does not need periodical grading with mechanical graders. All that is required, is to remove the wearing course wherever a patch occurs, mix a little water or preferably water and molasses (in the ratio of 3 : 1) to bring it to near about optimum moisture and ram it back with a hand rammer. Molasses is used to give a little extra strength to the soil to make up for the variation in the moisture contents from the optimum and curing of the area of each small patch before opening to traffic.

Some slight rutting that takes place during the dry weather gets more or less smoothed out automatically under the traffic during the wet weather. The road thus remains almost free of ruts and pot-holes and the whole section wears evenly.





