International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 10 Issue: 03 | Mar 2023 www.irjet.net p-ISSN: 2395-0072

STRENGTH STUDIES OF RECYCLED AGGREGATE FOR THE APPLICATION IN CONCRETE

FAISAL ALI BHAT [1], ER . SHILPA CHAUHAN [2]

[1]student of M.tech(CTM) at Rayat Bahra University
[2]Asst. Professor,Dept. Of civil Engineering ,Rayat Bahra University punjab ,India

---

Abstract - *Recycled summations correspond of crushed, graded inorganic patches reused from the material that have been used in the constructions and obliteration debris. The target of the present paper work is to determine the strength specific of recycled summations for the operation in concrete pavement construction. The compass of the paper is to determine and compare the compressive strength, flexural strength and sulphate resistance of concrete by using different probabilities of recycled summations. The disquisition was carried out by using plasticity test, compressive strength test, flexural strength test and sulphate resistance test. A aggregate of five composites with relief of coarse summations with 0, 10, 20, 30 and 40 recycled coarse summations were studied. The water cement rate was kept constant at0.38. It was observed that plasticity of concrete was dropped with the increase in recycled summations in concrete. For the strength characteristics, the results showed that the strengths of recycled aggregate concrete was similar to the strengths of natural summations concrete*

Key Words: compressive strength, flexural strength, sulphate Resistance, Concrete

1.INTRODUCTION

This In the period of construction, concrete has been the commanding structure material since it was discovered and set up doable for future due to its durability, easy conservation, wide range of parcels and severity to any shape and size(1- 3). Concrete is the emulsion mix of cement, aggregates, sand and water. Concrete gets hardened like monument by mixing water with cement and aggregates. Concrete has two type ingredients, active and inactive. The active bunch consists of water and cement The inactive part consists of sand and coarse aggregates. Concrete has high compressive strength and low tensile strength(7). To overcome this failing, brand mounts are used along with theconcrete. This type of concrete is called corroborated cement concrete(RCC).(8)

Concrete structures that are aimed to have service lives of at least 50 times have to be Crushed after 20 or 30 times because of deterioration caused by multitudinous agents. Old structures bear conservation for better and advanced economics earnings. The rate of annihilation has increased and there is a deficiency in ditching space and also increase in cost of jilting. Rather than ditching this Crushed concrete, use of Crushed as recycled concrete would not only reduce the cost but also will conserve the non renewable energy sources(9- 11). The use of Crushed concrete will further affect deduction in use of natural aggregates. The operation of natural aggregates is causing damage to natural resources performing in imbalance interrain.Recycled aggregates correspond to crushed, graded inorganic patches attained from the paraphernalia that have been used in constructions(13). Recycled aggregates are generally attained from structures, roads and islets which are Crushed due to completion of life, wars and earthquakes(12).

- **Prospects in India**

Indian Indian economy is of developing nature. So the problem of bedeviled waste is not as huge as in developed countries. But it is not far out when India may have to face this problem(32). In the down megacity areas of the metropolitan cosmopolises concrete halls are replacing the old structures causing generation of bedeviled waste which needs to be transported and dumped.In india only construction industry produces 10-12million tons of waste annually .projections for structure material demand of the covering sector indicate a deficiency of aggregates to the extent of about, 000 million m3(chapter 4, civicindia.nic.in)(18). A fresh 750 million m3 aggregates would be demanded for achieving the targets of the road sector(31). Recycling of aggregate material from construction and annihilation waste may reduce the demand- force gap in both these sectors. thus in a developing country like India, effective use of Crushed concrete could be of great help in reduction of concrete waste and maintaining a pollution free terrain(21- 26)

- **Barriers to Recycled Concrete Aggregate Use**

There There are several walls in use of RCA in concrete. Cost of concrete crushers is truly high which increases the original cost for plant(31). In addition, conservation cost of concrete crushers is also significant. Other barricade is related to quality of RCA. highways bear quality material that meets engineering, profitable and environmental considerations(Turley 2003). still, where high performance concrete is not demanded, RCA can be used and thus, virgin aggregate can be conserved(Meyer

2008)(12). A lot of fine bedeviled concrete aggregate is created during the crushing process. This spare fine aggregatetotal requires disposal or an alternate use. The absorption, strength, and impurities varies with the sources and type of RCA used(32). This means that it's useless or that it might negatively impact the new pavement structure. Durability performance of RCA is not well understood because of the limited and contrary disquisition results(Salem 2003). Concrete that contains RCA has lower compressive strength, flexural strength and sulphate resistance. It's also not known how RCA affects continuity, since utmost studies concentrate only on the parcels of RCA concrete(Olorunsogo 2002)(19). Government agencies also don't show any interest in quality assurance and are also slow to embrace the use of RCA due to enterprises about quality and a disinclination to change what has worked in the history(Turley 2003). The use of material specifications are hedge to the use of RCA in concrete. A performance- grounded or end result specification would allow further RCA use(Turley 2003). still, specific norms on how to use RCA in new concrete aren't presently available(17)(32)(33)

1.1 objectives

The study on use of Crushed concrete in pavement construction consists of conducting laboratory investigations on cement concrete prepared by using Crushed concrete to estimate its suitability for pavement construction[17-22] The main objectives of study are:

- To prepare mix design with recycled aggregates.
- To determine the compressive strength of the samples .
- To determine the flexural strength
- To determine the sulphate resistance strength of samples at the end of 7, 28 and 56 days.
- Slump test was performed on freshly mixed concrete, and compression test was performed on hardened concrete.
- samples of concrete were prepared with RCA and natural aggregate, changing their mixture design parameters, including coarse aggregate proportion

2. LITERATURE REVIEW

A lot of investigations have been done for the use of Crushed concrete and it was found that the use of recycled aggregate is an appropriate solution to the problem of dumping and transportation of Crushed concrete. It was found that the recycled aggregates are valuable building material in environmental, economical and technical aspects. Initially recycled aggregates were used as landfills but nowadays they are also used for constructions for building and roads. Recycled aggregates have been used as concrete kerb and gutter mix in Australia [Shing Chai NGO,2004]. In the project of Lenthall Street in Sydney, 10 mm recycled aggregates and blended recycled sand are used for concrete kerb and gutter mix.

- In road construction recycled aggregates are used as a granular base course. They have proved better than the natural aggregates when used as a granular base course. In case of wet subgrade areas, recycled aggregates stabilise the base and provide an improved working surface for pavement structure construction. Recycled aggregates are used as base, sub base course and sometimes for foundation purposes also[16]. In the USA, the use of recycling technology in a number of full scale pavement rehabilitation projects has been accomplished since 1976 [Kumar, Satish,2002].
- Market development study for recycled aggregates products [Shing Chai NGO, 2004] stated that recycled aggregates can be used in embankment fil[7]l. The embankment site is on the wet subgrade areas, recycled aggregates can stabilize the base and provide an improved working surface for the remaining work. Norwegian Building Research Institute mentioned that RCA can be used as backfill materials in pipe zones.
- In Lowa [Kumar, Satish,2002] recycled concrete was first used in 1976 in pavement was crushed and Crushed concrete was used for the construction of a 1 mile long and 22.5 cm thick highway pavement. In other construction of 17 mile long and 20 cm thick highway pavement, crushed concrete was used in Lowa in 1978. The Minnesota department of transportation recycled 16 mile long plain concrete pavement into a new concrete pavement on trunk highway in 1980[22[. In the Netherlands, recycled aggregates are used for partition walls in apartments. After the damage caused in Second World War, countries like Germany, England, Netherland and other European countries have tried to use recycled concrete in new construction and made a lot of investigations over it[5]. Some countries have developed code of practice for the use of recycled aggregates. In India recycled aggregates are not much used, but its future seems bright and one can predict the remarkable contribution of recycled aggregates.
- The ability to resist compression loads is called Compressive strength. It is found that the use of

RCA in the concrete mix decreases compressive strength compared to natural aggregate. It is also observed that, at 28 days, all mix designs exceeded 50MPa compressive strength Shayan 2003. In one study it is found that the compressive strength of natural concrete was 58.6 MPa, and the RCA concrete ranged from 50.9 to MPa[11]. The compressive strength for 50% RCA concrete was higher than 100% RCA concrete [Poon 2002].

- Tavakoli 1996 .Due to a lower w/c ratio Compressive strength may increase for RCA, 14% and 34% respectively in comparison of natural aggregates. The most of strength loss for RCA concrete can be caused by the presence of material smaller than 2 mm because natural sand has greater strength than RCA fines. It is recommended that RCA fines should not be more than 50% of the sand content . Bonding between the RCA and the cement can be affected by loose particles created during the crushing process[19]. Treating the RCA by impregnation of silica fume resulted in an increase in compressive strength of approximately at 30% at 7-days and 15% at 28-days. If RCA is exposed to ultrasound then it results in a uniform increase of 7% compressive strength over time [7]. Compressive strength of the final concrete is affected by the ageat which RCA has been crushed. For example, crushing concrete into RCA after three days compared to one day resulted in a seven percent increase in compressive strength of the new RCA concrete at 7 days. The difference in compressive strength of the new RCA concrete increased to 13% at the age of 90 days [16]

- Katz 2003. The compressive strength of the original crushed concrete affects the compressive strength of the RCA concrete .However, it is also found that RCA concrete can produce higher compressive strengths than the original concrete.For example, an 80MPa concrete was produced from an original 60MPa concrete . [29]

- In 2006, Poon C.S. et.al studied the environmental effects of using recycled aggregates. Concrete mixes were prepared with varying proportions of recycled aggregates. The proportion of recycled aggregates was kept varying from 0% to 100%. Target strength was kept 35 MPa. The investigations were made on affect of recycled aggregates on slump value and bleeding. From this study it was found that the use of recycled aggregates caused higher rate of bleeding[10]. The slump of concrete mixes or without recycled aggregates was increased due to replacement of cement by 25% fly ash. It reduced bleeding rate and bleeding capacity with only minor negative effects on concrete strength at or before 28 days, but it gave positive effects on strength at age of 90 days.[6]

- In 2008, Tabsh, Sami W. et.al The main objectives of study were the sources of recycled aggregates and the strength of recycled concrete . Test results showed that the losses as 50% for toughness and 12% for soundness test which are within acceptable limits. It was also found that the strength was reduced to 10-25% with the use of recycled aggregates.[23]

- Zaharieva 2004, Katz2003, Salem 2003. The ability to resist tension resulting from bending is called flexural strength. There are doubtful or conflicting results about how RCA use affects flexural strength. In some studies it was found that RCA decreases the flexural strength [and some other studies showed that RCA caused an increase in flexural strength (Poon 2002). One study showed a decrease in flexural strength between 10-20% [25]

DISCUSSION

Methodology of this study has following parts:

- Literature review of the available studies in various journals, conferences etc.
- Investigation of physical and mechanical properties of concrete with RCA and natural aggregate which includes sieve analysis, bulk density of aggregates (coarse+fine), water absorption of aggregates(coarse+fine) and specific gravity of aggregates(coarse+fine), through study
- Mix design of concrete (M40).
- Casting of test samples. (Cube for compressive strength and sulphate resistance, beams for flexural strength).
- Curing of samples in a water tank for a specified time period. (curing in MgSO4 solution for sulfate resistance).
- Samples testing for compressive strength, flexural strength and sulfate resistance at specified time periods.

Material Properties

The physical and mechanical properties of all ingredients like sand, natural coarse aggregates, cement and Crushed coarse aggregates are per IS: 2386-1963 were determined.

- Cement

OPC (Ordinary Portland Cement) of grade 43 was used which conformed to IS: 8112-1989. Testing of cement was done as per IS: 4031 The physical properties of cement are given ,Physical Properties of Cement of Grade 43 [23]

- Coarse Aggregates from Crushed Concrete

In the study, the coarse aggregates were obtained by breaking the waste concrete by using a 5 kg hammer to get aggregates of 20mm and below. The obtained material was then sieved and recombined to get the required grading[11]. These aggregates were sieved to get aggregates size between 4.75mm to 20mm. Coarse aggregate of sizes 20mm-10mm and 10mm-4.75mm were separated by sieving. This was done because different size aggregates fill each other to increase the strength. The particle shape of RCA was crushed and surface texture obtained was porous and rough as shown in Figure 4.1. This was due to the presence of attached mortar material to the old coarse aggregates. The water absorption of Crushed coarse aggregates was more than the natural coarse aggregates due to presence of mortar on RCA[18]. The specific gravity of Crushed coarse aggregates was also observed to be lower than that of natural aggregates.

- Water

Properties of water used were as per IS 456. It was free from deleterious materials. Water was used for mixing and curing concrete[23]. Portable water is generally taken for mixing and curing of concrete.

- Properties of Fresh concrete (Workability)

There are a lot of styles for measuring plasticity of concrete. Each system measures only a specified aspect of it and there's really no system which measures the plasticity of concrete in its summation. So, it's assumed that none of the styles are wholly satisfactory[30] But by checking the uniformity of the plasticity it was easier to ensure an invariant quality of concrete and hence invariant strength for a particular job.

RECOMMENDATIONS

Some revision can be made for RCA to come extensively used material for construction of concrete pavements. harmonious and predictable results need to be attained when using RCA as a relief for natural total in concrete. To achieve this farther disquisition is needed in the areas of parcels of summations, blend design and proportioning, performance, testing, and modelling perform petrographic analysis on the RCA samples to more probe their composition, quality and how important injurious material that can be included without affecting the performance of the concrete.

- In the present study, the RCA is taken from a single source. The results of RCA from different sources will be different. So it's needed to compare concrete composites with different sources of RCA including sources of RCA that are clean, polluted, and cured else.

- In the present study, only five type of composites are used with proportion of RCA up to 40. This chance of RCA can be increased. Compare concrete composites with a variety of coarse RCA content to find the optimal quantum that can be added without affecting performance.

- In the present study, only coarse total is used as replaced material. New study should be done that develop fresh designs that incorporate fine recycled total and concrete marshland- water to achieve a zero waste concrete.

3. CONCLUSIONS

The exploration on operation of RCA in construction of pavement is veritably important because material waste is gradationally adding with the increase in civic development and increase in population. Recycled summations are fluently available while natural summations need mining and their cost is much advanced than the cost of natural summations. Recycled summations are cheaper than the virgin summations, so builders can fluently go these for construction purpose if their strength is equal or similar to natural .aggregates.

- This study examines the parcels of RCA when used with natural coarse summations. A lot of studies have been carried out on use of RCA concrete in construction. But in case of trace construction some further disquisition is needed. The main ideal of the study was to probe whether RCA can be used as material summations for concrete pavement construction. Compressive strength, flexural strength and sulfate resistance of RCA concrete is examined, where it was observed that mixing ofRCA cause increased water immersion. Concrete blend of M40 was designed as per parcels of summations. The results of this study showed that RCA concrete gave similar strength to conventional concrete. This indicated that RCA concrete can be feasible source for construction of pavements. From the results, it's also set up that plasticity of concrete is dropped due to advanced water immersion. Whenever recycled total is applied, water content is covered precisely in concrete blend as water immersion is increased due to presence of pervious material.

- The compressive strength of all composites exceeded at the age of 28 days. Compressive strength of control blend i.e. of m0 is50.05 MPa which is lesser than the target strength of 48.25 for M40 concrete. Compressive strength of m1 is slightly increased to 50.36. So the compressive strength increases by0.5. For m2, compressive strength is increased to 50.20 MPa, it also showed an increase in compressive strength by0.3. Compressive strength of m3 is dropped to 49.11 MPa that showed a drop in compressive strength by1.9. But in case of m4, there's unforeseen increase in compressive strength that raises the compressive strength to52.36 MPa. Compressive strength is increased by4.5. So the results of test show that compressive strength doesn't follow a regular trend from m0 to m4. But from the results it's also concluded that compressive strength noway went below the target strength for 28 days. This indicates that RCA can be used as relief summations for compressive strength.

- Flexural strength also followed the same pattern as of compressive strength. Flexural strength of control blend is5.32 MPa at age of 28 days. Flexural strength of blend m1 increased to5.60 MPa. It shows that the increase in flexural strength is 5 for m1. For m2 flexural strength at age of 28 days is5.40 MPa, which shows an increase in flexural strength by1.5. Flexural strength of blend m3 is5.38 and the flexural strength increased by 1. For the blend m4, flexural strength is5.40 MPa. It shows that the flexural strength increased by1.5 at the age of 28 days. From the results and discussion of the results it's set up that the flexural strength of RCA concrete is similar to the natural total concrete which is a positive point. So the RCA concrete can be used for flexural strength by adjustingW/ C rate.

- Use of 5 of MgSO4 results caused the reduction in compressive strength. Effect of sulphate result increased when volume of Crushed concrete total increased. So an increase in sulphate caused a reduction in the compressive strength of concrete.

- It was set up that the RCA concrete have fairly lower bulk viscosity, specific graveness and high water immersion as compared to natural concrete. This was due to the presence of mortar in present on recycled coarse summations

- In this study, trial castings were done to arrive at water content and asked plasticity. So it was judicious to carry out trial castings with Crushed concrete total proposed to be used in order to arrive at the water content and its proportion to match the plasticity situations and strengths conditions independently.

From this study it was observed that the persecuted concrete was feasible source for construction of concrete pavements. provident and environmental pressures justify felicity of RCA concrete as indispensable to the natural concrete. Where there's non-availability of natural total from new jewels RCA can be a good or feasible relief option for

REFERENCES

[1] Ajdukiewicz, A., and Kliszczewica, A. (2002). “Influence of Recycled Aggregates on Mechanical Properties of HS/HPS,” Cement and Concrete Composites, V. 24, No. 2, 2002, pp. 269-279.

[2] Bairagi, N. K., Vidyadhara, H. S., and Ravande, K. (1990). “Mix Design Procedure for Recycled Aggregate Concrete,” Construction and BuildingMaterials, V. 4, No. 4, December 1990, pp. 188-193.

[3] Buyle-Bodin, F., “Influence of industrially produced recycled aggregates on flow of properties of concrete.” Materials and structures/ Mate’riaux et. Construction, Vol. no. 35, September-October 2002,pp 504-509.

[4] Chen, H.J., Yen, T., and Chen, K.H. (2003). “Use of Building Rubbles as Recycled Aggregate,”Cement and Concrete Research, V.33, No.1, pp. 125-132.

[5] FHWA. (2004). “Transportation Applications Of Recycled Concrete Aggregate: FHWA State of the Practice National Review September 2004,” U.S. Department of Transportation, Federal Highways Administration, Washington, DC.

[6] GTAA. (2007). “Reducing, Reusing and Recycling Terminal 2,” Toronto Pearson Today: Terminal 2, Terminal 2 Commemorative Issue, Greater Toronto Airports Authority, Toronto, ON.

[7] Hansen, T.C., and Hedegard, S.E. (1984). “Properties of Recycled Aggregate Concretes as Affected by Admixtures in Original Concretes,” ACI Journal, January-February 1984, pp. 21-26.

[8] Harrington, J. (2004). “States Achieve Recycling Success,” Roads and Bridges, V.42, No.7.

[9] Hendricks, Ch. F., “Use of Recycled materials in constructions”, Materials and structures/ Mate’riaux et. Construction, Vol. no. 36, November 2003,pp 604-608.

[10] IS: 456-2000, “Indian Standard Code of practice for plain and reinforced concrete”, (second revision), Bureau of Indian Standard, New Delhi.

[11] IS: 383-1963, "Indian Standard Specifications for Coarse and Fine Aggregate from Natural Sources for Concrete", Bureau of Indian Standard, New Delhi.

[12] IS: 516-1959, "Methods of Tests for Strength of Concrete", Bureau of Indian Standard, New Delhi.

[13] IS: 10262-1982, "Recommended Guidelines for Concrete Mix design", Bureau of Indian Standard, New Delhi.

[14] IS: 2386(Part-1)-1963, "Methods of Test for Aggregate for Concrete (Part-1 Particle Size and Shape)", Bureau of Indian Standard, New Delhi.

[15] IS: 8112-1989, "Specification for 43 Grade Ordinary Portland Cement", Bureau of Indian Standard, New Delhi.

[16] IS: 4031-1968, "Indian Standard Definitions And Terminology Relating To Hydraulic Cement", Bureau of Indian Standard, New Delhi.

[17] Katz, A. (2003). "Properties of Concrete Made with Recycled Aggregate from Partially Hydrated Old Concrete," Cement and Concrete Research, V. 343 No. 5, pp. 703-711.

[18] Katz A. (2004). "Treatments for the Improvement of Recycled Aggregate," Journal of Materials in Civil Engineering, V. 16 No. 6, November/December 2004 pp. 597- 603.

[19] Kumar, Satish(2002), " Design of concrete mix using aggregate from Crushed Concrete", M.Tech Thesis.

[20] Lin, Y.H., Tyan, Y.Y., Chang, T.P., and Chang, C.Y. (2004). "An Assessment of Optimal Mixture for Concrete Made With Recycled Concrete Aggregates," Cement and Concrete Research, V. 34, No. 8, pp. 1373-1380.

[22] Mehta, P.K. (2001). "Reducing the Environmental Impact of Concrete," Concrete International, V. 23, No.10, October 2001, pp. 61-66.

[23] Meyer, C. (2008). "The Greening of the Concrete Industry," 2nd Canadian Conference on Effective Design of Structures, paper #97, McMaster University, Hamilton, ON, 2008.

[24] Naik, T.R., and Moriconi, G. (2005). "Environmental-Friendly Durable Concrete Made with Recycled Materials for Sustainable Concrete Construction," International Symposium on Sustainable Development of Cement, Concrete and Concrete Structures, Toronto, Ontario, October 5-7, pp. 277-298.

[25] Oikonomou, N.D. (2005). "Recycled Concrete Aggregates," Cement andConcrete Composites, V. 25, No. 2, pp. 315-318