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Comparative Strength on Concrete in Rigid Pavements by Partially Replacement Materials as Fly Ash and Waste Glass Powder with Cement

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Abstract- **Many efforts have been made to use waste glass in concrete industry as a replacement of coarse aggregate, fine aggregate and cement. Fly ash is generated in huge quantities every day in major thermal power stations of India. The safe disposal of this fly ash is the major socio-economic problem before the authorities and is becoming a costly affair for them. Conventional method of concrete broad construction consumes the natural resources like stone metal, sand, murum, etc. And causes ecological imbalance the use of fly ash in concrete road construction will save such resources. A part of cement can be replaced by good quality fly ash and glass powder to the extent of 0-30% & 0-15% respectively. This wood results in lowering cost of resultant concrete without any loss in strength. The use of fly ash will solve the disposal problem and automatically reduce the construction cost .Because of the use of fly ash; rigid pavement behaves as a semi rigid pavement causing substantial reduction in cost of construction. If the fly ash is utilized on large scale for road construction, the infrastructure development can be completed at lesser cost and will also help for environmental protection of our country. A series of tests were conducted to study the effect of cement was replaced by glass powder (0%,5%, 10% and 15%) & fly ash (0%, 10%, 20%, and 30%) on compressive strength and durability. Hence our project aim is to evaluates the strength of hardened concrete, by means of partly replacement of cement with glass powder and fly ash design for M25 grade of concrete by preparing of concrete cubes & cylinders have been tested at the age of 7, 14 and 28 days with steady water curing situation.. The particle size effect was evaluated by using glass powder of size 600µm-100µm.The results showed that the maximum increase in strength of concrete occurred when 10% replacement was done with glass powder.**

Index Terms- Fly-ash, Glass powder, Workability, normal consistency, Compressive strength, Split Tensile strength.

I. INTRODUCTION

The transportation by road is the only road which could give maximum service to one all. This mode has also the maximum flexibility for travel with reference to route, direction, time and speed of travel. It is possible to provide door to door service only by road transport .Concrete pavement a large number of advantages such as long life span negligible maintenance, user and environment friendly and lower cost. Keeping in this view the whole life cycle cost analysis for the black topping and white topping have been done based on various conditions such as type of lane as single lane, two lane, four lane different traffic categories deterioration of road three categories.

A highway pavement is a structure consisting of superimposed layers of processed materials above the natural soil sub-grade, whose primary function is to distribute the applied vehicle loads to the sub-grade. The pavement structure should be able to provide a surface of acceptable riding quality, adequate skid resistance, favorable light reflecting characteristics, and low noise pollution. The ultimate aim is to ensure that the transmitted stresses due to wheel load are sufficiently reduced, so that they will not exceed bearing capacity of the sub- grade. Two types of pavements are generally recognized as serving this purpose, namely flexible pavements and rigid pavements. This gives an overview of pavement types, layers and their functions, cost analysis. In India transportation system mainly is governed by Indian road congress (IRC).

Various grades of concrete under similar condition of traffic and design concrete road are found to more suitable than bituminous road. Since the whole life cycle cost comes out to be lower in the range of 30% to 50% but for roads having traffic less than 400cv/day and road is in good condition, the difference between whole life costs of both the road is very less. The initial cost of concrete overlay is 15% to 60% more than the flexible overlay.

To design the road stretch as a flexible pavement by using different flexible methods like group index method, C.B.R. method as per IRC: 37-2001, tri axial method, California resistance value method, and as a rigid pavement as per IRC: for the collected design upon a given black cotton soil sub grade and to estimates the construction cost of designed pavement by each method. To propose a suitable or best methods to a given condition or problem.

The main objective of this study is to develop a strategy to select the most cost efficient pavement design method to carry out for sections of a highway network and also to identify the cost analysis of different pavement design methods. Prioritization based on Subjective Judgment, Prioritization based on Economic Analysis to develop a strategy for to select the most appropriate method to be carried out for design of a highway network. Analysis of data for a highway network problem to illustrate the proposed strategy and Interpretation of the results obtained.

II LITERATURE SURVEY

Since many years the utilization of fly ash in flexible pavements has been done to increase the stability, durability of roads and reduce the cost of construction of roads by replacing some percentage of concrete.

SudipBasak et al (2004) According to report of concerned authority, the accumulated fly ash in the last year over the country was about 100 million tons which is expected to be raised beyond 150 million tons by the year 2010. This necessitates effective utilization of this accumulated fly ash is being felt by the engineers and scientists. From the above illustrations and discussions, it is clear that fly ash can be used economically for embankment construction in the vicinity of thermal power stations when lead distance is less than 10 to 15 km. In case of rigid pavements, usage of fly ash leads to considerable savings even if fly ash is to be transported more than 50 km or perhaps 100 km. For rigid pavement construction in a large scale, part replacement of cement by dry fly ash acceptable

Prof. Jayeshkumar Pitroda studied that the replacement of cement with fly ash in the proportion of 10%, 20%, 30% & 40% by weight for the grade of M25 & M40. Research concluded that the compressive strength reduces when the cement is replaced with fly ash. As fly ash percentages increases compressive strength and split tensile strength decreases.

P. R. Wankhede & V. A. Fulari studied an effect of fly ash on properties of concrete. The study has been carried out for M25 grade of concrete and tested for 7 days, 14 days, and 28 days of curing. Cubes had been casted by replacing 0%, 10%, 20% & 30% cement with fly ash by weight. This paper also studied the variation in slump in different W/C ratio and the research concluded that slump loss of concrete increases with the increase in W/C ratio of concrete. Concrete with 10% & 20% replacement of cement with fly ash shows good compressive strength for 28 days for 0.35 W/C ratio. But in case of 30% replacement of cement with fly ash, compressive strength of concrete decreases.

Tomas U. Ganiron studied physical, chemical and mechanical properties of fly ash cement concrete. This research had done for 30% of fly ash replacement. Results were taken for 7 days and 14 days and concluded that fly ash can be used effectively as a material in concrete pavement.

Rakesh Sakaleet. al. studied the replacement of cement by waste glass powder in steps of 0%, 5%, 10%, 15% respectively by volume of cement and its effects on compressive strength, split tensile strength, workability and flexural strength are determined. It is found that the compressive and split tensile strengths of concrete increase initially as the replacement percentage of cement by glass powder increases and become maximum at about 20% by glass powder can be done without sacrificing the compressive strength.

Olukoet. al. investigated the compressive strength of Compressed Stabilized Earth Block (CSEB) by partially replacing the cement (stabilizer) in the block with Waste Glass Powder (WGP) and it was found from the results that, as WGP is added to compressed stabilized earth block, its strength reduces. Although the strength for CSEB without glass had the highest strength, CSEB with WGP indicated strengths higher than 3N/mm2 recommended as minimum strength for

CSEB at 28 days for the percentage of replacements used in this study, the highest of which was 60% No optimum value was observed for WGP addition to the CSEB as replacement for cement, however, sufficient strengths good enough for handling at early stages of the CSEB whether at particle size of 150 µm or 75 µm were achieved at 20% replacement of cement with WGP in CSEB. It could be concluded that the role of WGP in CSEB is more of filer than a binder.

Raghavendra K. and Virendra Kumara K. N investigated about the compressive strength, split tensile strength of M20 grade of concrete mixes with 20% constant replacement of waste glass powder in cement and partial replacement of waste foundry sand in fine aggregate. From the test results, strength was achieved very less on 7th and 14th days but it increase on the 28th day. High strength values were found at 20% replacement level in strength parameters. The compressive strength and split tensile strength of concrete at 7, 14 and 28 days increases initially as the percentage of replacement of waste glass powder and waste foundry sand increases and becomes maximum at a proportion respectively around A40, A40.

Ana Mafalda Matos aimed to evaluate the use of waste glass powder in powder type SSC. It could be concluded that waste glass powder can be used successfully in SSC further improving chloride penetration and water absorption by capillarity, maintaining strength levels. Although soda lime glass presents a high alkali content, use of ground waste glass as cement replacement in mortar, improved resistance to ASR. These results corroborate the pozzolanic nature of glass powder and its behavior with time. Although glass powder is a little coarser than cement, it still brings advantages when incorporated in cement.

Jitendra B. Jangid and A.C. Saoji studied the replacement of Glass Powder varying partially from 0 to 30% at interval 10% and tested for its Workability, Compressive Strength, Split Tensile Strength, for the age 7, 14 and 28 days and was compared with those of conventional concrete. The overall result showed that Waste Glass Powder could be utilized in concrete as a good substitute of cement. It was also found that Workability of concrete decreases as percentage of glass powder increases. Slump value of experiment's concrete ranges from 60 to 80mm highest compressive strength was observed when Glass Liquid Powder (GLP) replacement is about 20%. Highest split tensile strength was observed when GLP replacement is about 20%.

Ashutosh Sharma and Ashutosh Sangamnerkar showed that waste glass, if ground finer than 600µm shows a pozzolanic behaviour. It reacts with lime at early stage of hydration forming extra CSH gel there by forming denser cement matrix. Thus early consumption of alkalis by glass particles helps in the reduction of alkali-silica reaction hence enhancing the durability of concrete. Numbers of test were conducted to study the effect of 5%, 10% and 15% replacement of cement by glass powder on compressive strength and durability. The particle size effect was evaluated by using glass powder of size 600µm-100µm.The results showed that the maximum increase in strength of concrete occurred when 10% replacement was done with glass powder. Then found result

- Conventional concrete shows a 7 days compressive strength as 9 N/mm and 2.5% replacement of glass powder in cement increased the compressive strength by 37% in 7 days.
- 10% replacement of glass powder increment increased the compressive strength 52.6% in 14 days.
- 15% replacement of glass powder in cement increased the compressive strength by 39.8% in 28 days.

M. Adaway and Y. Wang aimed to determine the level of glass replacement resulting in optional compressive strength. Three concrete samples were tested at 7 and 28 days for glass replacement proportions of 0%, 5%, 10% and 15 %. Compressive strength was found to increase up to a level of 30% at which point the strength developed was 9% and 6% higher than the control after 7 and 28 days respectively. This demonstrates that concrete containing up to 30% fine glass aggregate exhibits higher compressive strength development than traditional concrete. The optimum percentages replacement of sand with fine glass aggregate was determined to be 30%.

Compressive strength was found to increase with the addition of waste glass to the mix up until the optimum level of replacement.

VeenaV.Bhatt and N. Bhavanishankar Rao studied the influence of replacement of cement by glass powder and found that there was an increase of 27% strength after replacing 20% glass powder, when w/c ratio was kept constant. Slump test was carried out and the slump was found to be 70 to 72mm even with 20% replacement. It was also found that with the increase in glass content, percentage of water absorption decrease. Considering the strength criteria, the replacement of cement by glass powder is feasible up to 2o%.

Prema Kumar W P et. al. concluded that cement in concrete is replaced by waste glass powder in steps of 5% from 0% to 40% by volume and its effects on compressive strength, split tensile strength, workability and weight density are determined. The results were found to be

- The 7 days, 14 days and 28 days compressive strengths of concrete increase initially as the replacement percentage of cement with glass powder increases, and become maximum at about 20% and later decreases.
- The split tensile strength of concrete increases initially as the replacement percentage of cement with glass powder increases, and becomes maximum about 20% later decrease.
- The slump and weight density of concrete decrease monotonically as the replacement percentage of cement with glass powder increases. The workability decreases when cement is replaced partially with glass powder.
- The study showed that there is a great potential for the utilization of glass powder in concrete as partial replacement of cement. About 30% of cement may be replaced with glass powder of size less than 100µm without any sacrifice on the compressive strength.

Dr. G. Vijayakumaret. al. examined the possibility of using Glass Powder as a partial replacement of cement for new concrete. Glass powder was partially replaced as 0%,5%,10% and 15% and tested for its compressive, split tensile strength up to 60 days of age and were compared with those of conventional concrete; for the results obtained, it was found that glass powder size less than 75 micro meter to prevent alkali silica reaction. After the study it was found that the conventional concrete tested at 28 days compressive strength as 31.1N/mm2, split tensile strength of 2.27N/mm2.

III. OBJECTIVE

Basic intention is to effectively utilize the glass powder and fly ash in rigid pavements.

Main objectives of current project work are

1. To compare the experimental results of glass powder and fly ash using in rigid pavement details and it performance the economical analysis.
2. To determine the optimum percentages glass powder and fly ash for M20 grade concrete based on compressive strength, flexural strength to test with different glass powder (0%,5%, 10% and 15%) and fly ash (0%, 10%, 20%, 30%) dosages.

Scope:

To study the behavior of pozzolanic materials used in rigid pavements are

1. Glass powder content as 0%,5%,10%,15% Fly ash content as 0%,10%, 20%,30%
2. Finally to obtain a Optimum content of glass powder and fly ash, will shows a maximum results of its compressive strength, and spilt tensile strength of rigid pavements.

IV. EXPERIMENTAL INVESTIGATION

Weigh batching is the very right procedure of measuring the substances on this project. Customarily for concrete continually weight batching approach adopted. Use of weight process in batching, allows accuracy, flexibility and ease. One of a kind varieties of weigh batchers are on hand, the distinct variety to be used, is dependent upon the character of the job. Weigh batching vegetation have automatic weighing equipment. The usage of this automatic gear for batching is considered one of sophistication and requires certified and skilled engineers. On this, further complication will come to regulate water content to cater for the moisture content material in the aggregate.

On huge work web sites, the weigh bucket variety of weighing equipment is used. This fed from a enormous overhead storage hopper and it discharges with the aid of gravity, straight into the mixer. The weighing is finished through a lever-arm method and two interlinked beams and jockey weights. The required range of say, coarse mixture is weighed, having best the shrink beam in operation. After balancing, with the aid of turning the smaller lever, to the left of the beam, the two beams are interlinked and the exceptional mixture is brought until them for stability. The final stability is indicated by way of the pointer on the scale to the proper of the beams. Discharge is through the swivel gate at the bottom. Automatic batching plants are available in small or large capacity. In this, the operator has only to press one or two buttons to put into motion the weighing of all the different materials, the flow of each being cut off when the correct weight is reached. In their most advanced forms, automatic plants are electrically operated on a punched card system. This type of plant is particularly only suitable for the production of ready-mixed concrete in which very frequent changes in mix proportion have to be made to meet the varying requirements of different customers.

Aggregate weighing machines require regular attention if they are to maintain their accuracy. Investigate calibrations must continuously be made by means of adding weights in the hopper equal to the full weight of the combination within the batch. The error observed is adjusted occasionally.

In small jobs, cement is often not weighed; it is added in bags assuming the weight of the bag as 50 kg. In reality, though the cement bag is made of 50 kg. At the factory, due to transpiration, handling at a number of places, it loses some cement, particularly, when jute bags are used. Actually, the burden of a cement bag on the website online is substantially much less. Repeatedly, the lack of weight becomes greater than 5 kg. This is likely one of the sources of error in quantity batching and likewise in weigh batching, when the cement isn't truly weighed. But in foremost fundamental concreting jobs, cement can be in reality weighed and the distinctive proportion as designed is maintained.

Casting of cubes and cylinders as done for M20 grade concrete, the mix proportion is 1:1.5:3 for which we are casting 3 cubes for normal concrete, with the partial replacement of concrete with fly ash of 0% is 3 cubes, for 10% 3 cubes, for 20% 3 cubes and for 30% cubes.

Compaction: Filling the Cube Moulds and Compacting the Concrete

After the sample has been remixed, immediately fill the cube moulds and compact the concrete, either by hand or by vibration. Any air trapped in the concrete will reduce the strength of the cube. Hence, the cubes must be fully compacted. However, care must also be taken not to over compact the concrete as this may cause segregation of the aggregates and cement paste in the mix. This may also reduce the final compressive strength.

Filling the mould (for 150 mm cube 3 equal layers)

150 mm moulds should be filled in three approximately equal layers (50 mm deep). A compacting bar is provided for compacting the concrete. It is a 380 mm long steel bar, weighs 1.8 kg and has a 25 mm square end for ramming. During the compaction of each layer with the compacting bar, the strokes should be distributed in a uniform manner over the surface of the concrete and each layer should be compacted to its full depth. During the compaction of the first layer, the compacting bar should not forcibly strike the bottom of the mould. For subsequent layers, the compacting bar should pass into the layer immediately below. The minimum number of strokes per layer required to produce full compaction will depend upon the workability of the concrete, but at least 35 strokes will be necessary except in the case of very high workability concrete. After the top layer has been compacted, a trowel should be used to finish off the surface level with the top of the mould, and the outside of the mould should be wiped clean.

Compressive Strength of Concrete

Out of many test applied to the concrete, this is the utmost important which gives an idea about all the characteristics of concrete. By this single test one judge that whether Concreting has been done properly or not.

Compressive strength of concrete depends on many factors such as water-cement ratio, cement strength, quality of concrete material, and quality control during production of concrete etc.

Test for compressive strength is carried out either on cube or cylinder. Various standard codes recommend concrete cylinder or concrete cube as the standard specimen for the test. American Society for Testing Materials ASTM C39/C39M provides Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens,

For cube test two types of specimens either cubes of 15 cm X 15 cm X 15 cm or 10cm X 10 cm x 10 cm depending upon the size of aggregate are used. For most of the works cubical moulds of size 15 cm x 15cm x 15 cm are commonly used.

This concrete is poured in the mould and tempered properly so as not to have any voids. After 24 hours these moulds are removed and test specimens are put in water for curing. The top surface of these specimens should be made even and smooth. This is done by putting cement paste and spreading smoothly on whole area of specimen.

These specimens are tested by compression testing machine after 7 days curing or 28 days curing. Load should be applied gradually at the rate of 140 kg/cm2 per minute till the Specimens fails. Load at the failure divided by area of specimen gives the compressive strength of concrete.

V.PREPARATION OF CUBE SPECIMENS

The proportion and material for making these test specimens are from the same concrete used in the field.

Sampling

1. Clean the mounds and apply oil
2. Fill the concrete in the molds in layers approximately 5cm thick
3. Compact each layer with not less than 35strokes per layer using a tamping rod (steel bar 16mm diameter and 60cm long, bullet pointed at lower end)
4. Level the top surface and smoothen it with a trowel

Split tensile strength apparatus

VI. TESTS ON CONCRETE CUBES FOR COMPRESSIVE STRENGTH

The outcomes of cubes are provided below:

0% of Fly Ash Replaced With Cement in Concrete Cubes for Compressive Strength

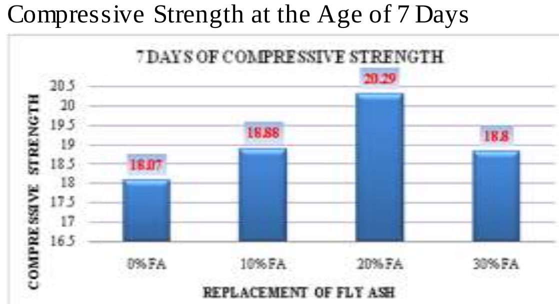
No. of days	Cube Numbers	load in KN	compressive strength in N/mm²	Avg. compressive strength in N/mm²
7	1	410	18.22	18.07
	2	400	17.77	
	3	410	18.22	
14	1	440	19.55	19.25
	2	410	18.22	
	3	450	19.99	
28	1	570	25.33	26.06
	2	590	26.21	
	3	600	26.66	

The average compressive strength for 7 days = 18.07 N/mm2

The average compressive strength for 14 days = 19.25 N/mm2

The average compressive strength for 28 days = 26.06 N/mm2

Compressive Strength at the Age of 7 Days



Compressive Strength at the Age of 14 Days

Compressive Strength at the Age of 28Days

VII. CONCLUSION

From the test results it was concluded that:

1. Concrete with 20% &10% replacement of cement by fly ash & waste glass powder shows good results for compressive strength and split tensile strength for 28 days.
2. This percentage replacement of cement by fly ash & waste glass powder gives better workability to concrete.
3. 3While increasing the percentage replacement of cement by fly ash & waste glass powder will reduces its compressive strength and split tensile strength of concrete.
4. To achieve economy, cement can be replaced by pozzolanic materials like fly ash & waste glass powder can be used effectively as a material in concrete pavements.

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