# Stabilization of Wet Mix Macadam with Emulsion

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Stabilization is the process of mixing a stabilizer, i.e; cement, with soil or imported aggregate to produce a material whose strength is greater than that of the original unbounded material. The use of stabilization to improve the properties of a material is becoming more widespread due to increased strength and load spreading ability that these materials offer. Stabilization technology is extremely relevant for heavily trafficked pavement where its benefits are being appreciated. There are different reasons for using stabilization, ranging from lack of good quality materials to a desire to reduce quantum of aggregate, consume less energy & saving the natural resources & hence safeguarding the environment. However, the main reason for using stabilization will usually be cost savings.

The main objective of stabilization is to improve the performance of material by increasing its strength, stiffness and durability. The addition of even small amount of stabilizer, for example upto 2 percent cement can modify the properties of a material. Large amount of stabilizer will cause a large change in properties of that material, for example 5 to 10 percent of cement added to clean gravel will cause it to behave like concrete & the pavement layer will be subjected to large shrinkage cracks.

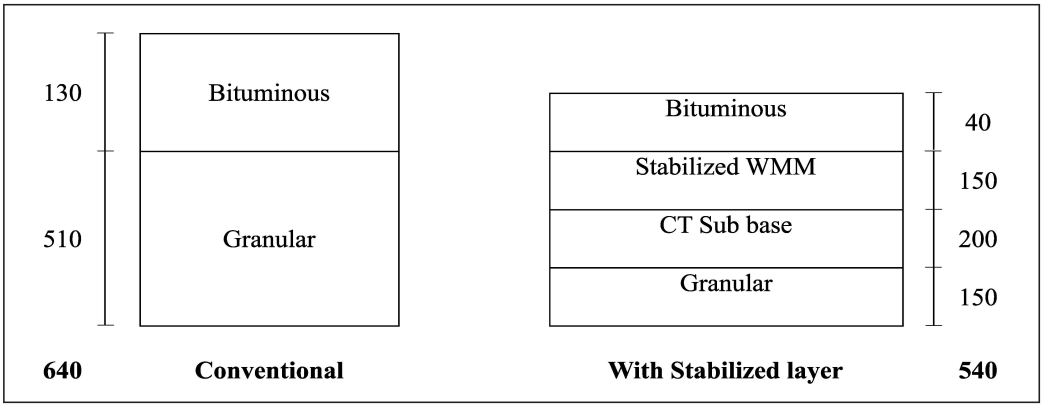
The strength of stabilized material will depend on many factors. These include:

- The chemical composition of the material to be stabilized.
- The stabilizer content
- The degree of compaction achieved
- The moisture content
- The success of mixing the material with the stabilizer
- Subsequent external environmental effects

Not all materials can be successfully stabilized, for example if cement is used as the stabilizer with sandy soil, it is more likely to yield satisfactory results as compared to soft clays.

IRC 37: 2012, Tentative Guidelines for the Design of Flexible Pavement usually suggests stabilization of granular layer with small quantity of cement ranging from 2% to 4%. IRC 37 also suggests usage of reclaimed asphalt pavements with the use of emulsion or foamed bitumen. With these guidelines, a project was selected in district Unnao in Uttar Pradesh named as Lucknow Bangarmau Bilhaur Road ch. 86.450 to 87.350 (old portion of State Highway-40) based on traffic census. The spectrum msa for the design was taken as 19 MSA and CBR of sub grade 6%. Width of existing pavement was 5 meters which has been widened to 10 meters. Design of flexible pavement based on

conventional method vis-a-vis with the use of stabilized layer is as follows :




Total thickness of existing granular layer was 250 mm. Upper 100 mm part of existing layer and 100 mm fresh granular layer mixed with 2 % cement was provided as sub base. Over cement treated sub base 150 mm stabilized WMM (fresh aggregate treated with 3.5 % bitumen emulsion & 1% cement) was placed. Over stabilized WMM base layer 40 mm bituminous concrete was placed. Design of pavement was carried out using IITPAVE software.

As seen from the above bars nearly 100 mm saving in crust of granular along with bituminous layer and approximately 16% cost saving was achieved using stabilized base and cement treated sub base.

**Advantages of stabilization with bitumen emulsion**

- Reduction in pavement thickness
- Cost reduction
- Environment friendly due to less consumption of aggregates & energy.
- Stabilization of granular layer for base using 4 % or higher cement usually develops cracks in top bituminous layer where as stabilization of base with emulsion does not result into any crack in bituminous top layer.
- Mixing of overall more percentage of cement in aggregate at site is difficult and can only be performed in proper way using cement spreader and recycler where as emulsion can easily be mixed with aggregate (WMM) at plant itself.
- Curing period of stabilized layer with cement is far more than stabilized layer of emulsion.
- Low to medium traffic can easily be allowed on bitumen stabilized layer where as in cement stabilized layer very low volume traffic can be allowed.

- Quality control of bitumen stabilized layer is easier than cement stabilized layer.
- Crack relief layer normally 75 mm to 100 mm is necessary over cemented base before applying bituminous layer to avoid shrinkage cracks where as bituminous layer DBM/BC can be placed directly over emulsion stabilized layer of base course.

## Scope of the Project

Initially short length of state highway was selected for case study with a view that if this stabilization works satisfactorily then large stretches of road with WMM stabilized layer can easily be used in different parts of state. Also similar technique can be used in construction of village roads. This project was started in October 2015 and was completed in March 2016.

## Construction

As described in IRC 37:2012 cold, mix recycling is a method of recycling where RAP, new aggregate (if needed), and emulsified bitumen or foamed bitumen without the need for heat are mixed in a centrally located cold mix plant. In the similar manner fresh WMM grading conforming to grading of WMM as per MORT&H was mixed with 3.5% bitumen emulsion (SS) and 1% cement at WMM Plant and was subsequently laid at site. Bituminous concrete was laid over stabilized layer after gap of 10 days.

8 days after the stabilized WMM

Finished work after BC

## Evaluation of constructed pavement

Construction of road was completed in March 2016. First visual inspection of road was carried out in the month of April 2016 & the road was in very good condition.

**FWD Measurement**

Second inspection was carried out in the month of October 2017. Road was in good condition and no cracks were visible. Deflections were measured using Falling Weight Deflectometer

**Name of Road :- Banger Mau Old GT Road**

**Field Deflection in Micron mm**

| SI No. | 0 | 230 | 600 | 900 | 1080 | 1360 | 1800 | Pav. Temp. | Season | Layer thickness in mm | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | Bit. | Gran. |
| 1 | 305.36 | 187.04 | 105.61 | 69.72 | 60.76 | 45.77 | 34.95 | 29.32 | Winter | 40 | 500 |
| 2 | 301.44 | 184.92 | 107.34 | 69.40 | 60.84 | 45.59 | 34.46 | 29.43 | Winter | 40 | 500 |
| 3 | 404.83 | 228.36 | 130.43 | 78.19 | 68.07 | 53.98 | 40.68 | 29.55 | Winter | 40 | 500 |
| 4 | 404.83 | 228.36 | 130.43 | 78.19 | 68.07 | 53.98 | 40.68 | 26.14 | Winter | 40 | 500 |
| 5 | 402.48 | 229.59 | 130.70 | 79.10 | 66.96 | 51.73 | 40.74 | 26.38 | Winter | 40 | 500 |
| 6 | 391.16 | 226.25 | 133.34 | 82.84 | 70.28 | 55.52 | 43.02 | 26.73 | Winter | 40 | 500 |

**Falling weight = 45 in KN**

## Normalised Deflection in mm

| SI No. | 0 | 230 | 600 | 900 | 1080 | 1360 | 1800 | Pav. Temp. | Season | Layer thickness in mm | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | Bit. | Gran. |
| 1 | 0.271 | 0.166 | 0.094 | 0.062 | 0.054 | 0.041 | 0.031 | 29.32 | Winter | 40 | 500 |
| 2 | 0.268 | 0.164 | 0.095 | 0.062 | 0.054 | 0.041 | 0.031 | 29.43 | Winter | 40 | 500 |
| 3 | 0.360 | 0.203 | 0.116 | 0.070 | 0.061 | 0.048 | 0.036 | 29.55 | Winter | 40 | 500 |
| 4 | 0.360 | 0.203 | 0.116 | 0.070 | 0.061 | 0.048 | 0.036 | 26.14 | Winter | 40 | 500 |
| 5 | 0.358 | 0.204 | 0.116 | 0.070 | 0.060 | 0.046 | 0.036 | 26.38 | Winter | 40 | 500 |
| 6 | 0.348 | 0.201 | 0.119 | 0.074 | 0.062 | 0.049 | 0.38 | 26.73 | Winter | 50 | 500 |

## Moduli Value (MPa)

| SI No. | Moduli Value from KGPBACK Program | | | Moduli Value after (Temp. & seasonal correction) | | |
|---|---|---|---|---|---|---|
| | Bit | GB | Sub | Bit | GB | Sub |
| 1 | 1645.30 | 600.00 | 100.00 | 1291.50 | 457.50 | 86.70 |
| 2 | 1660.30 | 599.50 | 100.00 | 1309.20 | 457.20 | 86.70 |
| 3 | 1676.10 | 594.60 | 100.00 | 1328.30 | 454.30 | 86.70 |
| 4 | 1676.10 | 594.60 | 100.00 | 1154.70 | 454.30 | 86.70 |
| 5 | 1255.20 | 471.90 | 190.90 | 873.20 | 378.00 | 161.10 |
| 6 | 1696.60 | 590.7 0 | 100.00 | 1197.30 | 452.00 | 86.70 |
| **15th percentile moduli** | | | | **1084.30** | **433.50** | **86.70** |

## Strain as per IITPAVE

**CBR = 6.00** **Et = $161.6 \times 10^{-6}$** **Fatigue Life = 102.1 msa**

**MSA = 19.00** **Ev = $280.8 \times 10^{-6}$** **Rutting Life = 178.3 msa**

## Conclusion

Normally modulus of fresh WMM over a granular base is 250 MPa, whereas modulus of WMM stabilized with 3.5% emulsion or 2.5% foamed bitumen ranges from 600 to 1200 MPa. IRC 37-2012 suggests modulus of aggregates treated with bitumen emulsion/ foamed bitumen as 600 MPa. The cost of road in this project as per conventional method was 3.11 Cr/Km.While using stabilization of granular layer cost was 2.56 Cr/Km, there by cost saving of approximately 16% was achieved, in addition to 10 cm reduction in crust thickness & a saving of 700 cum/km. of aggregate. This technique is environment friendly also. It was also observed that after 1 1/2 year after construction, pavement was in good condition and fatigue/rutting life were 102.10 MSA and 178.30 MSA respectively, against the designed 19 MSA. Stabilization of aggregate with emulsion (confirming to MoRTH WMM grading) is much easier as compared to stabilization of aggregate with cement because proper stabilization of aggregate with cement requires cement spreaders and recycler. Normal to medium traffic can be easily allowed directly over emulsion stabilized layer after few hours, whereas in case of cement stabilized layer only after 7 days, light traffic can be allowed. Execution and quality control of emulsion stabilization is easier than aggregate stabilized with cement.