Influence of Fly Ash on Mechanical Properties of Rubberized Concrete (M20 Grade)

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Abstract- -
Concrete was a wide range of building materials, as concrete was intended as a constructin material. R esearchers have tried to improve its quality and enhance its performance. The present investigation is aimed to study the effect of partial replacement of cement with fly ash in rubberized concrete. The percentage of rubber used in this study was 5 percentages replaced with coarse aggregate and fly ash varies from 0-20 percentage were replaced with cement in conventional concrete. Size of rubber strips used is about 10 mm. the mix design was targeted for M20 grade of concrete. The mix proportion of concrete was 1:1.5:3 with water cement ratio of 0.45. The fresh, hardened properties of rubber concrete are produced at two different exchange ratios of flight pegs co mpared to conventional concrete that does not have rubber or flight ash.
Test results show that the strength, which replaces 5% with rubber content compared to traditional con crete, slightly reduced strength. However, increasing the increase in flight ash from 10% to 20% impro ved the mechanical properties of rubber concrete. This study examines the effect of rubber particles on some properties of concrete.
Key Words: Fly ash, rubber, coarse aggregate, fine aggregate, cement, concrete

Introduction- Concrete is one of the main components in any concrete masonry construction. It is a homogeneous mixture of cement, fine aggregate, coarse aggregate and water mixed in definite proportions. Grade of a concrete is defined as the average compressive strength of 150mm cube at the age of 28 days. Different grades of concrete are M20, M25, M30 etc., As per IS 456-2000 Apart from these main components, a mixture in which beehives are used is used. It is a different mate rial than water, aggregates and cement used as a component in concrete or mortar. before or during mixing. Mineral admixtures like puzzolanic compounds, natural materials like volcanic ash and by product compounds like fly ash can be used. In our study waste or worn out rubber is used as replacement to the coarse aggregate to about 5% instead of disposing it out as waste material. fly ash to be replaced is about 20% of cement (by trial and error method). studies are made on both fresh as well as hardened properties of rubberized concrete and compared with normal concrete.

Need for replacement-

- Growth of cement usage leads to the greater production of CO_2 gas which is one of the major causes for **GLOBAL WARMING**.
- Excavation of sand and stones from river banks is one of the main cause for disasters caused due to **FLOODS.**
- To minimize the negative effects on environment due to increasing amount of waste rubber tyres**.**
- To achieve a better solution for tire rubber waste management.
- To explore the chance of adding reused rubber into the concrete to improve shrinkage properties and resistance to cracking of concrete.

Objectives of thesis

In this thesis work,

- To develop engineering database on the mechanical properties and to determine the necessary level of fluidity,
- generally termed as workability of fly ash and rubber concrete incorporating CLASS F fly ash, rubber, Ordinary Portland Cement and it is compared with normal concrete.
- To determine nominal mix of M20 grade of concrete is targeted to select optimum percentage of cement replacement by fly ash as cementitious material and rubber as coarse aggregate for obtaining maximum possible 28 days' compressive strength.

LITERATURE REVIEW

Dr. G. Portchejian has investigated on in this experiment tests on compressive strength and split tensile strength. So they founded that compressive strength decreases with the replacement of crumb rubber increased & 5%replacement of crumb rubber proves exceptionally well in compressive strength & tensile strength. It also gives more strength at 28th days for 5%. Thus by replacing fine aggregate by crumb rubber safeguard the environment.

Hossam E. M. Sallam (2008) In the present paper, an experimental work was carried out to study the effect of ground waste tire rubber addition on the mechanical properties and impact resistance of normal strength concrete (NSC) with and without silica fume. Three different volume ratios of crumb rubber (10%, 20%, and 30%) were used as a partial replacement of sand. Two different sizes of cylinders were tested under indirect tension test to study the size effect. Impact compression according to ACI Committee 544's repeated drop-weight impact test was carried out on discs of 150 mm diameter and 63 mm height.

Pacheco-Torgal et al. (2012) provide an overview in Construction and Building Materials on the properties and durability of concrete incorporating polymeric wastes like tire rubber and polyethylene terephthalate (PET) bottles, exploring their potential for sustainable construction.

Muhammad Mubaraki (2013) The effect of specimen thickness and crack length on the variations of mode I and mode II stress intensity factors (SIFs) have been analyzed by using three dimensional finite element analysis (3D FEA). Center cracked circular disc specimen (CCCD) was used in this investigation. Eight values of specimen thickness to specimen radius ratio were studied numerically, varied from 0.1 to 0.8. The present experimental research has been conducted to study the effect of replacing 10% of fine aggregate by volume with crumb rubber on crack initiation angle, crack path and fracture toughness for different mode of mixity.

Abdelaziz Meddah (2014) Recycling of waste rubber tires in pavements is considered as ecological and economical solutions due to their advantages. It may help preserving natural resources and producing an eco-friendly material. Roller compacted concrete used in pavements (RCCP) has the same basic ingredients as in ordinary concrete. But unlike the conventional concrete, it is an enough drier mix-stiff to be compacted by vibratory rollers. This study aims to experimentally investigate the possibility of using shredded rubber tire in RCCP.

J. Retama (2017) The influence of crumb-rubber on the mechanical properties of Portland cement concrete (PCC) is studied by experimental tests and numerical simulations. The main hypothesis of the study is that replacing part of the stone aggregate with crumb-rubber in the mix modifies the energy dissipation during the cracking process and affects the concrete behaviour under monotonically increasing loads. The experimental research program characterizes the mechanical properties of PCC for three different types of concrete with a variable content of crumb-rubber.

Navneet kour (2020) Crumb rubber concrete has been used to decrease pollution due to its storing in large areas.it can be used as chips, as fine or coarse aggregates or as sand. By Using it cracking and widening of concrete can be decreased. Replacing rubber particles with fine aggregates will effect shrinkage of rubber concrete in a positive way. The process of distributing different materials with rubber is quite hard and complicate.

Jianxin He (2021) Asphalt mixture is a type of textured composite material made of aggregates and mastic part. Overall strength and failure behavior in such materials depends on the texture or heterogeneity of the mixture. In particular, the crack growth mechanism from the tip of the pre-crack is significantly affected by the texture of the asphalt composite and environmental conditions. The crack can extend through the soft mastic, tight aggregates or interface of the mastic/aggregates. In this research, by performing some fracture tests on a typical asphalt mixture with different test specimens under mode I, mixed mode I/II and mixed mode I/III, the fracture resistance and trajectory of propagating crack is studied at two low and medium temperatures (i.e., −15 and +15 °C).

Ali Kheirbek (2022) a huge volume of waste is generated by natural and human-made disasters and by rapid urbanization that leads to the demolition of structures reaching the end of their service life. Using recycled aggregates in concrete producing reduces environmental pollution by decreasing the disposal of this waste material in landfills and preserving unreasonable exploitation of natural resources. This manuscript presents the results of an experimental program aiming to study the effect of recycled aggregates on the physical and the mechanical properties of roller compacted concrete (RCC).

Shiren Osman Ahmed has investigated (2023) on The utilization of recycled rubber tires as a partial substitution of the natural aggregate in concrete is the solution for safe disposal of it. Since that rubber affects the mechanical characteristics of concrete negatively due to the rubber and cement mortar low cohesion, it was necessary to improve these properties by adding pozzolanic additives such as fly ash. The objective of this paper is to study the effect of treated crumb rubber and fly ash on the performance of concrete.

MATERIALS

Cement – The broadly and most generally utilized cement in all types of construction works is Ordinary Portland Cement (OPC). The OPC 53 Grade cement conforming to IS: 12269-1987 was utilized for all concrete mixes.

Whereas the water is included in the Portland cement, chemical reactions happen between the cement and water and thus coming about within the energy release and the cement paste event which is mindful for making hardened substance.

Fig.no. cement

This process of response happens between cement and water is named as the hydration process and the help of the energy during this process is named as the heat of hydration. For the research work, the Ordinary Portland Cement of 53-grade use.

Fly Ash- Fly ashes from thermal power plants were used in the experiments of the present study. A brief review of literature about the physical and chemical properties; mineralogy and morphology behavior of fly ashes is presented. Literatures regarding concrete applications of fly ashes have been used in construction are also discussed. Fly ash is produced from burning of pulverized coal in thermal power plants. The pulverized coal is fed into the boilers and burnt with the supply of additional air. The temperature in the boiler exceeds 1600^{o}C and the most of the mineral matter present in the coal are fused and altered physically and chemically.

Fig no. fly ash

Waste Tyre Rubber- Bike tyre is trimmed into pieces of about 10 mm size by means of wood cutter and by using knifes. This rubber would be used to replace for about 5% with course aggregate. Two waste bike tyres from nearby puncher shop has been collected for the project.

Fig no. waste Tyre rubber

Coarse aggregates - coarse aggregates are made up of rock quarried from ground deposits. They are an integral part of many construction applications. Coarse aggregates can retain on IS 20mm sieve. They are used under a slab or pavement. Aggregates contribute 70 to 75% of weight within concrete.

Fig no. coarse aggregate

It is the prime ingredient within the concrete. When it blended with cement and water it gets to be glued and therefore the entire strong mix is bound during a strong mass which called concrete. Coarse aggregates are larger size filler materials in construction. As the name indicates, they are classified depending on the sizes of aggregate particles. The surface area of the coarse aggregate is less than fine aggregates. Coarse aggregates are utilized in concrete, railroad track ballast, etc.

Fine aggregates- fine aggregates can retain on 4.75 mm sieve. This is sparkling yellow, greyish, and adjusted. The expense of Construction Sand is nil because of its ordinary accessibility yet its transportation cost is more. Handling of these aggregates is simple by ordinary machines without utilizing and Blast materials or any Crushing machines.

Fig.no. fine aggregate

These are essential for strength, thermal and elastic properties of concrete. This is liberated from any Organic Materials or any radiation or solid stones. It is used for inlaying, mortar, and solid, street clearing, Plastering, filling under Foundations, fortified prepared blend solid, Building Blocks, and

assembling brick work blocks.

Water- water is an essential part of the construction process**.** 15 to 20% water is added to the mix to get the desirable properties out of the concrete. We use water which can easily available to the site. At the point when water is blended in with concrete it shapes a paste that ties all materials together. The part of water inside the mix is most basic due to the water-cement ratio (w/c extent). In this study w/c proportion is 0.40 taken out.

EXPERIMENTAL PROGRAM

Mix Proportion and Identification

A concrete mix of M20 nominal mix is used. The mix proportion of 1:1.5:3 is taken for this experiment. Three concrete mixtures were made by replacing cement with 0%, 10% and 20% of fly ash and Water cement ratio is 0.45. Mix-1 identified as CR0F0 Indicate 0% 0f rubber chips and 0% fly ash, Mix-2 identified as CR5F10 Indicate 5% of rubber chips and 10% fly ash, Mix-3 identified as CR5F20 indicate 10% of rubber chips and 20% fly ash. The details of mix proportion and identification are given in Table 3. The details of mix quantity per m^3 of concrete are given in Table 4.

Table 3 Details of concrete mix proportion along with identification

Concrete Mix Proportion	Mix Identity
Concrete mix with 100% NCA + 100% cement + 0% Rubber chips + 0% fly ash	CR0F0
Concrete mix with 95% NCA + 90% cement + 5% Rubber chips + 10% fly ash	CR5F10
Concrete mix with 95% NCA + 80% cement + 5% Rubber chips + 20% fly ash	CR5F10

Note:NCA=normalcoarseaggregate

TEST PROGRAMMER

The workability of fresh concrete mix is measured by slump cone test and the strength properties of hardened concrete are measured by compressive strength were test The concrete cubes of size 150 x 150 x 150 mm were tested for compressive strength after 7 days and 28 days

$f_{ck}=P/B^2$

Where f_{ck} is compressive strength in Mpa ,

P is maximum applied load in Newton,

B is size of cube specimen in mm.

Slump Cone Test

The slump cone test is a workability test of which workability of designed concrete is tested and the work for which it can be used can be known by the slump value.

Standard values

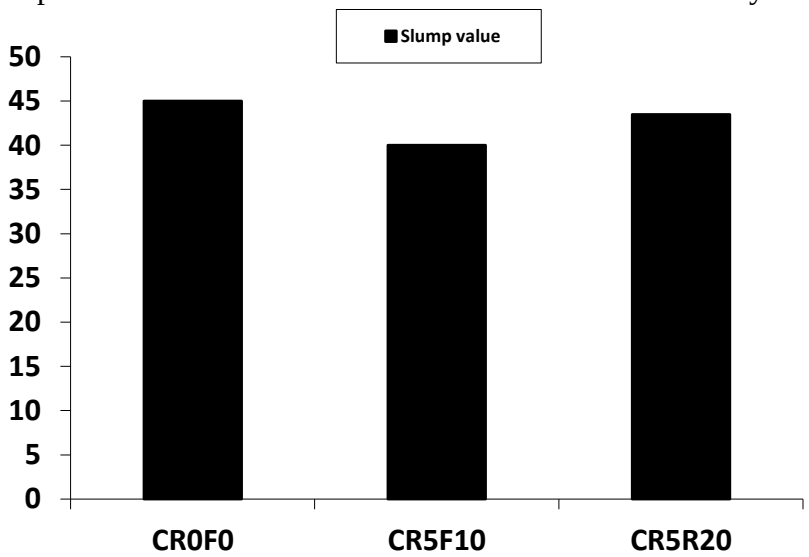
S.no	Name of work	Slump(mm)
1	Concrete for roads and mass Concrete	25 to 50
2	Concrete for R.C.C. beams and Slabs	50 to 100
3	Columns and retaining walls	75 to 125
4	Mass concrete in foundation	25 to 50

RESULTS

Fresh Concrete Test Results

The workability of fresh concrete is determined by slump cone test. The slump values for different concrete mix are shown in fig 4. From figure it is observed that, in (CR0F0) the slump is 45 mm and in 5% rubber and 10% fly ash replacement (CR5F10) the slump value is 40 mm this indicate low workability. When fly ash replacement increases to 20% the slump increases by 2mm i.e. 47mm as compare with CR5F10 and CR0F0. It is concluded that fly ash improves the workability of concrete.

Fig.4 Slump value for 5 % rubberized concrete with influence of fly ash



Mix Identity

CONCLUSIONS

- Workability of concrete increases as fly as increases from 10-20%
- As fly ash replacement percentage increase in 5% rubberized concrete, the compressive strength increases at all age.
- The replacement of 20% fly ash gives more compressive strength in 5%rubberized concrete than normal concrete without any replacement of rubber and Fly ash.
- The use of rubber will always help you find more climate construction work.

REFERENCES

[1] Sallam, H. E. M., Sherbini, A. S., Seleem, M. H., and Balaha, M. M., "Impact resistance of rubberized concrete", Engineering Research Journal Faculty of Engineering Minoufiya University. Vol. 31, No. 3, pp. 265-271, 2008.

[2] A. Ylmaz and N.Degirmenci, (2009), **"**Possibility of using waste tyre rubber and fly ash with Portland cement as construction materials**"**, Waste management, Vol. 29 (5), pp. 1541-1546.

[3] T.Uygunoglu and I.B.Topcu,(2010), "The role of scrap rubber particles on drying shrinkage and mechanical properties of self-consolidating mortars", construction and building materials,vol.24,pp.1141-1150**.**

[4] Pacheco-Torgal F., Ding Y., and Jalali S., "Properties and durability of concrete containing polymeric wastes (tyre rubber and polyethylene terephthalate bottles): An overview", Construction and Building Materials. Vol. 30, pp. 714-724. 2012.

[5] Mubaraki, M., Abd-Elhady, A.A., and Sallam, H.E.M., "Mixed mode fracture toughness of recycled tire rubber-filled concrete for airfield rigid pavements", International Journal of Pavement

Research and Technology. Vol. 6, No. 1, pp. 8- 14. 2013.

[6] Meddah, A., "Characterization of roller compacted concrete containing rubber-tire wastes". Thesis, National Polytechnic School of Algiers, pp.134, 2015.

[7] Retama, J., and Ayala, A.G., "Influence of crumb-rubber in the mechanical response of modified Portland cement concrete", Advances in Civil Engineering. pp. 1-9. 2017.

[8] Sofi, A., "Effect of waste tire rubber on mechanical and durability properties of concrete – A review", Ain Shams Engineering Journal. Vol. 9, pp. 2691–2700, 2018.

[9] AlJaberi, F.Y.," A study on the significance of the crumb rubber classification on the ductility test for rubberized asphalt binder". SN Applied Sciences. 1-1472. 2019.

[10] Abd-Elaal, E., Araby, Sh., Mills, J.E., Youssf, O., Roychand, R., Ma, X., Zhuge, Y., and Gravina, R.J., "Novel approach to improve crumb rubber concrete strength using thermal treatment", Construction and Building Materials. Vol. 229, pp. 1-11. 2019.

[11] Merwad, A.M., Elsisi, A.A., Mustafa, S.A.A., and Sallam, H.E., "Transverse impact on hollow and concrete filled steel tubular members: an overview", The Egyptian International Journal of Engineering Sciences and Technology. Vol. 32, pp. 49-58, 2020.

[12] Al-Khuzaie, M.G., Al-Humeidawi, B.H., and Al-Saidi, R.F., "Assessment of the mechanical properties of concrete pavement containing crumb rubber tires", Materials Science and Engineering. Vol. 737, pp. 1-13, 2020.

[13] Assaggaf, R.A., Ali, M.I., Al-Dulaijan, S.U., and Maslehuddin, M, "Properties of concrete with untreated and treated crumb rubber – A review. Journal of materials research and technology". Vol. 11, pp. 1753-1798. 2021.

[14] Toma, I.O., Stratulat, S.M.A., Mihai, B., Toma, A., and Taranu, G., "Experimental investigations on the long-term material properties of rubberized Portland cement concrete", Applied science. Vol. 11, pp. 1-17. 2021.

[15] Zhao, Z.F., Zhang, X.Z., Li, L.F., and Yang, Y., "Experimental study of working performance and mechanical properties to rubber with limestone powder concrete", Earth and Environmental Science. Vol. 783, pp.1-6, 2021.

[16] Assaggaf, R.A., Ali, M.R., Al-Dulaijan, S.U., and Maslehuddin, M., "Properties of concrete with untreated and treated crumb rubber - A review", Journal of Material Research and Technology. Vol. 11, pp. 1 7 5 3 -1 7 9 8, 2021.

[17] Awan, H.H., Javed, M.F., Yousaf, A., Aslam, F., Alabduljabbar, H., and Mosavi, A., "Experimental evaluation of untreated and pretreated crumb rubber used in concrete", Crystals. Vol. 11, No. 558, pp. 1-14. 2021.

[18] Yun Feng, L., Jiu Chen, A., and Dong Liu, H., "Effect of waste tire rubber particles on concrete

abrasion resistance under high- speed water flow", International Journal of Concrete Structures and Materials. pp. 15-37, 2021.

[19] Ren, F., Mo, J., Wang, Q., and Ming Ho, J. Ch., "Crumb rubber as a partial replacement for fine aggregate in concrete: An overview", Constructure and Building Materials, Vol. 343, No. 128049. 2022.

[19] Assaggaf, R.A., Maslehuddin, M., Al-Dulaijan, S.U., Al-Osta, M.A., Ali, M.R., and Shameem, M., "Cost-effective treatment of crumb rubber to improve the properties of crumb-rubber concrete", Case Studies in Construction Materials. Vol. 16, pp. 1-16, 2022.

[20] Merwad, A.M., El-Sisi, A.A., Mustafa, S.A.A., and Sallam, H.E., "Lateral impact response of rubberized-fibrous concrete-filled steel tubular columns: experiment and numerical study", Buildings. Vol. 12, pp. 1-19, 2022.

[21] Rahim, N.I., Mohammed, B.S., Abdulkadir, I., and Dahim, M., "Effect of crumb rubber, fly ash, and nano-silica on the properties of self-compacting concrete using response surface methodology", Materials. Vol. 15, pp. 1-22. 2022.

[22] ISO 1920 Concrete Tests-Dimensions, Tolerances, and Applicability of Test Specimens.

[23] ISO 4013 Determination of Flexural Strength of Test Specimens.

[24] BS-1881 Testing Concrete, Part 117 Method of Determination of Tensile Splitting Strength.

[25] ASTM Standard Test Method C143: Slump of Hydraulic Cement Concrete

[26] ISO 4012 Concrete-Determination of Compressive Strength of Test Specimens.

[27] ASTM C642. Standard Test Method for Density, Absorption, and Voids in Hardened Concrete. Philadelphia (PA): ASTM; 2001.

[28] BS 1881. Part 114 Methods for Determination of Density of Hardened Concrete.

[29]Manjula Bai K1, Jayasree J2 "An Experimental Investigation on Partial Replacements of Fine Aggregate with Crumb Rubber and Cement with Fly Ash" International Journal of Research Publication and Reviews. Vol 4, no 4, pp 5104-5109 April 2023.