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Laboratory Studies on Granular Sub Base

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Abstract **- Granular sub base layer is used in the construction of flexible pavement to provide a stress-transmitting medium to spread the surface wheel loads in such a manner as to prevent the shear and consolidation deformation.**
The laboratory studies were conducted as per MORTH guidelines. The conclusion drawn from the laboratory studies were gradation specifications are to be suitably changed so that locally available materials are to be used in the specified range of 75.00 to 2.36 mm with permeability criteria along with strength parameter the CBR value.

Keywords: **Granular Sub Base(GSB),CBR, Permeability etc.,**

INTORDUCTION

The Granular Sub Base (GSB) layers are used in the flexible pavements to provide a stress-transmitting medium to spread the surface wheel load to a large area so as to prevent the shear and consolidation deformations. Besides these layers are also acting as drainage layer so that capillary water cannot rise above the GSB layer. The capillary rise is likely to be determental if the water is reaching the sub-grade.

These layers are made of a granular materials (mixing with the crushed aggregates,murrum,gravel) of specified gradation,limit size of the ingredients. Generally the material used are rarely available with the required gradation the required strength parameter CBR. Therefore a proper mixing of the locally available material is satisfies the CBR value but still there is still debate over permeability of GSB layer. An improper mechanism of mix design may leads to the lesser resistance to sinking in to weak sub – grade soil leads to GSB materials to penetrate in to the soil forming the undulations and uneven surface in the flexible pavement.

1.1 *The Function Of Sub Base Course Layers*

A base course is defined as the layer of material that lies immediately below the wearing course of a pavement, and the sub base is a layer of material between the base and sub grade. Sometimes the material under a rigid pavement is called as sub base.

The sub base layer in the flexible pavement is used primarily to improve load supporting capacity by distributing the load to the finite thickness and frost succeptible layer.The materials used are with inferior material as compared to base layer .

1.2 Soil Aggregate Gradation

DENSITY AND STABILITY : The stability of a soil-aggregate mix depends on particle size distribution, particle shape , relative density , internal friction , and cohesion. A granular material designed for maximum stability should possess high internal friction to resist deformation under load. Internal friction and subsequent shearing resistance depend to a large extent upon density. Particle size, shape and distribution. Of these factors the size of the aggregate ,proportion of fine and coarse fraction.

An aggregate that contains little or no fines gains stability from grain-to –grain contact. An aggregate that contains no fines,usually has a relatively low density but is pervious and non-frost susceptible. However , this material is very difficult to handle during construction because of its no cohesive nature (Fig.1.1)

Fig1.1 AGGREGATES WITH NO FINES

An aggregate that contains the coarse with little fines will have high internal friction to resist deformation under load. Internal friction and subsequent shearing strength resistance depend to a large extent upon density formed by proportion of coarse and fine particles with there physical states with fines can be compacted readily and has stability ,frost susceptible(Fig.1.2)

Fig1.2 AGGREGATES WITH MINIMUM FINES

1.3 Effect Of Plasticity

As the material passing through the IS 425 micron sieve increases, the quality of the plasticity characteristics . Also the CBR value decreases as the percentage of IS 425 micron fine increases.Hence, according to MORTH specification for GSB liquid limit and plasticity index should be less than 25%and 6% respectively.

1.0 Morth Specification For Gsb

The materials used in the work shall be natural sand, murum, gravel, crushed stones or the combination. Materials like crushed slag , brick metal and kankar may be allowed with proper quality control tests. The material used shall be free from the organic or other deleterious material and should confirm to the one of the grading requirements.

2.1 Physical Properties

TABLE 2.1 GRADING FOR CLOSE GRADED GSB MATERIALS

IS SIEVE SIZE(mm)	GRADEI	GRADEII	GRADEIII
75.00	100	100	100
53.00	80-100	100	100
26.50	55-90	70-100	100
9.50	35-65	50-80	65-95
4.75	25-55	40-65	50-80
2.36	20-40	30-50	40-65
0.425	10-25	15-25	20-35
0.075	3-10	3-10	3-10
CBR(min)	30	25	20

2.2 Strength Of The Sub-Base

It shall be ensured prior to actual execution that the material to be used in the sub –base satisfies the requirements of the CBR and other physical properties compacted and finished.

2.3 Gsb Mix Design

The GSB generally make up the greatest thickness for the pavement structure and provide bearing strength and drainage for the pavement structure. Hence ,proper size,grading,shape,and durability are important attributes to the overall performance of the pavement structure.

The GSB layers particularly bottom layers should be designed to have sufficient permeability offering negligible resistance to the flow and also to resist the flowing of foundation material (Sub-grade) resulting in problems like piping at transverse pavement joints in roads subjected to a large volume of traffic.

2.0 Laboratory Study

The material used in this study was not satisfying the requirements with the liquid limit and plasticity criteria and also the strength parameter. An attempt was made to check the suitability of crusher dust in reducing the liquid limit, plasticity and strength according to the specifications. The crusher dust used in the study is passing IS 425 micron sieve which is added in proportions till the criteria satisfies.

The native soil as the liquid limit of 38.33% and the plastic limit of 15.12%. after mixing the soil with the crusher dust ,the liquid limit and plastic limit as been decrease to the desirable limit as per MORTH specification.

The results are as tabulated in the Table 3.1 with the proportion of mix and the variation of Liquid and plasticity index.

TABLE 3.1 THE PERCENTAGE VARIATION IN THE LIQUID LIMIT AND PLASTICITY INDEX WITH THE CRUSHER DUST

	Native soil	80% +20%*	60% +40%*	50% +50%*	40% +60%*
Liquid Limit (%)	38.33	35.18	33.54	28.76	23.18
PlasticLimit (%)	23.21	20.84	22.30	21.59	17.98
Plasticity Index	15.12	14.34	11.24	7.17	5.20

* indicates the crusher dust passing the 425 micron sieve, by adding to the total weight of the soil.
The material of the proportion of 40% of the soil and the 60% of the crusher dust is used in the testing and the proportion satisfies the required gradation.

3.1 Obtained Gradation

The gradation is obtained by blending the 60% of the crusher dust (passing 425 micron)and 40% of the soil by weight. The proportions of each materials are obtained from the Routhfutch method according to the each grades as per MORTH specification. The obtained gradations are as tabulated in the Table3.3

TABLE 3.2 OBTAINED GRADATION

IS Sieve(mm)	Dense GradeI	Dense GradeII	Dense GradeIII
75.00	100	100	100
53.00	93.4	100	0
26.50	73.6	82.1	100
9.50	39.39	65	81
4.75	31.88	51	71
2.36	27.33	44.3	49.3
0.425	14.8	17.4	22.7
0.075	4.7	3.2	4.6

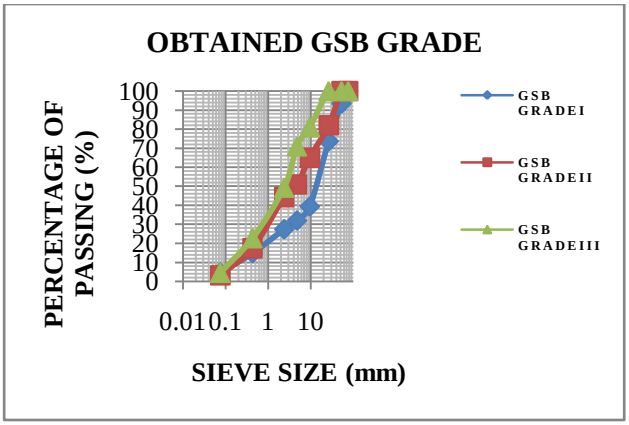

Fig3.1 Obtained GSB Dense Grade

3.2 Optimum Moisture Content

To know the OMC of the soil –aggregate mix to get the maximum dry density the test is conducted on the CBR mould itself to get the required OMC and Maximum Dry Density (MDD) for the different grading.

TABLE3.3 OMC AND MDD FOR GSB

GSB GRADEI		GSB GRADEII		GSB GRADEIII	
OMC(%)	Dry Density (gm/cc)	OMC(%)	Dry Density (gm/cc)	OMC(%)	Dry Density (gm/cc)
2	1.92	2	1.81	2	1.70
4	2.02	3	1.90	4	1.83
6	1.95	3.5	1.95	5	1.92
8	1.87	5	1.86	6	1.87
				7	1.76

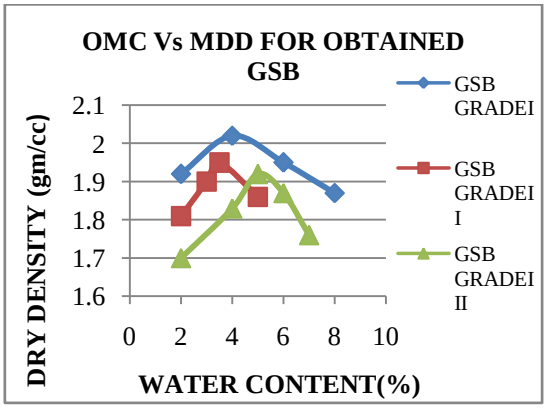

Fig3.2 OMC Vs MDD FOR OBTAINED GSB

After obtaining the proprtions and OMC the CBR test and permeability tests were conducted.The obtained CBR results are tabulated in the table 3.3

TABLE 3.3 OBTAINED CBR VALUES

	GRADEI	GRADEII	GRADEIII
Deflection (mm)	Load(kg)	Load(kg)	Load(kg)
0	0	0	0
0.5	30	25	35
1.0	88	50	75
1.5	140	110	115
2.0	200	190	150
2.5	270	250	195
3	350	330	260
4	510	440	370
5	670	575	445
7.5	1230	875	525
10.0	1770	1250	625
12.5	2150	1475	750

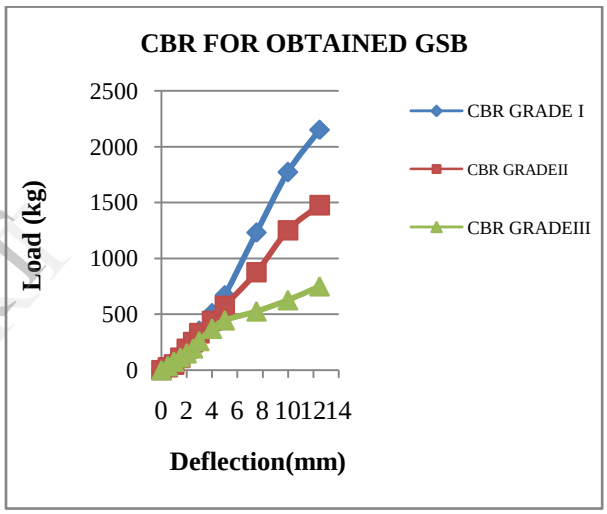

Fig3.3 Obtained CBR values for GSB Dense Grade

3.0 DISSCUSSION

1. Grade I consists of 33% of 53.00 mm down+34% of the 26.50 mm down+33% of the 4.75 mm down(combination of 40% soil+60% crusher dust)
2. Grade II consists of 42% of 26.50 mm down+25% of the 9.50 mm down+33% of the 4.75 mm down(combination of 40% soil+60% crusher dust)
3. Grade III consists of 58% of 26.50 mm down+42% of the 4.75 mm down (combination of 40% soil+60% crusher dust)
4. The co-efficient of permeability values obtained are as follows:
   a. GRADEI:1.038x10^{-3} cm/sec
   b. GRADEII:2.50x10^{-5}cm/sec
   c. GRADEIII:1.28x10^{-5} cm/sec

4.0 CONCLUSION

1. The gradation satisfies the strength requirement according to the MORTH for the respective Grades.
2. The limited study indicates presence of the fines below 2.36mm sieve makes the GSB impermeable.
3. The graduation requirement as to be suitable changed in such a way that material used in the construction should be from 75.00 mm to 2.36 mm only with little fines.
4. If the above criterion satisfies locally available soil, sand can also be used in the construction of the GSB.

5.0 REFERENCES

1. MORTH Hand Book,4th Edition.
2. Principles of Pavement Design ,EJ Yoder ,2nd Edition.