Partial Replacement of Aggregate in Roller Compacted Concrete by Demolished Aggregate

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Abstract

Roller-compacted concrete (RCC) consists of an engineered mixture of dense-graded aggregates, portland cement and water. This zero slump concrete mixture, when placed with an asphalt paver and compacted to high density, provides a high-strength, durable pavement structure. RCC uses no forms, requires no conventional finishing, and needs no dowels or reinforcing steel, making it an economical choice. When cubes were tested, the compressive strength for M20 mixes at 7 days, 14 days and 28 days. It can be used as base course and sub-base course for flexible and rigid pavements.

Keywords: Roller Compacted Concrete, Consistency, Conventional Concrete

I. INTRODUCTION

Roller compacted concrete is a zero-slump concrete consisting of dense-graded aggregate and sand, cementations' materials, and water. Because it contains a relatively small amount of water, it cannot be placed by the same methods used for conventional (slump) concrete. Roller compacted concrete has the same basic ingredient as conventional concrete: cement, water, and aggregates. The basic difference is that roller compacted concrete is a much drier mix with practically zero slumps. It is drier, and looks and feels like damp gravel. It does not require any forms, dowels, reinforcing steel & finishing. Also, the method of compaction is different than the conventional compacted concrete and it is compacted by vibratory or pneumatic-tired rollers. The objective of mix design is to produce a roller compacted concrete mix that has sufficient paste volume to coat the aggregates in the mix and to fill in the voids between them. Any of the basic roller compacted concrete proportioning methods like those based on concrete consistency testing, the solid suspension model, the optimal paste volume method, and soil compaction testing may be used for mix design. Roller-Compacted Concrete uses aggregate sizes often found in conventional concrete. However, the blending of aggregates will be different than that done in case of conventional concrete. Crushed aggregates are preferable in roller compacted concrete mixes due to the sharp interlocking edges of the particles, which help to reduce segregation, provide higher strengths, and better aggregate interlock at joints and cracks. The use of roller compacted concrete for pavements at industrial facilities such as port and intermodal container terminals is particularly appropriate because of the ability to construct low-cost concrete pavements over large areas. Roller compacted concrete is also used in Bulk material storage, General cargo storage, Container terminals, Road / rail transfer facilities, Truck parks, Tank roads and parking, Sewage sludge stacking, Composting slabs and Pre-casting yards. To carryout experimental analysis for M20 grade of concrete. Casting of cubes of M20 grade with 0%, 10% 20% and 30% replacement to know compressive strength.

II. LITERATURE REVIEW

M.N. Haque reported conceptive analysis of many inferior and marginal aggregates, waste products, and other deleterious materials which do not meet standards and specification to be use in the manufacturing of Roller compacted concrete, pavement construction. RCC containing marginal aggregates becoming cost effective and competitive. Mechanically weak and poorly graded materials can be used to manufacture RCC of adequate strength for use in pavement structures. Marginal quality aggregate require higher amount of cement to produce similar strength. Silt content up to 10% in aggregate will improve workability and compatibility of RCC. Where Fly ash is locally available it can be use replace cement and fine aggregated in mix design and help gain in strength and durability to RCC pavements. All the construction sites it's difficult to arrange good quality of material hence adjust in the mix proportion is best approach to utilize the available resources to minimize the cost impact and saving in natural resources.

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Schrader presented the effect of compaction methods, water content, and other variables on density, pore pressure, practical construction problems in RCC construction. The mix has a no-slump consistency which precludes internal vibration. RCC is compacted by massive external forces rather than by being consolidated under its own weight with internal or external vibration. In fact, if it approaches a consistency that could be internally vibrated, damaging pore pressure may develop by roller compaction. Aggregate gradation is critical to compatibility and can differ from conventional concrete. Strength is dependent on the degree of compaction, but some latitude exists once the RCC mix nears its maximum density. Laboratory compaction methods are varied, and some are suited to only select mixes. The degree of field compaction achieved can be determined with the nuclear testing gauge.

T. P. Dolen reported interaction analysis of air content and the freeze-thaw (FT) durability of RCC and reported It is possible to entrain air in "more workable" RCC mixtures with Vebe consistency times ranging from approximately 5 to 35 seconds. Air entrainment improves the workability of RCC mixtures, resulting in lower Vebe consistency times and reduced segregation. FT durability of air entrained RCC increased from 66 to up to 409 percent above that of the non-air entrained mixtures.

III. MATERIAL USED

- Fine Aggregate: Locally available river sand passing through 4.75 mm sieve and retained on 75 micron sieve were used.
- Coarse aggregate: Crushed blue granite of coarse aggregate passing through 24mm sieve and retained on 20mm sieve were used.
- Water: Potable water was used for the concrete. The pH value was 7.25. The same water was used for mixing and curing of concrete cubes and cylinder.
- Recycled Aggregate: Recycled aggregate is produced by crushing concrete, and sometimes asphalt, to reclaim the aggregate. Recycled aggregate can be used for many purposes. The primary market is road base.

IV. METHODOLOGY

A. Impact value of Aggregates

The property of a material to resist impact is known as toughness. Due to movement of vehicles on the road the aggregates are subjected to impact resulting in their breaking down into smaller pieces. The aggregates should therefore have sufficient toughness to resist their disintegration due to impact. The weighted of the dry mould is taken. The aggregates are taken of size range 12.5 mm to 10 mm by IS sieve 12.5mm and IS sieve 10mm and is filled in mould in three layers with 25 times tamping each layer by tamping rod. The weight of mould and aggregates are noted down. The hammer is lifted at 380 mm height and allows to fall freely. It is repeated giving 25 blows. Remove the crushed aggregate from the cup and sieve it through 2.36 mm IS sieve. The passed aggregates are weighted. Computing the aggregate impact value.

B. Los Angeles Abrasion Value

The aggregate used in surface course of the highway pavements are subjected to wearing due to movement of traffic.

Due to the continues movement of vehicles tires it may cause wear and tear of road pavement which may cause detoriation. The road aggregates should be hard enough to resist abrasion. The aggregate of size between 20-12.5 mm and 12.5 -10 mm are taken in 2.5 kg each. The material is filled in cylinder with 12 metallic balls and rotates 500 rounds at 35 to 40 rpm. The materials is sieved by IS 1.7mm sieve and the weight of material pass is noted down.

C. Slump Cone Test

The cement and fine aggregate are mixed thoroughly until uniform color on a rigid and non absorbent surface. Then coarse aggregate is added and mixed it thoroughly and then water is added and mixed it until the concrete appeared to be homogenous. Slump cone mould is thoroughly cleaned and oil is applied inside of it. Now the mixed sample is placed in three layers. After placing of every layer in mould, 25 blows were applied on it by using tamping rod taking care to distribute the strokes evenly over the cross section. After complete filling of three layers, the top surface is leveled with trowel. Now slowly lift the slump cone mould vertically without disturbance of placed sample. Height of the sample specimen is noted. The difference between the initial and final height of the sample gives the slump value in mm.

D. Casting

Cube moulds of 150mm in size were cast in conventional method to know the compressive strengths of grade of concrete. The cylindrical moulds of diameter 150mm X height 300mm were cast to know the split tensile strength test. These moulds were cleaned and applied oil inside surface. Now the moulds were placed on vibration machine and filled with green concrete in five layers by giving vibration to each layer for a period of 2 minutes.

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E. Curing

The test specimens are stored in moist air for twenty four hours and then specimens are de-mould and submerged in clear fresh water for 28 days.

F. Procedure (Testing)

Specimens are removed from water after curing, wiped out the excess water and the surface is dried. The specimens are placed in CTM and then tested for compressive strength as per IS: 516-1959 and the results were tabulated.

V. RESULT AND DISCUSSION

M20 Grade concrete cubes of 150mm were used to determine the compressive strength. In total 24 cubes were cast, among which 6 cubes each with 0%, 10%, 20% and 30% replacement and cured in water for a period of 28 days. The compressive strength was carried out after 7, 14 and 28days.

Table

% Replacement	*7 day Strength in MPa*	*14 day Strength in MPa*	*28 day Strength in MPa*
0%	*13.5*	*15.6*	*18.28*
10%	*12.34*	*13.75*	*17.83*
20%	*11.96*	*12.98*	*15.24*
30%	*11.00*	*11.31*	*13.57*

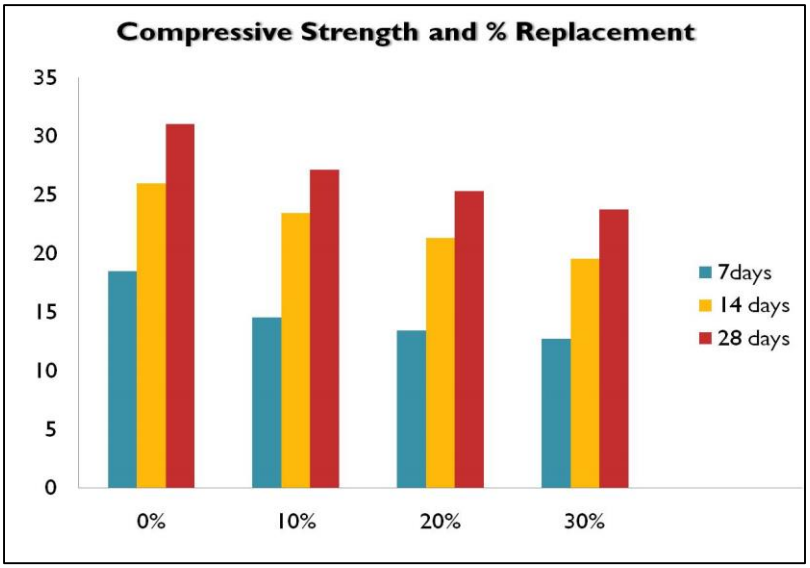

Fig. 1: Compressive Strength and % Replacement

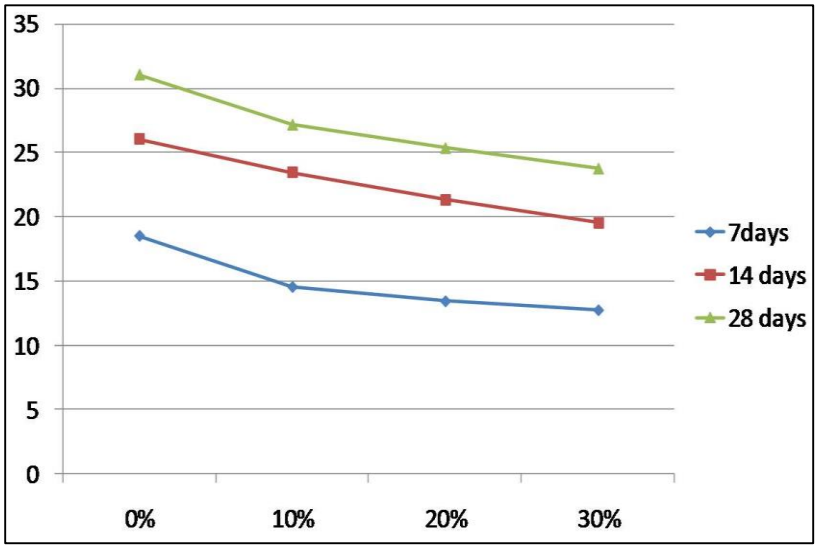

Fig. 2: Result

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VI. CONCLUSION

The cubes are prepared of M20 grade of concrete of ratio 1:1.5:3. The coarse aggregate are partially replaced in 0%, 10%, 20% and 30% with recycled aggregate. The compressive strength of the cubes is 31.05, 27.16, 25.34 and 23.75 with 0%, 10%, 20% and 30% replacement respectively after 28 days of curing by CTM. The roller compacted concrete with 10% replacement can be used in surface coarse. It can be used in pavement base with 20% and 30% replacement. Roller compacted concrete eliminates the pavements joints, no need of providing dowel bars, no construction joints.

RCC is a stiff, zero-slump concrete mix has the same ingredients similar to conventional concrete. It is mixed, placed, and compacted using the same type of equipment that is used for asphalt pavement construction.

Compressive strength increases with increase in cement content. At initial stage the increase in strength is stable but at 28 days strength variation is quite considerable. From the strength behavior of RCC, it can be recommended for paving applications.

The high strength of RCC pavements eliminates common and costly problems traditionally associated with asphalt pavements, In summary and conclusion, the benefit of pavement construction using RCC over asphalt concrete is economical advantage resulting from its less thickness rather than flexible pavement, in addition to its ease of production, construction, and speed of operation.

REFERENCES

[1] Olek, J., P. J. Tikalsky, and R. L. Carrasquillo. 1986. Production of concrete containing fly ash for pavement applications. Research report 364-2 (May). Austin: University of Texas Center for Transportation Research
[2] Soroushian, P. 1990. Durability characteristics of fly ash concrete. In Recent advances in concrete technology seminar, MSU-CTS 4 (February), 6.1-6.18. East Lansing: Michigan State University.
[3] COURARD, L., MICHEL, F. & DELHEZ, P. 2010. Use of concrete road recycled aggregates for roller compacted concrete. Construction and Building Materials, 24, 390-395.
[4] DURAN ATIŞ, C. 2005. Strength properties of high-volume fly ash roller compacted and workable concrete, and influence of curing condition. Cement and Concrete Research, 35, 1112-1121.
[5] Myle Nguyen James, Wonchang Choi and Taher, Abu-Lebdeh presented a paper on use of recycled aggregate and fly ash in concrete pavement.
[6] L.Javier Malvar presented a paper on use of flyash in concrete pavements.
[7] M.C.Natarajan and Lenin das discusses about Concrete mix proportioning as per IS 10262:2009 – Comparison with IS 10262:1982 and ACI 211.1-91
[8] Synthesis of Current and Projected Concrete Highway Technology, David Whiting, et al, SHRP-C-345, Strategic Highway Research Program, National Research Council.
[9] ACI Committee 226. 1987a. Ground granulated blast furnace slag as a cementitious constituent in concrete ACI 226.AR-87. Detroit: American Concrete Institute.
[10] ACI Committee 207.5R-99 " Roller-Compacted Mass Concrete, ", March 29, 1999
[11] Mehta P.K., Monterio P.J.M., Concrete Microstructure Properties and Materials, 3rd ed., McGraw-Hill, 2006
[12] Schrader E.K., "Roller Compacted Concrete for RCC Dams- A General Overview with Comments Pertinent to High vs Low Cementitious Content and the Cine Dam", 2001.

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