CONSTRUCTION OF RIGID PAVEMENT BY USING GREEN CONCRETE

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Abstract : Pavement is major part of highway section. Pavement is the asphalted path for pedestrians at the side of the road. In this pavement methods rigid pavement more stable and in this pavement used the materials as the cement concrete or reinforced concrete slabs. The rigid pavement has rigidity and high modulus of elasticity to distribute the loads over a relatively wide area soil sub-grade. Rigid pavement which resist the more against the external loads and long-life periods ifit is well designed. In India the present rate of utilization the waste materials is only about 10%. The objective of is to study and describe the use of fly ash & plastic waste and building waste material. Rigid pavement structure is composed of hydraulic cement concrete surface course and under laying and sub base. Concrete is prepared by mixing various constituents like cement, and various admixtures, which are economically available .Using of waste materials in rigid pavement by partially replacement of cement with fly ash, sand with plastic waste and aggregates with building wastes, which are improves the strength and more stable of slab, long life period, reduced the cost and to reduce the emission of CO2 in the environment. The project is aimed to find the alternatives strength by replacement of waste materials. Using the waste material control the environmental pollution.

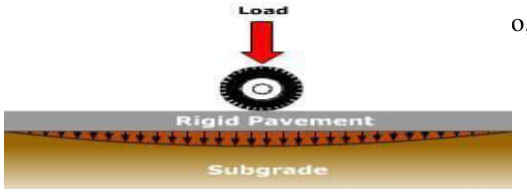
Keyword: pavement, cement ,aggregates, flyash, plastic waste, Green concrete,CO2 emission,Building Waste,

1. INTRODUCTION

1.1. General

Pavements are multi-layered structures with an asphalt or concrete slab resting on foundation system comprising layers of geometric such as the base, sub base, and subgrade. In rigid pavements structures deflects very little under loading due to the high modulus elasticity of their surface course this is the reason behind the naming of this structure. A rigid pavement structure is typically composed of a PCC surface course built on top of either the subgrade or under laying base course. Because of its relative rigidity, the pavement structure distributes the

LOAD DISTRIBUTION



o, structural

The structure of a rigid pavement consist of

- Surface course
- Granular base or stabilized base course

- Granular sub base or stabilized sub base course
- Subgrade soil

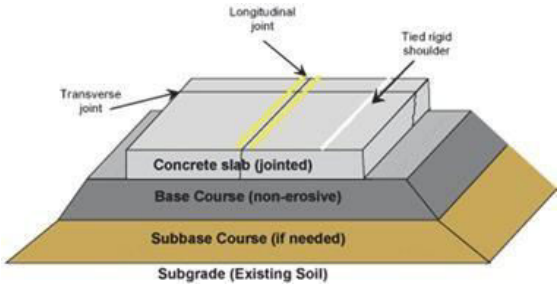


Fig2: Cross Section of Rigid Pavement

1.2. RIGID PAVEMENT

In India, waste produced from different construction work and companies was found ranging from 0.10 to 5.14 million tons per year (Shrivastava and Chini 2012) as shown in Table1.4 and Figure 1.1. It was concluded from (Mindess & Young et al 1981) that some changes can be done in the constituents of the cement but it will affect some property of concrete. Among all the bogus compounds, C3S (Tri calcium Silicate) is responsible for achieving the early strength and the initial setting time of concrete. C2S (Dia calcium silicate) is used to increase Latter strength of Cement and used as a Low heat cement, used for Mass concreting like bridge, piers, abutments, foundation, water retaining structures, retaining walls etc.C3A (Tri calcium aluminate) doesn't contribute Strength but it control the Setting time of Cement and Shrinkage.C4AF(Tetra calcium Alumino Ferrate) Very low contribution to Strength, Control setting time and Impart colour to cement.

1.3.OBJECTIVES OF PROJECT

- The main objective is to encourage the use of these construction materials in building.
- The objective of this project is to study and describe the use of fly ash and plastic waste and buildingwaste materials in rigid pavement.
- The project is aimed to find the alternative strength by replacement of green concrete and to reduce the emission of co2 in the environment.
- To make sustainable environmental,we are using eco-friendly materials.
- To decrease the disposal problem on the ground surface by using waste materials in the pavement construction.

2.LITERATURE REVIEW :

Jerath and Hanson (2007): He conducted the study to check the durability of concrete by increasing the gradation of aggregate with fly ash content. The usage of high quantity of fly ash decreases the water content of mixwhich gives high compressive and flexural strength. Densegraded aggregate with 45% of fly ash in place of cement reduces the specific gravity, permeability, absorption and voids in concrete mix which increase the durability of the rigid pavement in every climate conditions.

Wang et al. (2017) : He examined the effect on concrete when fly ash is added to mix. Fly ash was added to mix in replacement of cementations material like cement. While preparing sample for testing w/c ratio have to keep .35 and 25 and replacement of cement from 8% to 15% can be done. Test to find compressive strength, chloride permeability and shrinkage of new concrete mix. After analysing result it was found that 15% substitution give the optimum result.

Naveen Lasiyal, Lt.Gurkirat Singh Pawar and Meenakshi Dixit (2016):

- Conducted the effect of plastic waste as partial replacement of fine aggregate in concrete.
- The percentages replacement of fine aggregate with plastic waste is 0%, 1%, 2% and 3% (PET Bottles).
- The tests which are conducted are Compressive strength test, Flexural strength and Split tensile

strength.

- They concluded that, up to the 2% replacement, it gives the optimum values for compressive strength, Flexural strength and Split tensile strength.
- By partial replacement of plastic waste the weight alsoreduced.

NVVSSL Shilpa Devi Gadde, P. Manikumar and K. Abhiram (2017) :

- He conducted a study on Demolished concrete by partial replacement of coarse aggregate.
- The percentage replacement of Demolished concrete with coarse aggregate are 0%,25% , 50% 75% and 100%.
- The grade of the concrete is M30 and the size of the aggregates are 20 mm.
- The tests which are conducted are Compressive strength and Slump cone test.
- They conclude that the Compressive strength of the demolished concrete is near to the conventional concrete at 25% to 50% replacement.

The slump value is decreasing with increasing in replacement percentage.

Reema, Dr.Md.Daniyal Dr. Sitesh Kumar Singh and Col.Ram Kishore Singh:

- They conducted the Partial replacement of coarse aggregate with demolished waste in concrete.
- The percentage replacement of coarse aggregate with demolished waste are 0%,10% , 15% and 20%.They used the M25 grade of concrete.
- The tests conducted for fresh concrete are Slump cone test and Compaction factor test.
- They concluded that the strength is decreasing increasing the percentage replacement and use of recycled coarse aggregate upto 20% did not effect the functional requirements of Structure.

As compare to normal concrete the workability, impact value, water absorption crushing strength are high.

- By this literature review, we conclude that upto the 10% replacement of cement with fly ash is giving good strength.
- So we are taking constant 10% replacement of cementwith fly ash in our project.
- By the above literature reviews, we conclude that upto the 2% replacement of sand with plastic is giving strength which is equal to conventional mix. So we are taking 1%, 2% &3% replacement of sand with plastic
- After reading above review, we conclude that upto 20% replacement of coarse aggregates with demolished waste is giving good results. So we are taking 10%, 20%, &.30% replacement of coarse aggregate with demolished waste.

3.METHODOLOGY AND MATERIAL USSED

3.1.Methodology

The devastated building material has been collected the demolished concrete waste, fly ash and plastic waste to be collected from industrial wastages Crush the demolished Concrete debris into smaller particles, then conduct grain size analysis, differentiate the sieve size of 40 mm passed, and 20 mm Size retained. This Size of demolished waste used as an aggregate in modified for pavement.Conduct sieve analysis for Coarse conventional aggregates also.

3.1.2.Construction steps involves in rigid pavement

- Preparation of soil subgrade
- Preparation of base course
- Preparation of surface course
- Design mix ratio process

- Batching and mixing process
- Compaction and finishing
- Curing

PREPARATION OF SOIL SUBGRADE:

Where formation soils of very good quality, 150mm thickness layer should prepared compacted. And checked for the trueness and by means of scratch template, Soil subgrade should be prepared at least before advancing concreting.

Prepared soil subgrade should be complete the following requirements;

- There should not be any soft patches on the preparesoil subgrade.
- Soli subgrade should present the uniform support tothe concrete slab
- Minimum modulus of soli sub grade reaction obtained with plate bearing test should be 5.5kg/cm2.

PREPARATION OF BASE COURSE:

This is immediately below the surface course and its function is to distribute the stresses transmitted through the surface course evenly onto the layers below. Invariably, it consists of granular or bituminous material, and acts as a structural part of the pavement.to provide the thickness of the base course is the 150mm and fill the layer crushed aggregates of 20mm to 40mm and to get desirable strength in the pavement.

Prepared base course should be complete the following requirements:

- It should be strong layer in the rigid pavement.
- To act as the structural portion of the pavement and thus distribute the loads.
- To attend the requirements of tests in aggregates for the base course layer and used the stone dust for sufficient and get compacted well.
- Aggregate test are grain size distribution,abrasiontest, impact test, shape test, absorption test etc.These test are to done for the good quality of aggregates for the base course layer in rigid pavement.

PREPARATION OF SURFACE COURSE:

It acts as major role in the rigid pavement. The provide thickness in the pavement is 200mm and materials used as the concrete and it may laid over the base course.

Prepared surface course should be complete the followingrequirements:

- To perform the structural portion of the pavement .
- To resist the abrasive forces, it should be smooth and skid resist.
- To reduce the amount of surface water penetrating the pavement.
- To provide uniform riding surface.
- The material used in the surface layer of concrete to conduct the all the test such like slump cone test, compressive strength ,water absorption test etc.., to get good quality of concrete in the rigid pavement.

BATCHING AND MIXING PROCESSs

- In this project we are used the standard mix ration M25grade.

Cement is measured in number of bags, if cement stored in silos is used its weight is taken as 1440kg\m2.course aggregate and fine aggregate are batched in weigh batching plant and put into the hopper of the mixer along with the required quantity of the cement water is measured in volume. The mixing of each batch is should be at least 11\2 minutes count.

COMPACTION AND FINISHING:

Compaction is the process that expels entrapped air from freshly placed concrete and packs the aggregate particles together so as to increase the density of the concrete. Compaction of concrete is one of the important site operations that together enable the fresh concrete to reach its potential design strength, density and low permeability. Properly carried out it ensures that concrete fully surrounds and protects the reinforcement, tendons and cast-in inserts. It also has a direct impact on achieving the specified surface finish.

3.2.MATERIALS USED

The materials used in research are:

1.Portland cement (53 grade)

2.Fine aggregate (4.75mm)

3.Coarse aggregate (20mm)

4.Fly ash

5.Plastic waste

6.Demolished Concrete.

DIMENSION OF OUR CONSTRUCTION RIGID PAVEMENT

M25 Grade – 1:1:2

Length :1.2m

Width : 0.6m

Thickness:0.15m

3.3.Mix design

Adopted Grade was M25 for prepararion of concrete .

3.3.1 General

Density of cement = 1440kg/m3

Density of sand = 1600kg/m3

Density of aggregates = 1800kg/m3

Dry volume = 1.54 to 1.57*wet volumeM25=1:1:2

Sum of ratios =1+1+2=4

Assuming 1.54(wet volume) = dry volume.

3.3.2.Basic calculations:

For 1m3 volume

Volume(V) = length(L)*breadth(B)*height(H)

V = 1m*1m*1m = 1m3

Weight of cement = 1/4*1.54*1*1440 =554.4 kg

Weight of sand = 1/4*1.54*1*1600 =616 kg

Weight of aggregates = 2/4*1.54*1*1800 = 1386kg

3.3.3.For standard cube size

FOR 150*150*150mm size cube

Volume = 0.15*0.15*0.15 = 0.003375m3

Weight of cement = 0.003375*[1/4*1.54*1440]

= 1.871kg

Weight of sand = 0.003375*[1/4*1.54*1600]

= 2.079kg

Weight of aggregates = 0.003375*[2/4*1.54*1800]

=4.678kg

Weight of water:

w/c = 0.5 (assume)

w = 0.5*1.87= 0.935 litres

3.3.4.For standard cylinder size

For 300 mm (height) * 150 mm (diameter) size cylinder.

Volume = π r2 h = π D h

= π*0.15*0.3

= 0.0053m3

Weight of cement = 0.0053*[1/4*1.54*1440]

=2.938kg

Weight of sand = 0.0053*[1/4*1.54*1600]

= 3.264 kg

Weight of aggregates = 0.0053*[2/4*1.54*1800]

= 7.345kg

Weight of water

w/c = 0.5(assume)

w = 0.5*2.938

4.TEST ON SOIL

4.1.CALIFORNIA BEARING TEST

Procedure for Penetration Test:

1.Place the mould assembly with test specimen on thelower plate of penetration testing machine. To prevent up heaval of soil into the hole of the surcharge weights, 2.5 kg annular weight shall be placed on the soil surface prior to seating the penetration plunger after which the remainder of the surcharge weights shall be placed.

2.Set the penetration piston at the center of the specimen with the smallest possible load, but in no case in excess of 4 kg so that full contact of the piston on the sample is established.

3.Set the load and deformation gauges to read zero. Apply the load on the piston so that the penetration rate is about 1.25 mm/min.

4.Record the load readings at penetrations of 0.5, 1.0, 1.5, 2.0, 2.5, 4.0, 5.0, 7.5, 10 and 12.5 mm.

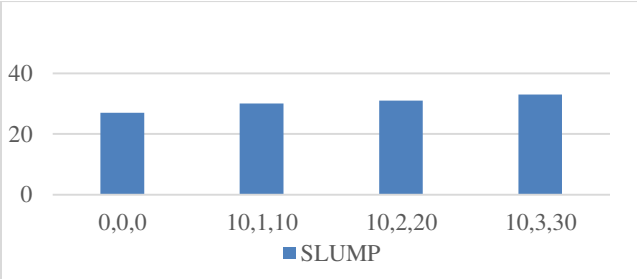
5.Raise the plunger and detach the mould from the loading equipment. Take about 20 to 50 g of soil from the top 30 mm layer and determine the moisture content.

5.RESULT AND DISCUSSION

5.1.Workability in Terms of Slump

S.NO	Mix Proportion	Slump(mm)
1	0-0-0	27
2	10-1-10	30
3	10-2-20	31
4	10-3-30	33

Table: 2 slumps for M25 grade concrete with different replacement percentages of cement with fly ash and sand with plastic waste and fine aggregate with demolished building waste.



Graph 1: Variation of slumps for M25 grade concrete with different replacement percentages.

5.2.COMPRESSION STRENGTH

S. No.	Replacement %	Compressive strength N/mm^2		
		7 day	14 day	28 day
1.	0-0-0	17.78	23.3	25.7
2.	10-1-10	17.43	22.7	25.3
3.	10-2-20	16.8	22.3	24.8
4.	10-3-30	16.1	21.3	24

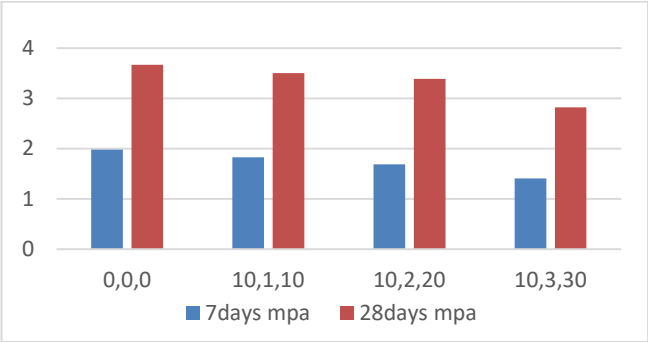
Table: 3 compression strength of concrete

Graph2: Variation of compression strength concrete

5.3.SPLIT TENSILE STRENGTH

S. No.	Replacement %	Split Tensile Strength N/mm^2	
		7 day	28 day
1.	0-0-0	1.98	3.67
2.	10-1-10	1.83	3.5
3.	10-2-20	1.69	3.39
4.	10-3-30	1.41	2.82

Table 4: split tensile strength



Graph: 3 Variation of split tensile strength

6.CONCLUSION

- For making a sustainable environment it is necessary to reuse the demolished concrete and other waste materials.The materials that comes during the demolishing of buildings like concrete plastics and metals and etc. should be reused. Usage of waste materials also reduces the cost of landfill.
- If some serious steps will not be taken right now then the production of waste increased up to 300 million tons per year.
- This project focus on study of the various waste materials and their potential use in concrete pavement. At present the rising cost of construction materials is the factor of great concern.
- Therefore, there is reuse of these materials for preserving virgin aggregate resources. From this study we can conclude that the usage of waste materials in concrete has many advantages.

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