Technical Note No:10

Sub: APRR Project - Stabilization of Soils/ FDR with STABIL ROAD Technology - Precautions to be taken during Execution - Reg.

Ref: Stabil Road Technology taken up in Package 18 & 19 of Krishna District.

*****

1. Introduction:

As a Pilot base road in Package 18 &19 of Krishna Dist. were selected for implementation of **STABIL ROAD Technology** duly replacing the conventional provisions such as GSB and WMM to enhance the life of the pavement. In these packages two types of stabilization is involved i.e., Soil stabilization (in-situ / barrow) and Full Depth Reclamation (FDR) using cement plus Stabil Road as additive.

Soil Stabilization (in-situ/barrow soils):

Stabilization is the process of blending and mixing materials with a soil to improve certain propertiesof the soil.The process may include the mixing of commercially available additives that may alter strength,texture or placticity of the soil.

Additive/Commercial Chemical Stabilization(CCS): Additive /CCS stabilization is achieved by the addition of proper percentage of cement and Stabilizer to the soils. The selection of type and quantity or the percentage of additive and Stabilizer to be used depends up on the soil classification and the degree of improvement in soil quality desired. When it is desired to improve the strength and durability significantly, larger quantities of additive like cement and Stabilizer (Stabil Road) are used. After the additive and Stabilizer spreading on the prepared base , mixing, sprinkling water and compaction at OMC are achieved by High end machinary.

FDR: Full-depth reclamation of asphalt pavement, also referred to as FDR, is a rehabilitation method that involves recycling an existing asphalt pavement and its underlying layer(s) into a new base layer. Usually, the pulverized material is uniformly blended with an additional stabilizing material such as **Portland cement plus Stabil Road** to provide an upgraded, homogeneous material. Finally, the stabilized material is compacted in place with rollers. The result is a stiff, stabilized base that is ready for a new rigid or flexible surface course.

The details of STABIL ROAD are as follows:

Stabil Road: Whitish Powder made of 100% natural minerals with no Synthetic chemicals.

Purpose : To enhance the properties of soil in terms of durability strength, elastic properties and Replacement of Metalling and soling.

Result : Non water - absorbing layer, reduce the cracking due to hydration of cement, increasing the elasticity of the stabilized surface.

Effect on soil : Not harmful to the soil or its applicators.

Product : Germany.

Accredited : by Indian Road Congress (IRC) .

2. Suitability of materials for stabilization (Cement + Stabil Road):

The properties required for soils to be stabilized with cement plus Stabil Road is on par with the specifications laid down for cement stabilization as per IRC: SP:89- 2010 & Clause 404 of MoRD 2014.

2.1 Cement Stabilization

Generally granular soils **free** of high concentration of organic matter or deleterious salts are suitable for cement stabilization. For checking the suitability of soils, it would be advantageous to keep the following criterion in view.

a) Plasticity of product (PP) expressed as product of PI of soil and percentage fraction passing 75-micron sieve should not exceed 60.
b) Uniformity coefficient of soil should be greater than 5 and preferably greater than 10.
c) Highly micaceous soils are not suitable cement stabilization.
d) Soils that are having organic content higher than 2 percent and also those soils having sulphate and carbonate concentration greater than 0.2 percent are not suitable for cement stabilization.

Desirable Properties of Cement

2.1.1 Cement: Cement for cement stabilization should comply with the requirements of IS 269,455 or 1489.

2.1.2 Soil Properties

Soil stabilization is likely to be effective based on the material passing through 75 microns sieve as shown in Table. 5.

Table 5 Guide to the Type of Stabilization likely to be Effective

Type of Stabilization	Soil Properties					
	More than 25% passing the 0.075 mm sieve			Less than 25% passing the 0.075 mm sieve		
	PI < 10	10 <PI< 20	PI > 20	PI < 6, PP < 60	PI < 10	PI > 10
Cement	Yes	Yes	•	Yes	Yes	Yes

2.2 Specifications and Test Requirements for Stabilized Materials.

2.2.1 General Requirement

The pavement performance of a stabilized road will be largely governed by the gradation and type of soil/granular material used for the purpose of Stabilization. The strength of stabilized materials can be evaluated in many ways of which the most popular are the **Unconfined Compressive Strength (UCS)** test and **California Bearing Ratio (CBR)** test.

2.2.2 Stabilization with Cement plus Stabilroad.

2 Requirement for bound sub-bases/bases

Granular materials, gravel, sand, latentic soils, Sandy silty material, crushed slag, crushed concrete, brick metal and kankar etc. stabilized with cement as sub-base and base layer of pavement. The main requirements of stabilized layer for different layers of a pavement structure as indicated above are summarized in Table 7 and 8. The gradation indicated in **Table 8 are intended as tentative specification.** Gradation for cement bound materials **as per clause 404 of MoRD** specifications can also be adopted.

Table 7 Material Characteristics for Cement Modified Granular Materials

Properties	Specified Value
Liquid Limit (%)	<45
Plasticity Index	<20
Organic content (%)	<2
Total SO_4 content (%)	0.2
Water absorption of coarse aggregates	<2% (If the is value is >2% the soundness test shall be carried out on the materials delivered to site as per IS 383)
10 percent fines value when tested as per BS 812(III)	≥ 50 kN

Table 8 Gradation Requirement for Cement Bound Materials for Base/Sub-bases/Capping Layer

Sieve size	Grading I	Grading II	Grading III	Grading IV
75.0 mm		100		100
53.0 mm	100	80-100	100	--
45.0 mm	95-100			
37.5 mm			--	95-100
26.5 mm		55-90	70-100	55-75
22.4 mm	60-80			
11.2 mm	40-60			
9.5 mm		35-65	50-80	
4.75 mm	25-40	25-55	40-65	10-30
2.36 mm	15-30	20-40	30-50	-
0.600 μ		-	-	
0.425 μ	8-22	10-35	15-25	-
0.300 μ		-		
0.075 μ	0-8	3-10	3-10	0-10
7 days Unconfined Compressive Strength (MPa) for cement bound materials or 28 days strength for lime-fly ash & lime-cement-fly ash bound materials	12*/6**	7*/4.5**	3*/1.5**	1.5*/0.75**

* Average value of a batch of 5 cubes

** Minimum strength of an individual cube within the batch. For Grading IV the unconfined compressive strength and CBR requirement are equally acceptable alternatives

Grading limits of materials for Stabilization with Cement as per MoRD 2014.Table 400.5

IS Sieve	Percent by Weight Passing Within the Range	
	Sub-base	Base
53.0 mm		100
37.5 mm	95-100	
19.0 mm	45-100	
9.5 mm		35-100
4.75 mm		25-100
600 micron	8-65	
300 micron	5-40	
75 micron	0-10	

2.3 Water: It shall meet the requirement as per IS:456. The permissible limits for solids in water should be as given in **Table.**

Table 10 Permissible Limit for Solid in Water for Soil Stabilization

Solids	Permissible Limit (Maximum)
Organic	200 mg/litre
Inorganic	3000 mg/litre
Sulphates (as SO_4)	400 mg/litre
Chloride (as Cl)	2000 mg/litre
Suspended matter	2000 mg/litre

2.4 Quantity of Cement and Stabil Road in stabilized mix:

The quantity of cement to be added as percent by weight of the dry soil and the quantity of Stabil Road to be added as percent by weight of cement. The mix design shall be done on the basis of 7-day Unconfined Compressive Strength.

2.5 Minimum Compressive Strength

The mix shall be designed for a **minimum laboratory 7-day** compressive strength of **3.0 MPa** for use in **base** course, and 1.7 MPa for sub-base as per clause 404.2.6 of MoRD. The same was also confirmed by the NRIDA, New Delhi for Stabil Road technology. (**Enclosure-**1)

2.6 Execution methodology of Stabil Road Technology

Stabilization with barrowed soil/ in-situ soil and Full Depth Reclamation:

- If barrowed soil is used which is having CBR > or equal to 5% and laid for a required thickness as per IRC:SP:72-2015 (Fig.6) and compacted with vibrator roller as levelling course for stabilization
- Then the Cement is spread with Cement Spreading machine uniformly over the surface of the road to a width of 3.90 meters in two passes. The cement content used is as per design mix based on MDD of barrowed soil.

- The additive (STABIL ROAD) is spread over the cement layer based on design mix.
- Then high end Writzen recycler machine is used to recycle the road to the required depth duly mixing the soil, cement and additive with required quantity of water at OMC.
- Then Sheep foot roller of 20 T is passed with high vibration to get 100% density as per Standard Proctor's compaction test.
- The road surface is levelled with motor grader.
- The road is compacted with vibratory roller and then with Pneumatic tyre roller to get smooth surface.
- The road is cured for 7 days and tested for assessing the UCS by extracting cores from road.
- The wearing course (BT/CC) will be laid over the Stabilized Base.

The High-End Machinery used in the construction process are as follows

Levelling with barrowed soil and lime marking

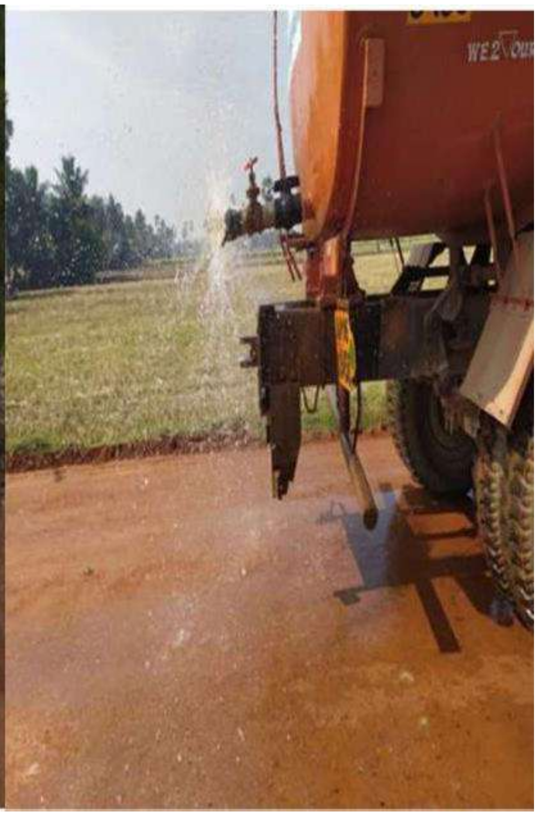
Cement Spreading with Cement Spreader

Additive Spreading **Recycler attached with Water Tanker**

After Recycling **Rolling with Sheep Foot Roller (20T)**

Grading with Motor Grader

Plain Rolling with Vibratory Roller



Rolling with PTM Roller to get Smooth Surface

Curing

Finished surface of the Road **Extraction of Cores for testing UCS**

Cores Extracted from Stabilized Base and ready for testing.

3 Construction Operations

3.1 Weather limitations

Stabilization shall **not** be done when the air temperature in the shade is **less than 10 degrees Celsius.**

3.2 Moisture content for Compaction

The moisture content at compaction determined as per IS:2720(Part2) shall be **within 2 percent** of the optimum moisture content corresponding to IS: 2720(Part 7).

3.3 Rolling

Compaction shall continue until the density achieved is at least **100 percent** of the maximum dry density of the material as per IS:2720 (Part 7). Care shall be taken to see that the compaction of cement stabilized materials is compacted **within two hours of its mixing** or such shorter period as may be found necessary in dry weather.

3.4 Curing

Curing of the compacted layer shall be carried out for a **minimum period of 7 days** by spreading moist straw/wet gunny bags or sand and sprinkling water periodically. After the curing period is over, subsequent pavement layers shall be laid as early as possible to prevent the surface from drying out.

3.5 Strength

Cement treated soil sub-base/base shall be tested for the Unconfined Compressive Strength value at **7 days**, actually obtained in situ. In case of any variation in in-situ value the pavement design shall be reviewed for the actual UCS value. The extra pavement thickness needed on account of lower UCS shall be constructed by the Contractor at his own cost.

3.6 Surface Finish and Quality Control of Works

Tests on Cement treated Sub-base/Bases shall be as given in clause 1800.3.5.1 of MoRD 2014.

1803.5.1 *Tests prior to construction*

The quality control tests to be carried out prior to construction shall be as given in **Table 1800.10.**

Table 1800.10 Quality Control Tests Prior to Construction

	Type of Test	Frequency
1)	Quality of cement and Purity of Lime (IS:1514) (if used for pre-treatment)	One test for each lot
2)	Unconfined Compressive Strength Test (IS:4332 Part 5)	One test on a set of 3 specimens per km length.

1803.5.2 *Tests during construction*

The quality control tests to be carried out during construction shall be as given in **Table 1800.11**.

Table 1800.11 Quality Control Tests during Construction

Type of Test		Frequency
1)	Pulverization of soil clods	At least 3 tests daily, well spread over the day's work.
2)	Placement Moisture Content (IS:2720 Part 2)	-do-
3)	Insitu Density measurements (IS:2720 Part 28)	-do- i) Average of 3 test results shall not be less than the specified degree of compaction. ii) Individual test values of the degree of compaction attained shall not be less than 1 percent of the specified degree of compaction.
4)	Thickness of compacted layer	At random

4. Reasons for formation of Cracks:

Shrinkage through natural process of hydration and curing.

a) Compacting material at high moisture levels (above optimum moisture content):

Moisture in excess of that needed for maximum density provides higher potential for shrinkage, since the material can undergo more drying.

b) Using a soil that contains a high percentage of clay:

Soil-cement made with clays develops higher total shrinkage, but crack widths are smaller and individual cracks more closely spaced.

However, soil-cement made with granular soils produces less shrinkage, but larger cracks spaced at greater intervals.

Coarse-grained soils containing **between 5% and 35% fines** passing the IS **75-micron sieve** produce the most economical soil-cement base.

Note: May be due to high percentage of clay or fines

c) Rapid moisture loss:

After a cement treated material is placed, it immediately begins to lose moisture through evaporation unless proper curing procedures are followed.

Moisture loss causes two problems:

1) the material dries quickly and will undergo more shrinkage, and
2) there may not be enough moisture to continue hydration of the cement (which will reduce the final strength).

d) Failing to achieve required compaction:

Poorly compacted materials have high void ratios, with more unrestricted space to undergo movement, thus resulting in higher shrinkage and wider cracks.

e) Using excessive amounts of cement in the stabilized mix:

Although cement hydration contributes less to shrinkage than does moisture loss, excessive amounts of cement can exacerbate cracking in two ways:

- Increased cement contents cause greater consumption of water during hydration, thus increasing shrinkage.
- More importantly, higher cement levels cause higher rigidity and excessive strength (both tensile and compressive). Higher tensile strength results in cracks.

Shrinkage and Cracking

5 Preventive Measures: Wide Cracks

a) Provide proper construction techniques:

- Proper construction techniques
- Providing good quality control during field operations

With cement stabilized bases, a quality project relies **on several important factors** including the:

- Use of appropriate cement and moisture contents
- Thorough mixing,
- Adequate compaction, and
- Curing.
- Stabilization process must be accomplished within a reasonable time-frame (**within two hours of cement** mixing) to ensure that the cement does not hydrate before final compaction is achieved.

b) Compact the cement treated material at or slightly less than optimum moisture content:

- Too much water in the soil-cement mix creates the potential for excessive drying, which can lead to wide shrinkage cracks.
- Ideally, the field moisture content during compaction should be within a range of zero to slightly below (minus 2%) optimum.

c) Reduce the percentage of clay in the treated soil:

Because clay holds more water and is compacted at a higher moisture content, the potential for shrinkage cracking is greater.

Blending in granular, sandy materials can help reduce the clay percentage. Therefore, if the stabilized material has a high clay content, monitoring the water content during compaction is especially important.

d) Proportion the proper amount of cement in the mix:

- Enough cement should be added to the soil-aggregate mixture to achieve the desired engineering properties
- More than that amount is unnecessary, uneconomical, and can lead to additional cracking.
- Therefore, laboratory testing should be conducted to evaluate the engineering properties desired.

This could include unconfined compression tests, wet dry durability testing, and Atterberg Limits (liquid limit, plastic limit, plasticity index). bearing capacity, durability, and shrinkage properties.

e) Provide a stress relief layer in the pavement structure:

Cracks in the base layer can cause stress Concentrations in the asphalt surface. These stress concentrations lead to reflective cracks in the asphalt. Placing a flexible material between the base and surface layers will provide stress relief. This can be accomplished by using:

1) A bituminous surface treatment (chip seal) between the stabilized base and surface.

2) A geotextile fabric between the stabilized base and surface, or between the asphalt binder and surface courses.

3) A 50 to 100 mm layer of unbound granular material between the stabilized base layer and the asphalt surface.

(**Crack Relief layer** vide Fig. 6 as per IRC: SP:72-2015, **From T6 to T9,** 3,00,000 ESAL traffic onwards shall be provided (**Enclosure-2)**

f) Take positive steps for curing immediately after final compaction:

- The surface of the cement-treated layer must be kept moist until a permanent moisture barrier is in place.
- **The compacted stabilized base should never be allowed to dry completely, even for a short period of time.**
- Once a moisture barrier is placed, water curing can stop. The moisture barrier can be a bituminous emulsion prime coat or even a chip seal.

g) Curing:

- Proper curing of soil cement is important because strength gain is dependent upon time, temperature, and the presence of water.
- About **7-day curing** period is desired, during which time equipment heavier than rubber-tired rollers is prohibited.
- Light local traffic, however, is often allowed on the completed soil cement immediately after construction provided that the curing coat is not damaged.
- Water-sprinkling and bituminous coating are **two** popular **methods of curing.**
- In **bituminous curing,** the soil cement is commonly sealed with bitumen emulsion.
- Before emulsion is applied, the surface of the soil cement should be moist and free of dry loose materials. In most cases, a light application of water precedes the bituminous coating.
- If **traffic is allowed** on the soil cement during the curing period, it is desirable to **apply sand** over the bituminous coating to minimize tracking of the bituminous material.

h) Delay paving as long as practical following the placing of the prime coat.:

- If the final paving of the asphalt surface is delayed for a period of time (14 to 28 days), it allows more time for any shrinkage cracks to develop.
- Placing the surface after most of the shrinkage has occurred can result in fewer and/or thinner cracks in the asphalt layer, as the asphalt will tend to bridge the already-formed cracks.
- This strategy can be combined **with item f)** to delay final asphalt application if a combined chip seal and asphalt surface are used. The chip seal can be applied soon after the base is constructed (even the next day) to seal the surface and provide a durable surface for traffic.
- The asphalt course can then be placed many months (or even years) after the chip seal depending on the traffic and extent of surface wear.

i) "Precrack" the pavement:

- This method to reduce or eliminate reflection cracking is relatively new, but has shown excellent results to date.
- The procedure is to apply loading to the soil-cement (using several passes of a vibrating roller) **1-2 days after final compaction.**

6 Conclusions

1) Based on the suitability, the design mix for in-situ soils/barrow soils shall be arrived for each and every road to attain 7 days UCS of 3 MPa for stabilized Base after satisfying the physical properties of soils mentioned in Table 7.

2) Check the suitability of soils, in-situ/barrow, for stabilization during execution about gradation as per MoRD and physical properties of soil mentioned in Table 7.
3) For FDR after assessing the existing crust thickness, add additional material if necessary, to the required crust as per designed traffic and arrive the design mix as mentioned in item no (1) for stabilization.
4) Under FDR, it is advised, not to disturb GSB layer during recycling process.
5) The crust required for Stabilization has to be arrived based on traffic and Sub grade CBR as per Fig. 6 of IRC: SP:72-2015. Total crust thickness required for stabilized base will be equal to the thickness of CT Sub base plus CT base of that particular traffic and sub grade strength as per Fig.6.
6) If the traffic exceeds T9 category the requirements of stabilized base will be as per IRC:37 & IRC: SP:89 (Part II)-2018.

Enclosures: 1&2 and IRC Accreditation letter

KPD 31/5/21

Design Engineer
PMC. APRRP
Vijayawada

References:

1) IRC: SP:89-2010: Guidelines for Soil and Granular material Stabilization using Cement, Lime & Fly Ash.
2) IRC: SP:89 (Part II)-2018: Guidelines for the Design of Stabilized Pavements.
3) IRC: SP:72-2015: Guidelines for the Design of Flexible Pavements for Low Volume Rural Roads.
4) MoRD- 2014

Enclosure- 1: Guidelines issued by NRIDA on STABIL ROAD Technology.

File No.NRRDA-P017(24)/1/2020-JD(Tech)

B.C. Pradhan,
Director (Technical)
Tel No: 26179557
Fax No: 26179555
Email: pradhan.bharat@pmgsy.nic.in

Letter No. NRRDA-PO17(24)/1/2020-JD (Tech) (EFMS: 369957) dated 30 .09.2020

To
Shri. B. Subba Reddy,
Engineer-in-Chief (PR),
ZP Compound, Opp PWD Grounds,
MG Road, Vijayawada,
Government of Andhra Pradesh.

Subject: Andhra Pradesh - PMGSY - Directions on following IRC SP 72 norms on using alternate technology in Cement/Soil Stabilization/ FDR using Additives like Stabil Road & Cement under PMGSY Program for Flexible Pavements under Panchayat Raj Engineering Department (Rural Roads) - Requested- Regarding.

Sir,

This has a reference to your letter no. DEE-II/PMGSY/Alternate Technologies/2019 dated 02.09.2020 requesting to issue clear direction on following IRC: SP:72 norms on using alternate technology in Cement/Soil Stabilization/ FDR using Additives like Stabil Road & Cement under PMGSY Program for Flexible Pavements under Panchayat Raj Engineering Department (Rural Roads).

In this connection it is requested to follow the new technology Initiative guidelines issued in May 2013, IRC SP:72:2015, IRC: SP:88 (Part II)-2018 and also the clarifications issued vide letter no. DO# NRIDA-POI 7(24)/18/2017-JD (Tech) (E:358405) dated: 22.05.2019 in respect of Zydex Nano Technology. Further, it should be ensured that the gradation analysis and minimum strength requirements should conform to the requirements of materials as per Clause 404 of MoRD specifications for Cement Stabilized sub base and bases, and the targeted UCS values are achieved with proposed doses of stabilizer.

Further, CDAC is being requested to include 'StabilRoad' under the new technology module for using sub-grade, sub-base, and base courses so that the States can upload proposals on OMMAS as and when required.

Yours sincerely,

Sd/-

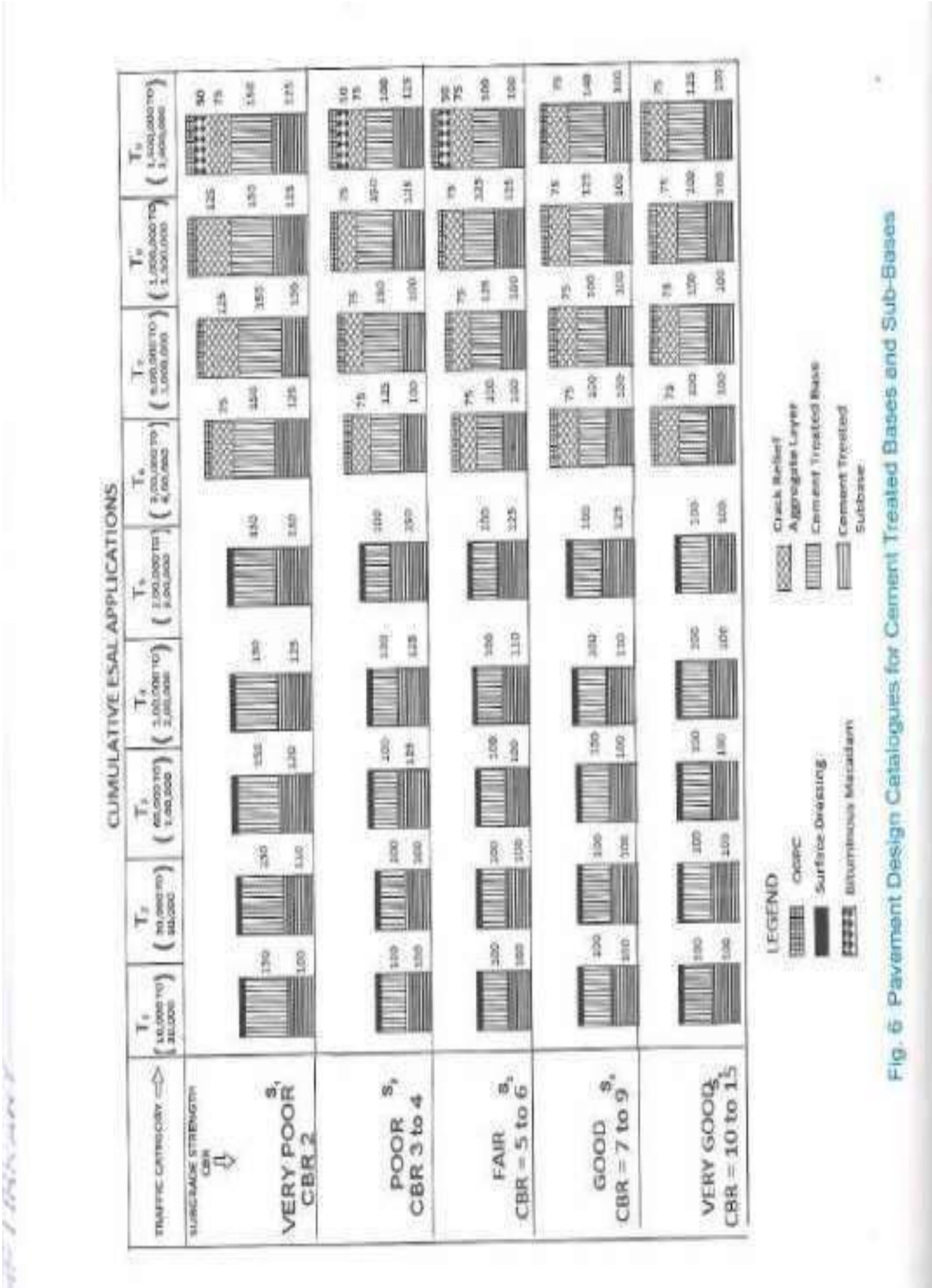
(B. C. Pradhan)

CC: Copy to Shri. M Srinavasa Rao, Joint Director, CDAC, Pune for making necessary entries on OMMAS.

True copy/

(पि. मोहनसुंदरम)
(P. Mohanasundaram)
संयुक्त निदेशक (तकनीकी) / Joint Director (Technical)
राष्ट्रीय ग्रामीण अवसंरचना विकास एजेंसी, ग्रामीण विकास मंत्रालय
NRIDA, Ministry of Rural Development
भारत सरकार / Govt. of India

Enclosure - 2: Fig. 6 of IRC: SP:72-2015- Pavement design catalogue for Cement Treated Bases/Sub - Bases.



Enclosure-IRC Accreditation of STABIL ROAD

भारतीय सड़क काँग्रेस
कामा कोटि मार्ग, सेक्टर-6
आर.के. पुरम, नई दिल्ली-110022 (भारत)

INDIAN ROADS CONGRESS
Kama Koti Marg, Sector-6
R.K. Puram, New Delhi-110 022 (INDIA)
Tel.: 011-26105160, 26185273, 26171548, 26185315

No. IRC-24(7)/2018 (ACC-305) **Dated 21st January, 2020**

M/s. Avani Ecoprojects Private Limited
Plot No. 1076, Road No. 44
Jubilee Hills
Hyderabad – 500 033

Sub: Accreditation of New Materials and Techniques - "StabilRoad"

This is to inform that the Committee for Accreditation of New Materials and Techniques, Indian Roads Congress, New Delhi has accredited **"StabilRoad – used for construction of stabilized pavements"** promoted/ developed by M/s. Avani Ecoprojects Private Limited.

(i) The Accreditation certificate shall remain **valid for a period of three years from the date of issue of this Certificate of Accreditation** or till the date the licensee (Manufacturer/ distributor/vendor etc) enjoys the legal production/marketing right interested/passed on him by the patent company/sole proprietor of material/technology in terms to the agreement, whichever is earlier.

(ii) The accredited material shall, however, conform to provisions relevant National/International Standards.

(iii) The developer/promoter shall have to strive to furnish the performance reports of the accredited material/technique from the client/user agency (State PWD/NHAI/BRO/ NHIDCL/Rural Road Agencies/Corporate Bodies etc) evaluated over a period of time (preferably half-yearly cycle) to establish their suitability for adoption and formulation of guidelines and codes of practice for their future usage in the Highway Sector.

(iv) The promoter/developer of the accredited material/technique shall be required to bear the extra cost involved in the field trials.

(v) The Highway Research Board shall advise the relevant Committees of IRC for considering/recommending the usage of accredited new material/techniques based upon satisfactory performance report from the client and Head of user department, from their experience.

(vi) The temporary approval, trial usage in any work shall not entitle the manufacturer/vendor, to use it as a "Certificate" for marketing purposes either in India or in other countries.

(vii) The Highway Research Board as a body shall not be responsible for adverse performance or failure of a stretch of road or part of bridge where the accredited new material/product has been tried on experimental basis.

(viii) The developers/promoters shall show long term commitment to the goal of innovative infrastructure development in India.

Yours faithfully,

(R V Patil)
Deputy Director (Tech.)

Please Note : All correspondence should be addressed to the Secretary General by designation only

सैटेलाइट ऑफिस : जामनगर हाउस, शाहजहाँ रोड, नई दिल्ली
Satellite Office : Jamnagar House, Shahjahan Road, New Delhi-110011
दूरभाष/Tel: +91 (11) 23387140, 23384543, 23387759