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CONSIDERATION AND PREPARATION OF JOB MIX FORMULA FOR FULL DEPTH RECLAMATION PAVEMENT BY CHEMICAL STABILIZATION

Ashok Kumar Sahayogi[1*], Govind Pandey [1],Ambika Behl[2],

[1]Department of Civil Engineering, Madan Mohan Malaviya University of Technology, Gorakhpur-273016, India
[2]CSIR - Central Road Research Institute (CRRI)-110025, India

Abstract
The Full Depth Reclamation (FDR) methodology is a sustainable way for rehabilitating pavements that recycles existing damaged materials, which are combined with stabilizing additives to provide a resilient and economical road surface. The Job Mix Formula (JMF) for FDR through chemical stabilization is essential for maintaining the structural integrity, longevity, and performance of reclaimed pavement. This paper examines the considerations and preparation of the JMF for FDR projects, emphasizing the selection and optimization of materials, including the current pavement structure, soil conditions, and suitable chemical stabilizers like as lime, cement, or fly ash. The formulation procedure entails laboratory testing to ascertain the ideal stabilizer content and mix proportions, with essential studies comprising Unconfined Compressive Strength (UCS), moisture-density connections, and durability evaluations. The JMF seeks to attain particular engineering characteristics like as strength, workability, and environmental resistance. The study emphasizes the significance of field verification via pilot test sections, quality control protocols, and the necessity for ongoing modifications during construction to fulfill performance standards. The study emphasizes the importance of an effectively designed JMF for the success of FDR projects, enhancing the long-term sustainability and performance of pavement structures while decreasing costs and mitigating the environmental impact of road construction.

Keywords: Chemical stabilization, Full Depth Reclamation (FDR), Pavement Rehabilitation

1. Introduction

Through the construction of new roads and the renovation of old ones, the Pradhan Mantri Gram Sadak Yojana (PMGSY) seeks to provide rural communities in India with all-weather road connection.(Pmgsy Guide,2022). Full Depth Reclamation (FDR), one of the cutting-edge road construction techniques, was presented by the Ministry to the State of Uttar Pradesh this year. FDR is recycling bituminous pavement that has worn down and its underlying layers into a new base layer by pulverizing the pavement (wearing course, base, and sub-base) and blending it with cementations agent, water, and corrective aggregates (if necessary) in accordance with the mix design to create a cementations stabilized base. It is an environmentally friendly pavement restoration solution. By giving the new pavement a more stable and robust base, it improves its structural capability. The State of Uttar Pradesh under FDR has been granted permission to build 695 roads totaling 5396 km by the Ministry in FY 2021–2022. These rural roads, which are mostly low volume, are vital for serving passenger vehicles, enabling the delivery of farm produce to markets, and tying together villages and towns. Despite its significance, a lot of rural roads have thin bituminous surfaces that are easily damaged by weather, traffic, and moisture intrusion. This can result in early distresses such rutting, raveling, and cracking (Lan et al., 2022). Replacing the surface layer alone is insufficient to address these problems. The base, sub-base, and sub grade are among the levels below the surface where the main issue frequently resides. By recycling these layers, FDR creates a new, stabilized foundation layer from the bituminous pavement that is

currently in place as well as the granular layers underneath it, such as Granular Sub foundation (GSB), Wet Mix Macadam (WMM), and Water Bound Macadam (Brain et al.,2014).To create a homogenous, improved material, the crushed material is then combined with stabilizing components such as bituminous emulsion, foamed asphalt, Portland cement, or other Commercial Chemical Stabilizers (CCS).The end product is a robust, cement-stabilized layer that, when supported by a consistently compacted and structurally sound foundation, functions similarly to a semi rigid pavement(Ordenet,al,2019). The majority of Indian roads are situated in rural areas and frequently cross low-lying areas that are near able to water logging. As such, it is imperative to keep the embankment height between 0.60 and 1.0 meters above the surrounding ground level. By taking this precaution, damage from capillary action is lessened (IRC:SP:89, 2010). It is only advisable to consider cement treated base (CTB) layers directly atop the sub grade if the sub grade is robust and has a California Bearing Ratio (CBR) of ≥ 5%, along with sufficient drainage arrangements(ARRA, FDR202, 2016). By addressing these goals, the study seeks to enhance FDR's efficacy as a rehabilitation technique, guaranteeing more resilient and long-lasting rural roads under thePMGSYprogram.
My research objective is to careful preparation of the Job Mix Formula for FDR pavements with chemical stabilizers guarantees the successful restoration of damaged pavements. The procedure entails evaluating the current materials, choosing and refining chemical stabilizers, conducting extensive testing in the lab and on the job site, and maintaining strict quality control during construction.

2. Methodology

Important Factors for a Successful FDR The reasonable and efficient combination of method and end-result specifications, such as the following essential to the success of FDR. Selecting the right kind and quantity of stabilizing agents is known as mix design. Ensuring appropriate application, mixing, curing, and compaction procedures is known as quality control. Employee Training: Employees participating in recycling activities received training. The choice of stabilizing agents, the cement ratio (if applicable), and the cold mix's volumetric characteristics should all be important tests in the mix design process. There should be instructions on how to apply water, mix, cure, compact, and reach the required Unconfined Compressive Strength (UCS).

2.1 Data collection and sampling for preparation of JMF

FDR base sample was collected and prepared in situ and laboratory, was characterized for application in the construction of FDR base as rigid pavement layer (Cement, additive and soil mixes) as a replacement of virgin aggregate. To ascertain the physical characteristics of the suggested FDR mix, the samples should be inspected in their entirety. For the aim of mix design, the samples need to be measured, examined, and tested.
The sampling team should visually inspect the existing roadway during field sampling operations to assess whether areas of significant distress, such as heavily rutted or patched areas, call for the collection of additional material samples, especially if the sub grade/sub-base is thought to be wet or unstable. Samples should be taken at each site where the types and/or thicknesses of the materials vary throughout the route, with at least one sample obtained for every kilometer of the roadway, if the project review finds that these things. Every material sample needs to be kept apart, and a core log needs to be kept track of where each one is. It can be necessary to use many mix designs if the sample gradation and material type ,soil type change dramatically throughout the course of the project.

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2.2 Laboratory Examination

Different tests on FDR base namely, compressive, flexural, MDD Test, drying shrinkage, and gradation test of existing road metal were carried out in the laboratory. JMF (Aggregate : Soil) MoRTH Table: 400-4 & (2720 Part-4) 59:41 OPC -43 Grade Cement Content (%) 4.0 - OPC -43 Grade Cement Quantity (Kg/Cum) 84.0 - OMC (%) IS:2720 Part-8 8.9 - (gm/cc) IS:2720 Part-8 2.10 - UCS 7 Days (MPa) IRC SP89 Part-II-2018 4.72 4.5-7 MPa UCS 28 Days (MPa) IRC SP89 Part-II- 2018 5.42 4.5-7 MPa Flexural Strength (MPa) IRC SP89 Part-II-2018 1.08 20% of 28 Days UCS Strength Residual Strength (MPa) IRC SP89 Part-II- 2018 6.65 Not less than 20% of 28 Days UCS strength Durability (%) IRC SP89 Part-II- 2018 5.65FDD - Additive Type (Physical form) Liquid and powder respectively ,Source of Manufacturing Indian IRC Accredition Yes Accredition Code Name IRC Toxicity leaching Test Certification IRC: SP89(Part-II-2018) N.on-Toxic Required Qunatity As per JMF 0.75 Kg/cum each Required Additive Content Percentage NA Existing Road Width (M) 3.00 Proposed Road Width (M) 3.90 Proposed Depth of FDR Stabilization
(mm)210

To get the ideal moisture level and maximum dry density for various FDR blends, do Proctor testing. Create mix design samples using different types of additives and compactive efforts. Examine the ITS, UCS, and other pertinent mechanical characteristics. Conduct testing for durability such as wet-dry cycles and freeze-thaw cycles. Selecting the Water Content for the Design of Full Depth Reclamation (FDR). Selecting the optimal water content is crucial to the Full Depth Reclamation (FDR) process since it directly affects the workability, compaction, and ultimate strength of the stabilized base layer. Calculating the amount of water required to give the mixture the required properties is the process. The following are the steps and considerations to make when determining the water content for an FDR design:

Proctor Test: The Standard Proctor Test or Modified Proctor Test can be used to determine the material's maximum dry density (MDD) and optimum moisture content (OMC). This test helps find the amount of water needed to condense the recovered mix to the highest possible density.

2.3Mix Design Trials

To fine-tune the amounts of water and additives, mix designs are tested. The following steps must be taken:

Sample Preparation: Take many samples of the ground material at various moisture content levels. Add the stabilizing materials (lime, cement, and asphalt emulsion) to each sample in accordance with the specifications of the mix design.

Compaction: Compact each sample using the specified compaction method (often a Proctor mold).

Curing: Samples should be allowed to cure for 7, 14, or 28 days, depending on the stabilizing agent used. Testing for Sturdiness and Durability Determine the optimal moisture content for optimal performance by analyzing the cured samples using tests such as Unconfined Compressive Strength (UCS), Indirect Tensile Strength (ITS), and durability tests (such as freeze-thaw and wet-dry cycles).

2.2. Modification of Moisture Contentin the Field

There are often differences between conditions in the lab and in the outdoors. Therefore, while constructing, adjustments to the water content may be necessary Field Experiments,To validate lab results, do field experiments. Adjust the water content in light of compaction data and field observations.

Weather: When construction, bear in mind that the moisture content may be affected by the surrounding weather conditions, such as temperature, humidity, and rainfall.

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2.3. Guidelines and Ideal Practices

Follow these recommendations to ensure that the appropriate water content is selected and maintained during the FDR process: Ensure that the water has been added to the mixture in an equal amount. This can be done with water trucks that have spray bars or other suitable equipment. Prevent Over-Wetting: Try not to apply too much water as this could lead to problems with compaction, weakening, and segregation. Monitoring: Always keep an eye on the moisture content while combining and compacting. Adjustments should be made as necessary to maintain the optimal moisture level. Moisture Content Objective: The target moisture content typically consists of in control manner.

Field Experiments

Apply FDR procedures with different types of additives and compaction techniques on specific pavement areas. Observe and modify compaction efforts in response to current field conditions.To evaluate the efficacy of additive kinds and compaction, gather performance data over time.

Fig. 1 Field Photograph Showing sample collection and field investigation

Analyzing and Assessing Data

The best compactive effort for each FDR combination should be determined by analyzing data from the field and lab.Examine the differences in pavement longevity performance improvements provided by various additives. Determine and verify the structural numbers for pavements treated with various additives by utilizing actual data from field operations in conjunction with theoretical models. Extra Advantages: benefits of different additives in terms of numbers for prolonging the life and toughness of FDR pavements. Structural Numbers: To help with the design and established structural numbers for FDR pavements with various additives. Existing crust materials collected from the site by the client.Ordinary Portland Cement (OMC) of grade 43 conforming to IS: 8112 was used for the stabilization of existing crust materials.

POWDER FORM ADDITIVE:1

1. Combined Gradation of Aggregate-Soil Mixture

To obtain sufficient compaction for full-depth reclamation, pulverized asphalt, cement, and CCS must be combined with fine aggregate and non-plastic fines. Not all of the asphalt pavement will be broken down into small enough pieces by the roadway declaimer to give the mix with a sufficient amount of fine aggregate. The underlying sub-base is typically mixed into the FDR in part, or more material of the necessary gradation can be added, to ensure that there is enough fine aggregate in the mix to achieve compaction. The MoRD specifications' gradation requirements for the in-situ pulverized materials must be met.

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Table 1.

Seive Size(mm)	Aggregate Mass retained (g)	Cumulative Mass Retained (g)	Cumulative % retained	Percentage Passing (%)	Lower Limit (%)	Upper Limit (%)
53	0	0	0	100	100	100
37.5	2130	2130	10.65	89.35	95	100
19	3590	5720	28.6	71.40	45	100
9.5	1530	7250	36.25	63.75	35	100
4.75	1900	9150	45.75	54.25	25	100
0.6	5208	14358	71.79	28.21	8	65
0.3	1736	16094	80.47	19.53	5	40
0.075	2604	18698	93.49	6.51	0	10

2. Moisture Content Vs MDD (g/cc)

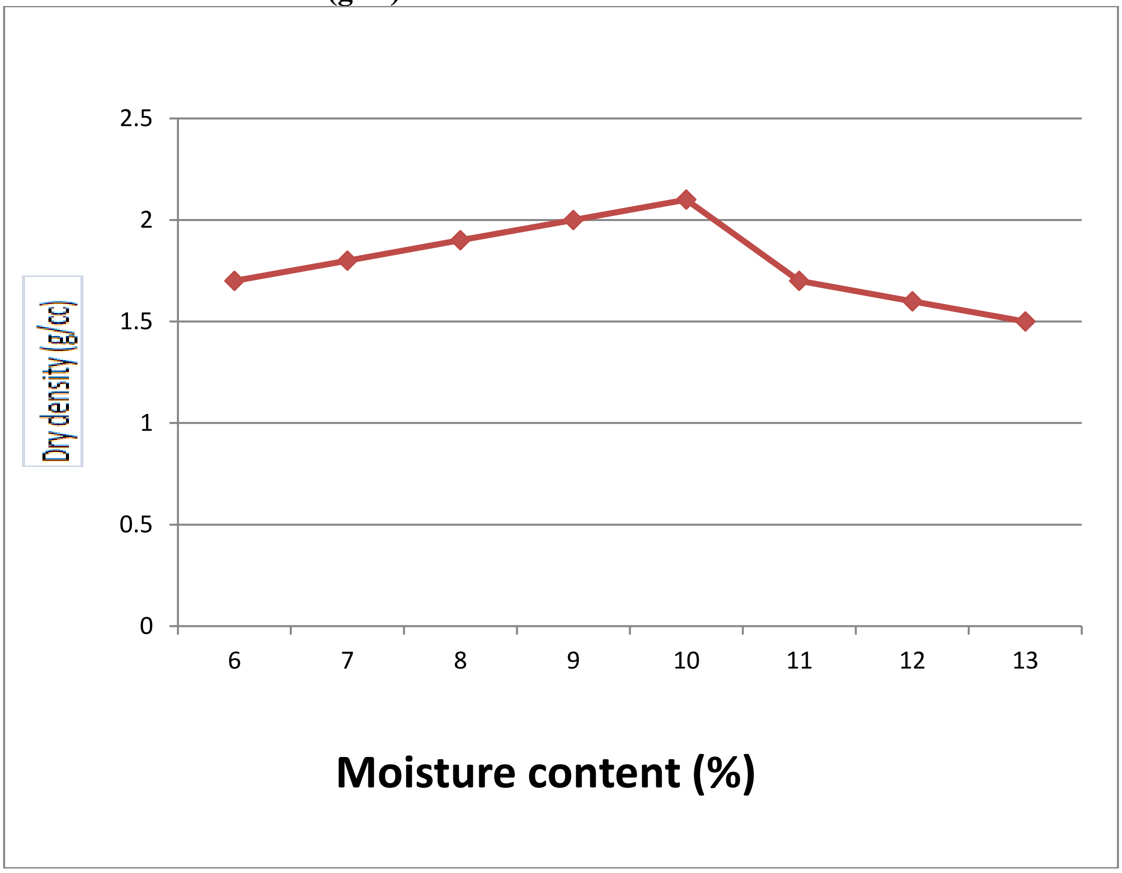

Fig.2

3. Aggerberg Limits

Material passing 425 micron was collected fordetermining its liquid limit and plastic limit so as to get the plasticity index of the soil. Test was conducted is accordance with IS: 2720 (Part-5).

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Liquid Limit (LL), Plastic Limit (PL), and Plasticity Index (PI):-

Table 2.

Particular	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (PI), %
Materials passing 425 micron	29.63	17.57	12.06

4. Unconfined Compressive Strength

The unconfined compressive strength (UCS) test on aggregate soil mixture samples were carried out in accordance with IRC: SP: 89-2018.

UCS Test 7 days:- Additive-1 (Powder base additive)

Table 3.

Table 3(i): Unconfined Compressive Strength of aggregate soil mixture with cement 4.25% + Additive-1,@4.0% by weight of cement (clayey soil)						
	Sample	**Weight (Kg)**	**Load (kN)**	**Area (mm)**	**UCS (MPa)**	**Mixture proportion**
1	Cube	6.186	69	15386	4.08	Cement 4.25%
2	Cube	5.780	85	15386	5.05	Additive-1,4.0% by weight of cement
3	Cube	6.581	76	15386	4.51	
				Avg.	4.54	
Table 3(ii) Unconfined Compressive Strength of aggregate soil mixture with cement @4.5% + Additive-1, @4.0% by weight of cement						
	Sample	**Weight (Kg)**	**Load (kN)**	**Area**	**UCS (MPa)**	**Mixture proportion**
1	Cube	5.864	76	15386	3.43	Cement 4.5 %
2	Cube	6.145	58	15386	3.27	Additive-1,4.0% by weight of cement
3	Cube	6.242	90	15386	5.32	
				Avg.	4.06	
Table 3(ii) Unconfined Compressive Strength of aggregate soil mixture with cement @5.0% + Additive-1 @4.0% by weight of cement						
	Sample	**Weight (Kg)**	**Load (kN)**	**Area**	**UCS (MPa)**	**Mixture proportion**
1	Cubes	5.915	56	15386	3.34	Cement 5%
2	Cubes	6.195	62	15386	3.68	Additive-1, 4.0% by weight of cement
2	Cubes	6.342	73	15386	4.32	
				Avg.	3.76	

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UCS Test (28 days):-

Table 4.

Table 3(i): Unconfined Compressive Strength of aggregate soil mixture with cement 4.25% + Additive-1@4.0% by weight of cement						
	Sample	**Weight (Kg)**	**Load (kN)**	**Area**	**UCS (MPa)**	**Mixture proportion**
1	Cube	6.210	72	15386	4.28	Cement 4.25%
2	Cube	6.098	71	15386	4.22	Additive-1,4.0% by weight of cement
3	Cube	5.822	90	15386	5.34	
				Avg.	4.61	
Table 3(ii) Unconfined Compressive Strength of aggregate soil mixture with cement @4.5% + Additive-1 @4.0% by weight of cement						
	Sample	**Weight (Kg)**	**Load (kN)**	**Area**	**UCS (MPa)**	**Mixture proportion**
1	Cube	5.840	91	15386	5.40	Cement 4.5 %
2	Cube	6.210	103	15386	6.12	Additive-1 4.0% by weight of cement
3	Cube	5.667	90	15386	5.34	
				Avg.	5.62	
Table 3(ii) Unconfined Compressive Strength of aggregate soil mixture with cement @5.0% + Additive-1@4.0% by weight of cement						
	Sample	**Weight (Kg)**	**Load (kN)**	**Area**	**UCS (MPa)**	**Mixture proportion**
1	Cubes	5.715	85	15386	5.05	Cement 5%
2	Cubes	6.102	90	15386	5.39	Additive-1, 4.0% by weight of cement
2	Cubes	5.982	92	15386	5.42	
				Avg.	5.28	

5. Durability Study of Stabilized Aggregate Soil Mixture

Two cylindrical test samples were subjected to wetting and drying test for determining weight loss after 12 cycles. All the samples were crushed to failure in compression testing machine at the end of their simulation period in accordance with IRC: SP 89 and laboratory test results are being presented.

Durability test (wetting & drying) and Residual Strength:-

Table 5:

Sample no.	Dia (after Wetting)	Height (after Wetting)	% Loss after 12 cycles	Residual strength (MPa)
1	140	200	6.53	3.82
2	140	200	6.64	3.69

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6. Flexural Strength

Table 6: Flexural Strength of Beam samples.

S.No.	Sample	Height	Length	Breadth	Load	Flexural Strength
		mm	mm	mm	kN	MPa
1	Beam	100	500	100	3.180	1.272
2	Beam	100	500	100	2.970	1.188
3	Beam	100	500	100	2.920	1.168

Another Liquid Form Additive

1. Combined Gradation of Aggregate-Soil Mixture

Table 7:

Sieve Size(mm)	Aggregate Mass retained (g)	Cumulative Mass Retained (g)	Cumulative % retained	Percentage Passing (%)	Lower Limit (%)	Upper Limit (%)
53	100	97.92	100	100	100	100
37.5	100	69.57	89.75	91.62	95	100
19	98.8	40.46	52.10	60.83	45	100
9.5	65.80	31.10	35.26	47.06	35	100
4.75	29.40	25.11	24.07	37.91	25	100
0.6	2.99	16.94	16.36	25.77	8.65	65
0.3	2.15	15.25	14.73	23.2	5	40
0.075	0.43	0.31	0.35	0.55	0	10

2. Moisture Content Vs MDD (g/cc)

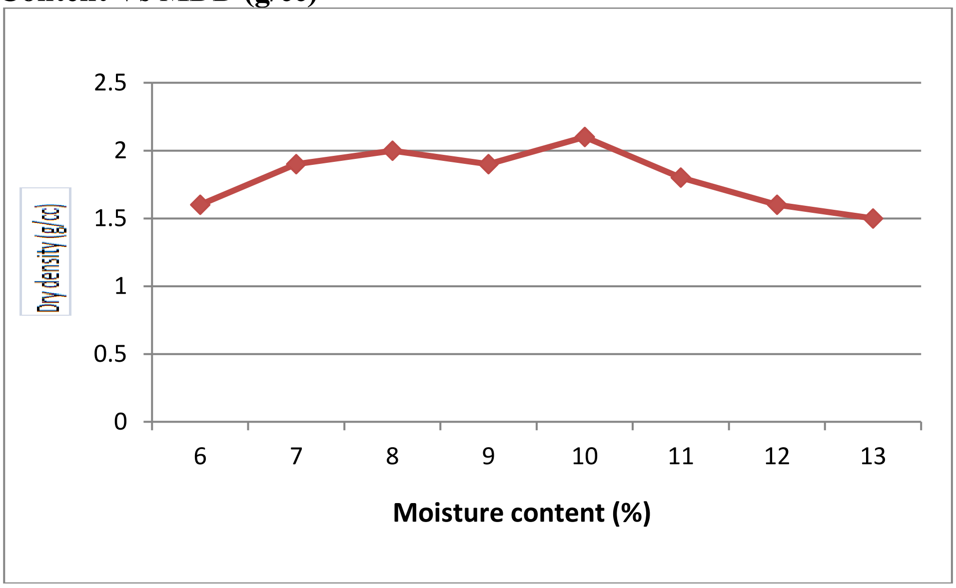

Fig.3

3. Atterburg Limits

Material passing 425 micron was collected for determining its liquid limit and plastic limit so as to get the plasticity index of the soil. Test was conducted is accordance with IS: 2720 (Part-5).

Table 7:

Sample Location	LL(%)	PL(%)	PI(%)
X	23	17.8	5.20

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4. Unconfined Compressive Strength (UCS) Test (7 days)

The unconfined compressive strength (UCS) test on aggregate soil mixture samples were carried out in accordance with IRC: SP: 89-2018.

UCS Test 7 Days:-Additive-2 (liquid base additive)

Table 8: Unconfined Compressive Strength of aggregate soil mixture with cement 4.0% + Additive-2 @0.70 kg/m3 by weight of cement(clayey soil)

	Sample	Weight (Kg)	Load (kN)	Area (mm2)	UCS (MPa)	Mixture proportion
1	Cube	6.047	59.7	15386	3.61	Cement 4.0%
2	Cube	5.008	51.80	15386	3.02	Additive-2. 0.70 Kg/m3 by weight of cement
3	Cube	5.653	64.40	15386	3.82	
				Avg.	3.48	

Table 9: Unconfined Compressive Strength of aggregate soil mixture with cement @4.5% + Powder form additive @4.0% by weight of cement

	Sample	Weight (Kg)	Load (kN)	Area	UCS (MPa)	Mixture proportion
1	Cube	5.982	92	15386	5.42	Cement 4.5 %
2	Cube	5.720	71	15386	4.20	Additive-2. 0.70 Kg/m3 by weight of cement
3	Cube	5.962	71	15386	4.20	
				Avg.	4.61	

Table 10: Unconfined Compressive Strength of aggregate soil mixture with cement @5.0% + Additive-2 @0.70 kg/m3 by weight of cement

	Sample	Weight (Kg)	Load (kN)	Area	UCS (MPa)	Mixture proportion
1	Cubes	5.865	93	15386	5.52	Cement 5%
2	Cubes	6.161	80	15386	4.75	Additive-2. 0.70 Kg/m3 by weight of cement
2	Cubes	6.173	70	15386	4.16	
				Avg.	4.81	

UCS Test 28 days:-

Table 11: Unconfined Compressive Strength of aggregate soil mixture with cement 4.25% + Additive (liquid) @0.70 kg/m3 by weight of cement

	Sample	Weight (Kg)	Load (kN)	Area	UCS (MPa)	Mixture proportion
1	Cube	5.097	89	15386	5.22	Cement 4.0%
2	Cube	5.135	92.9	15386	5.41	Additive-2. 0.70 Kg/m3 by weight of cement
3	Cube	4.779	78.1	15386	4.54	
				Avg.	5.06	

Table 12: Unconfined Compressive Strength of aggregate soil mixture with cement @4.5% + Additive-2 @0.70 kg/m3 by weight of cement

	Sample	Weight (Kg)	Load (kN)	Area	UCS (MPa)	Mixture proportion
1	Cube	5.990	85	15386	5.03	Cement 4.5 %
2	Cube	6.534	75	15386	4.43	Additive-2. 0.70 Kg/m3 by weight of cement
3	Cube	5.743	84	15386	4.97	

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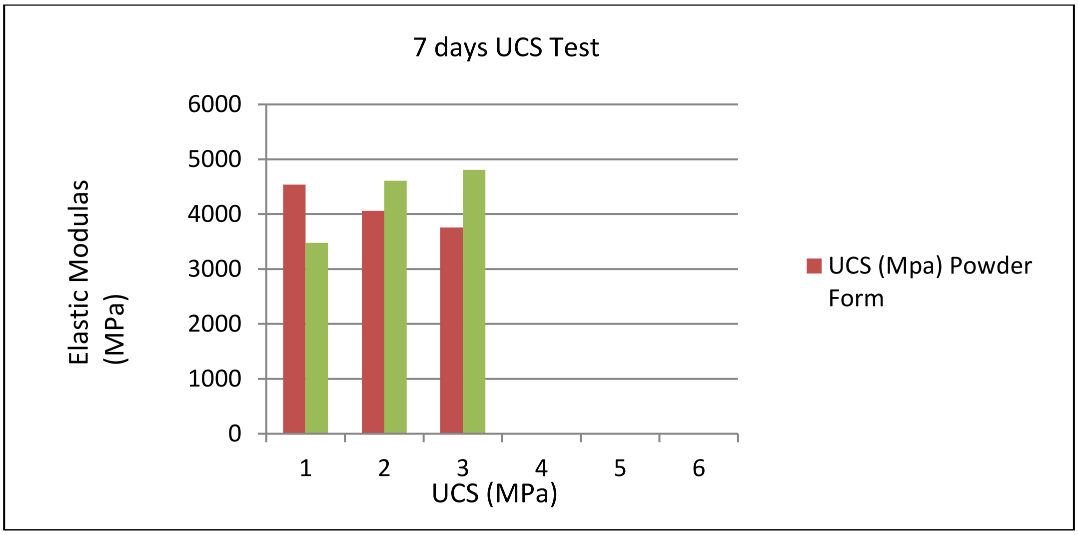
				Avg.	4.81	
Table 13:Unconfined Compressive Strength of aggregate soil mixture with cement @5.0% + Additive-2 @0.70 kg/m3 by weight of cement						
	Sample	**Weight (Kg)**	**Load (kN)**	**Area**	**UCS (MPa)**	**Mixture proportion**
1	Cubes	6.271	84	15386	4.99	Cement 5%
2	Cubes	6.215	79	15386	4.69	Additive-2. 0.70 Kg/m3 by weight of cement
2	Cubes	5.782	85	15386	5.05	
				Avg.	4.97	



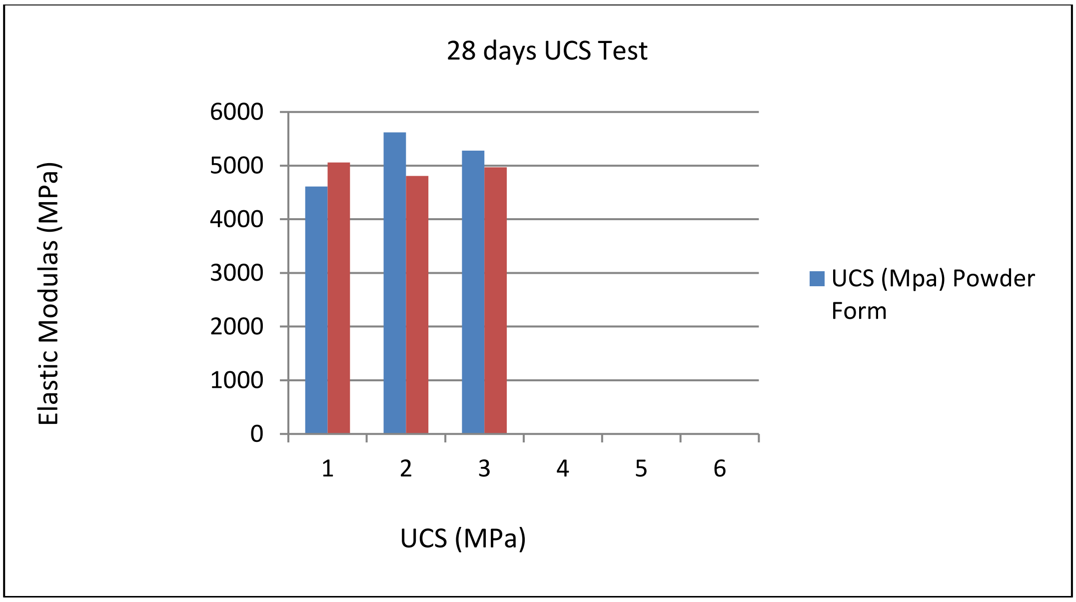


Fig.4

5. Durability Test

In order to check the Residual strength of the stabilized mix, wetting and drying 12 cycles was carried out on laboratory casted casted 150x150x150 mm cube moulds with combination of 4.5 % cement and Additive-2 stabilizer dosage of 0.70 kg/m3 . Test was got conducted in accordance with IRC SP:89 (Part II): IS 4332 (Part IV) .Test specimens were subjected to the wetting and drying test for 12 cycles and the test results summary averaged of three sample is Presented in Table(14).

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Table 14:

Description	% Mass Loss	Avg. %Mass Loss	Specified as perIRC: SP : 89 Part II
Welting & Drying Test (12 cycle) Mass Loss in %	5.84	5.91	< 14%
	4.59		
	7.3		

6. Residual Strength

In order to check the Residual Strength of the stabilized mix, wetting and drying 12 cycles was carried out on laboratory casted 150x150x150 mm cube moulds with combination of 4.5% cement and Additive-2 stabilizer dosage of 0.70 kg/m3. Then UCS test was got conducted on the conditioned samples in accordance with IRC: SP 89 (Part II).

Table (15):

Description	% Mass Loss	Avg. %Mass Loss	Specified as perIRC: SP : 89 Part II
3 Cube Sample	6.63	6.77	Should not be less than 20% of 28 days UCS strength
	6.56		
	7.11		

7. Flexural strength

Tests were conducted on laboratory-casted 500x100x100 mm beam molds using a combination of 4.5% cement and a 0.75 kg/m3 liquid stabilizer Additive-2 dosage to determine the flexural strength of the stabilized mix. The test was carried out in compliance with IS 516 (Part I/ Sec I) and IRC: SP 89 (Part II).

Table 16:

Beam Mould No.	Length	Height	Width	Load	Position of Fracture	Flexural Strength	Avg. Flexural Strength	Specified as per IRC : SP : 89 Part II
	mm	mm	Gm	KN	mm	MPa	MPa	20% of 28 days UCS Value
1	500	100	10842	2.8	158	1.12	1.08	
2	500	100	10789	2.7	152	1.04		
3	500	100	10956	2.6	168	1.08		

Result and Discussion:

The study will employ a methodical methodology that includes fieldwork, laboratory testing, and performance evaluations in order to accomplish these goals.

The UCS strength obtained for 7 days,28 days for combinations tested for Additive-1 powder stabilizer dosage meets with different dosage of cement 4.25 %,4.50% and 5.00%+ 4.00% additive by weight of cement. andAdditive-2 liquid stabilizer dosage meets theLiquid stabilizer dosage meets with different dosage of cement 4.00 %,4.50% and 5.00% + 0.70 additive by0.70 Kg/m3fordesired criteria. The Durability and residual obtained 6.53% ,5.91 % and 6.77 MPa for combination tested with Cement 4.5 % + 0.70 kg/m3 liquid stabilizer dosage 0.70 kg/m3 meets the desired criteria and average flexural strength in1.18 MPa and 1.08 MPa.Based on the above results the following combination of mix recommended: Existing FDR mix with 4.5 % cement and stabilizer dosage of 0.70 kg/m3.

The compositions of the considered matrix are given as below:

(1) Ordinary Portland cement (OPC) 43 grade: 5.0 % by weight of total, Aggregate-soil mixture.Powder form Stabilizer = 4.0 % by weight of cement.
(2) Ordinary Portland cement (OPC) 43 grade: 5.0 % by weight of total, Aggregate-soil mixture.Liquid form Stabilizer = 0.70 kg/m3 by weight of cement.

The approximate quantity of cement and Powder form stabilizer for 1 m3 of RPM material are as follow:
(1) Weight of RPM = 2115 kg
(2) Cement (OPC-43 grade) @ 5.0 % by weight of existing RPM = 105.75 kg.
(3) Powder form stabilizer @4.3 % by weight of cement = 4.547 kg
Total weight = 2225.29 kg
(4) Quantity of water to be added = 222.53 kg or liters.
This guarantees the long-term functionality of rural roads under the PMGSY(INDIA) initiative that have been repaired and rehabilitated.

Summary of Key Recommendations:
1. **Replacement Strategy**:
   - Identify and replace Essex-sized aggregate (max size > 53.0 mm) in the sub-base with virgin aggregates of the same size to improve the stability and performance of the FDR base layer.
2. **Gradation Enhancement**:
   - Gradation can be further optimized by incorporating aggregates up to 63.0 mm and 90.0 mm, potentially leading to improved mechanical properties and longevity of the FDR pavement.
   - Future research should focus on these gradation improvements to develop more effective FDR base mixes.

Benefits of Complete Reclamation
The majority of pavement distress is treatable with the required strength. Substantial structural upgrades to the pavement crust, particularly in the base course. Better performance requires less maintenance when the base is stronger. A reduced constructing timeline as a result of mechanical work. Cost-effectiveness as a result of using less or no extra expensive granular material due to increased carriage. Enhances Riding Quality with the employment of a mechanized grader and suitable compaction using the right compaction tools. Hauling costs were reduced by using marginal material that was readily available locally or by using less granular material (stone aggregate) that contained more lead. Removes the need for material disposal because damaged and existing asphalt binder materials can be recovered and utilized again. Leads to the preservation of natural resources because the stabilized base course is built with little to no stone aggregate usage. Fewer issues with air quality and a lower carbon footprint as a result of reducing the various building activities, such as the extraction and processing of stone and the transportation of stone aggregates to construction sites with longer lead times. Lessen the impact of construction on the communities by cutting down on the amount of time needed for it.

Conclusion

The preparation of Job Mix Formula for Full Depth Reclamation through chemical stabilization necessitates an in-depth comprehension of components, laboratory analysis, and field modifications to guarantee the pavement's performance meets specifications. Success hinges on the selection of an appropriate stabilizer, the accurate determination of mix proportions, and the execution of comprehensive field and laboratory testing to validate the final design. These factors can help engineers create a strong mix design that guarantees the performance and lifespan of the recycled

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pavement. According to this research recommends that stabilization with chemical, Cement and soil are more suitable to reduces in terms of economy, time, and environmental impact etc,. In conclusion, for the preparation of job mix design of FDR pavements semi flexible base which UCS is recommended for 3.0 MPa to 7.0 MPa . Gradation tolerance refers to the allowable deviation in the percent passing each sieve from the target (job mix) gradation. Intermediate sieves are all the sieves between the largest and smallest specified in the gradation limits. The first sieve (largest) and last sieve (smallest) are excluded because they typically have different or tighter tolerances, or sometimes none at all the research provides a framework for enhancing the gradation of sub-base mixes in FDR pavements, focusing on replacing oversized aggregates which achieves same volume and density of replaced aggregate and incorporating larger aggregate sizes for better stabilization and performance.

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