iJETRM
International Journal of Engineering Technology Research & Management

STABILITY AND FLOW ANALYSIS OF BITUMINOUS CONCRETE GRADE II USING RECLAIMED ASPHALT PAVEMENT

Vishal Dhiman[*1]
Vivek Dhiman[2]
*[1,2]Department of Civil Engineering, Arni University, Kathgarh H.P

ABSTRACT

The most common method of rehabilitation for asphalt pavements involves the crushing of asphalt layers in distress before interference. This procedure reproduces road compatibility, eliminates problems associated with cracking reflection, and maintains pavement geometry.

Worldwide distributed maintenance technology generates a large amount of recovered asphalt (RAP) as a product of the milling process. Although research management can also produce negligible production and surplus in mixed asphalt plants. In both cases, the bitumen binder and mineral complexes contained in the PR have important residual properties that should not be underestimated. Research management should not be reorganized into waste materials, but must be reused appropriately. (Asphalt road concrete, concrete bitumen for very thin layers, soft asphalt, hot-rolled asphalt, asphalt stone putty, asphalt putty, asphalt as well as asphalt, Porous asphalt).

Only on-site recycling or cold factory recycling or a place can truly maximize the amount of recycle without compromising the mechanical properties of the final product while exploiting the intrinsic properties of RAP. Recycling in place of life is a process in situ consisting of heating, grinding and mixing paving layers in distress with virgin aggregates, virgin folders and regeneration agents. In some countries, however, this technology has declined in some countries because of emissions that could pose a threat to workers and the environment.

The increased use of RAP in asphalt mixtures requires a vast study, similar to those approved for recycling hot asphalt in the plant to enable quality control and thus high-performance materials for production.

Keywords:
Marble Dust, CBR, UCS, Resilient Modulus, IITPAVE

INTRODUCTION

The most common method of rehabilitation for asphalt pavements involves the crushing of asphalt layers in distress before interference. This procedure reproduces road compatibility, eliminates problems associated with cracking reflection, and maintains pavement geometry.

Worldwide distributed maintenance technology generates a large amount of recovered asphalt (RAP) as a product of the milling process. Although research management can also produce negligible production and surplus in mixed asphalt plants. In both cases, the bitumen binder and mineral complexes contained in the PR have important residual properties that should not be underestimated. Research management should not be reorganized into waste materials, but must be reused appropriately. (Asphalt road concrete, concrete bitumen for very thin layers, soft asphalt, hot-rolled asphalt, asphalt stone putty, asphalt putty, asphalt as well as asphalt, Porous asphalt).

Only on-site recycling or cold factory recycling or a place can truly maximize the amount of recycle without compromising the mechanical properties of the final product while exploiting the intrinsic properties of RAP. Recycling in place of life is a process in situ consisting of heating, grinding and mixing paving layers in distress with virgin aggregates, virgin folders and regeneration agents. In some countries, however, this technology has declined in some countries because of emissions that could pose a threat to workers and the environment.

The increased use of RAP in asphalt mixtures requires a vast study, similar to those approved for recycling hot asphalt in the plant to enable quality control and thus high-performance materials for production.

ISSN: 2456-9348
Impact Factor: 5.004

IJETRM
International Journal of Engineering Technology Research & Management

Experimental Study

1.1 Materials

The soil used for the experimental study was obtained in Banur, Punjab (India). 88.3% of the soil passed through a 0.075 mm sieve and had limit values of liquidity and plasticity of 28.7 and 16.67 respectively. As a result, soil was classified as CL (inorganic clays with low to medium plasticity) according to the Unified Soil Classification System (USC).

Waste marble dust was brought from a marble cutting store. 97.65% of marble dust passed through 4.75mm with 25.75% of marble dust passed through 0.075mm sieve. Specific gravity of marble dust was found to be 2.62.

Figure 1 shows the grain size distribution curve of clay and marble marble dust.

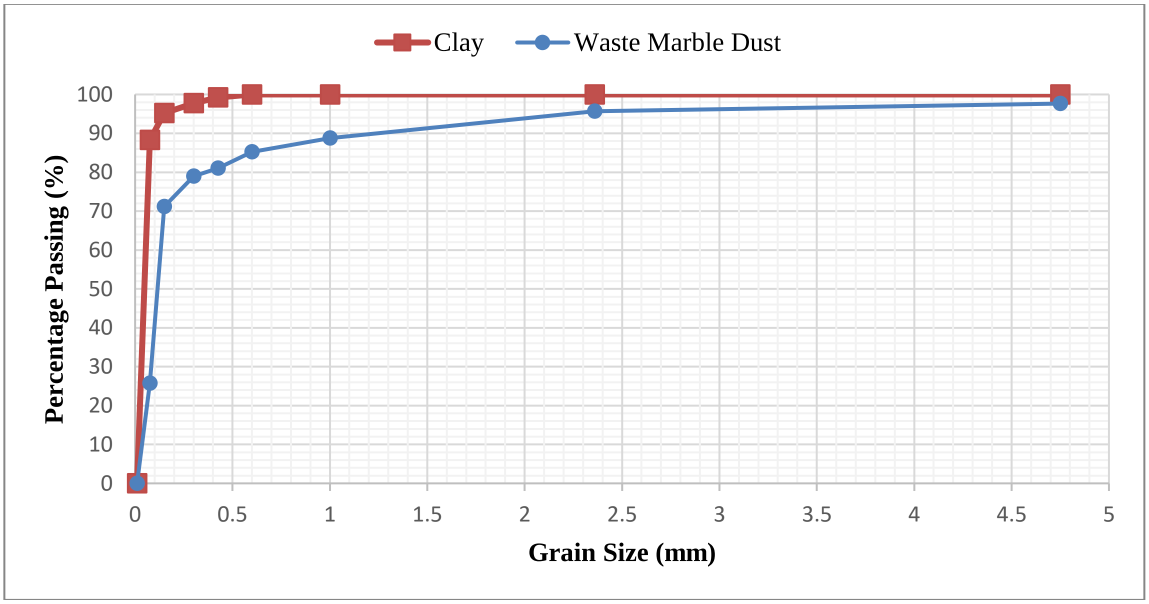

Figure 1: Particle size distribution of clay and marble dust used in the study

1.2 Tests conducted

The following tests were used: Atterberg limit test, Proctor compaction test, California bearing ratio (CBR), unconfined compressive strength (UCS), to determine the limit of liquidity and the limit of plasticity, the optimal moisture content and maximum dry density, California bearing ratio, and unconfined soil compressive strength at different percentages of marble dust. Marble dust was added at 10%, 15%, 20% and 25% by weight of soil. The liquidity and plasticity limits calculated from the Atterberg limit test an important role in determining the plasticity index that determines the range of plastic properties of the soil. The value of the liquidity limit for each sample was calculated using the Casagrande tool, in accordance with the procedure specified in IS2720 (Part V): 1985.

A light compaction test was carried out for each of the samples to determine the optimum maximum moisture content and dry density in accordance with the procedure specified in IS2720 (Part VII): 1980. Optimum water content determined using this method was used to prepare California Bearing Ratio (CBR) and Unlimited Compression Resistance (UCS) test samples. The CBR tests for clay dust and marble dust mixtures were carried out under impregnation conditions and the values were determined in accordance with IS2720 (Part XVI): 1987. Unconfined compression strength values (UCS) were also determined at similar percentages of clay dust and marble. Sample preparation and testing were performed in accordance with IS2720 (Part X): 1991.

iJETRM
International Journal of Engineering Technology Research & Management

Results and Discussions

There was a decrease in the liquidity limit and an increase in plastic limit values when adding marble dust. As a result, the value of the plasticity index also decreased when adding marble dust to the base soil. The values obtained at different percentages of mixtures of soil dust and marble are presented in Table 1.

Table 1: Effect of marble dust on Atterberg's Limits

Soil ID	Liquid Limit, %	Plastic Limit, %	Plasticity Index, %
CM0	29.7	15.67	13.03
CM1	25.8	16.64	7.26
CM1.5	23.3	17.34	6.06
CM2	21.8	18.55	4.25
CM2.5	21.1	19.14	3.16

CM0 being clay with 0% of marble dust, CM1 of clay with 10% of marble dust, CM1.5 of clay with 15% of marble dust, CM2 of clay with 20% of marble dust and CM2.5 of clay containing 25% of marble dust by weight
Optimum Moisture Content (OMC) values decreased and maximum dry density (MDD) values increased, with up to 20% added marble dust in the basal soil. At 25%, the value of the optimal moisture content (OMC) increased and that of the maximum dry density (MDD) decreased with respect to the previous value obtained. The variation in optimal moisture content (OMC) and maximum dry density (MDD) for different mixtures of clay and marble dust is shown in Figure 2.

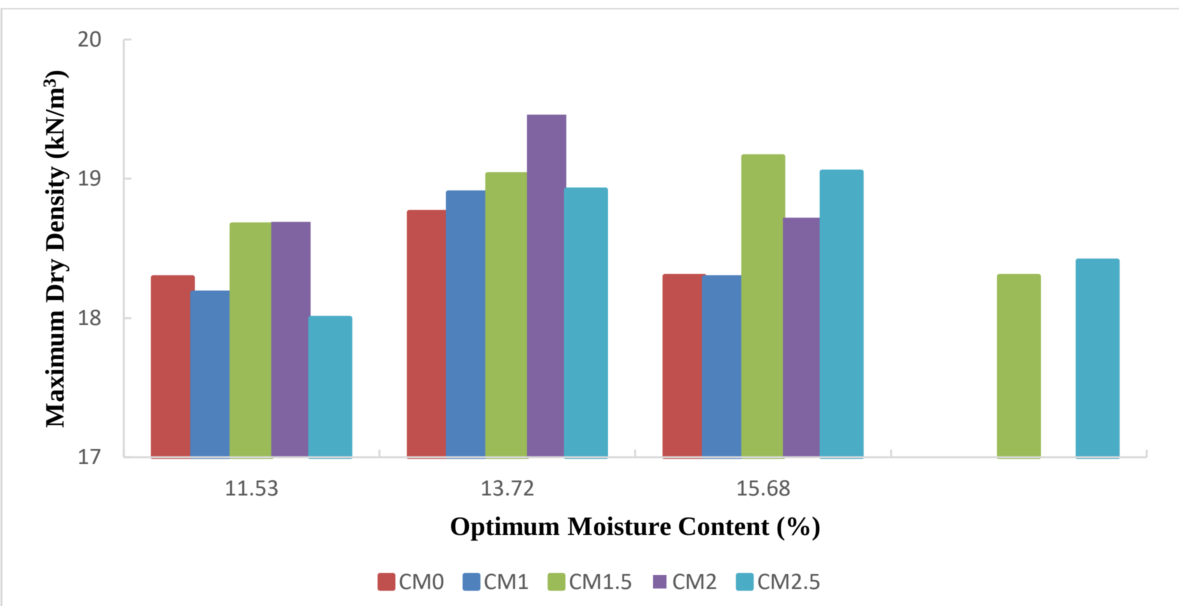

Figure 2: Compaction curves at different clay and marble dust percentages

California bearing ratio (CBR) and unconfined compressive strength (UCS) values increased when marble dust was present at 5%, 10%, 15% and 20% by weight of the soil. CBR and UCS showed a slight reduction in value when marble dust was present at 25% by weight of the soil. The calculated values are shown in Table 2.

IJETRM
International Journal of Engineering Technology Research & Management

Table 2: California bearing ratio and unconfined compressive strength values at different clay and marble dust percentages

Soil ID	California Bearing Ratio, %	Unconfined Compressive Strength, kPa
CM0	2.96	62.34
CM1	3.89	105.25
CM1.5	4.67	111.34
CM2	6.08	136.75
CM2.5	6.03	131.77

Design of flexible pavement section using IITPAVE

1.3 Design Considerations

The design of the pavement was carried out for traffic of 50 msa. The values of the Poisson's ratio were considered to be 0.35 for all layers, ie the bituminous layers, the granular layers and the subgrade. Tire pressure and single-wheel load were taken at 0.56 MPa and 20 000 N. The two-wheeled configuration was used to analyze fatigue and rut values.

4.2. Determination of the resilience module (M_R)

For the bituminous layers, namely DBM and BC, it was assumed that the temperature was 35°C and the bitumen quality was VG40. On this basis, the resilience module value of bituminous layers was taken as 3,000 MPa (see Table 7.1, IRC 37: 2012).

The determination of the foundation soil Resilient Modulus was performed in accordance with the correlations suggested by Heukelom and Klomp (1962), Thompson and Robnett (1979), Transport and Road Research Laboratory (TRRL), Erdem Çöleri (2007). Resilient Modulus values calculated using these empirical equations are shown in Table3.

Table 3 Subgrade resilient modulus (M_R) values

Soil ID	Resilient Modulus, MPa			
	Heukelom and Klomp	Thompson and Robnett	TRRL	Erdem Çöleri
CM0	29.6	25.06	35.24	65.74
CM1	38.9	38.23	41.98	76.52
CM1.5	46.7	40.099	47.19	78.82
CM2	60.8	47.87	55.87	82.30
CM2.5	60.3	46.36	55.58	73.98

Based on the resilient modulus (M_R) of the support, the Resilient Modulus values of the granular layers were calculated according to Equation 7.1 of IRC37: 2012.

1.4 Determination of the limiting strains

The value of the maximum tensile strain at the bottom of the bituminous layer (ε_t) was calculated using Equation 6.1 of IRC37: 2012. The calculated value of the maximum allowable tensile strain was 155.27 $\mu\varepsilon$. In addition, the value

iJETRM
International Journal of Engineering Technology Research & Management

of the allowable vertical deformation in the foundation soil was determined using Equation 6.4 of IRC37: 2012 and the value was 371.7 με.

4.4. Determination of actual deformations and pavement thickness

The actual strain values were calculated with IITPAVE. The data was entered as specified in the sections above and the pavement thickness was determined using the methods mentioned above. The actual strain values calculated for various M_R values determined using Erdem Çöleri (2007), Heukelom and Klomp (1962), Transport and Road Research Laboratory (TRRL), Thompson and Robnett (1979) are shown in Tables 4 to 7.

Table 4: Actual strain values for Erdem Çöleri Method

Soil ID	Actual Tensile Strain (ε_t), με	Actual Compressive Strain (ε_z), με
CM0	153.4	170.7
CM1	153.2	213.8
CM1.5	152.7	218.8
CM2	152.1	227.2
CM2.5	152.6	200.5

Table 5: Actual strain values for Heukelom and Klomp method

Soil ID	Actual Tensile Strain (ε_t), με	Actual Compressive Strain (ε_z), με
CM0	153.9	198.2
CM1	153.7	178.7
CM1.5	153.1	228.3
CM2	152.4	281.6
CM2.5	152.5	294.8

Table 6: Actual strain values for TRRL method

Soil ID	Actual Tensile Strain (ε_t), με	Actual Compressive Strain (ε_z), με
CM0	153.7	181.3
CM1	153.6	199.1
CM1.5	153.0	226.8
CM2	152.5	263.7
CM2.5	152.8	264.7

Table 7: Actual strain values for Thompson and Robnett method

Soil ID	Actual Tensile Strain (ε_t), με	Actual Compressive Strain (ε_z), με
CM0	153.8	220.8
CM1	153.7	174.0
CM1.5	153.6	186.4
CM2	153.4	232.9
CM2.5	153.5	225.6

The total thickness of the crust calculated using all methods is illustrated in Figure 3 and the thickness of the granular layers is illustrated in Figure 4. The thickness of the bituminous layers was 160 mm for the Erdem method Çöleri. For the Heukelom Klomp method, the thickness of the bituminous layer was 205 mm for the CM0 and 190 mm for the rest of the cases. In addition, for the TRRL method, the thickness of the bituminous layer was 195 mm for the CM0 and 190 mm for the rest of the cases. The Thompson and Robnett method had a bituminous layer thickness of 215 mm for CM0 and 190 mm for the remaining cases.

iJETRM
International Journal of Engineering Technology Research & Management

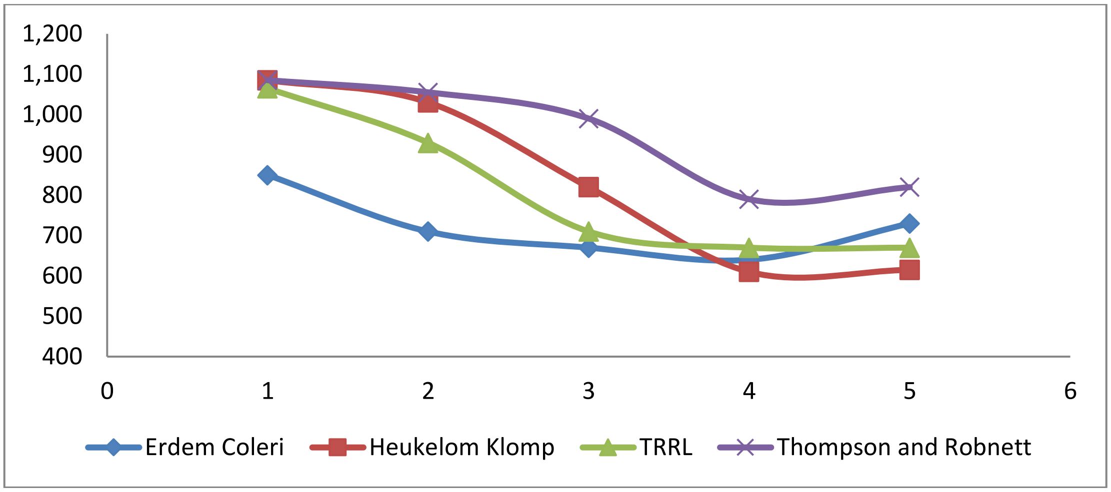

Figure 3: Total crust thickness calculated for every clay and marble dust mix calculated using various methods

Figure 4 shows variation of granular layer thickness obtained for different clay and marble dust mixtures using resilient modulus (M_R) values calculated by methods specified above.

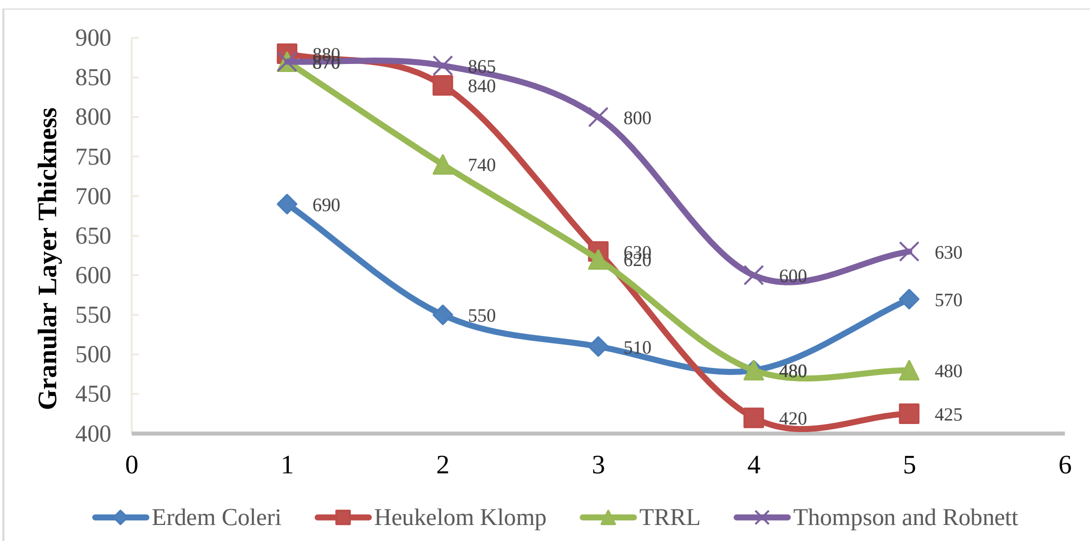

Figure 4:Thickness of granular layers calculated for every clay and marble dust mix using various methods

5. Conclusion

The addition of marble dust has increased the bearing capacity of the base soil. Pavement design also showed a subsequent decrease in pavement thickness when adding marble dust. Thus, used marble dust can be used effectively with the base soil for building foundations or embankments. Moreover, among various methods, the Resilient Modulus (M_R) calculated using the equation specified by Erdem Çöleri (2007) gave the highest value and even a 160 mm bituminous layer thickness allowed reliable pavement design.

International Journal of Engineering Technology Research & Management

REFERENCES

[1] IS: 2720 (Part IV)-1985: “Method of Test of Soils: Grain Size Analysis”, New Delhi, India: Bureau of Indian Standards
[2] IS: 2720 (Part V)- 1985: “Method of Test of Soils: Determination of Liquid Limit and Plastic Limit”, New Delhi, India: BIS
[3] IS: 2720 (Part VII)- 1980 “Method of Test of Soils: Determination of Water Content-Dry Density Relation using light compaction”, New Delhi, India: BIS
[4] IS: 2720 (Part XVI) -1987 “Method of Test of Soils: Laboratory Determination of CBR”, New Delhi, India: BIS
[5] IS: 2720 (Part X)-1991 “Method of Test of Soils: Determination of Unconfined Compressive Strength”, New Delhi, India: BIS
[6] IRC: 37-2012: “Guidelines for the Design of Flexible Pavements”, New Delhi, India: Indian Road Congress
[7] Thompson, M.R., and Robnett, Q.L. (1979). Resilient Properties of Subgrade Soils. Journal
[8] of Transportation Engineering, Vol. (105), No. 1, pp. 71-89.
[9] Çöleri, E. (2007). Relation Between Resilient Modulus and Soil Index Properties of Unbound Materials (master’s thesis). CiteSeerX. (10.1.1.632.9765)
[10] Heukelom, W., and Klomp, A.J.G. (1962). Dynamic Testing as a Means of Controlling Pavement during and after Construction, Proceedings of the 1st international Conference on the Structural Design of Asphalt Pavement, University of Michigan:Ann Arbor, Mich.
[11] Dione, A., Fall, M.Yves. Berthaud. Benboudjema, F.& Michou A. (2014). Implementation of Resilient Modulus-CBR relationship in Mechanistic-Empirical (M.-E) Pavement Design. Revue Cames – Sci. Appl. & de l’Ing., Vol. 1(2), 65-71. ISSN 2312-8712.
[12] Indian Bureau of Mines (2016, November). Indian Minerals Yearbook (Part- III: Mineral Reviews), 54th Edition, Marble. Retrieved from www.ibm.gov.in
[13] Pollution board proposes recycle of marble slurry to minimize hazards. (2014, December 19). The Times of India.