Sustainability, Agri, Food and Environmental Research, (ISSN: 0719-3726), vol 12(2), 2024
http://dx.doi.org/10.7770/safer-V12N2-art749

Performance analysis of fiber reinforced concrete by partial replacement of coarse aggregate with waste ceramic tiles.

Análisis de comportamiento del hormigón fibroreforzado mediante sustitución parcial de árido grueso por baldosas cerámicas de desecho.

Kaushik V. Pai Fondekar[1], Shwetha Prasanna[2], Samrudhi Mandurkar[3], Viraj Shirodkar[4], Shashank Naik[5], Sarvesh Parwar[6], Anant Naik[7], Shubham Madkaikar[8]

[1]Assistant Professor, [2]Associate Professor [3, 4, 5,6,7,8] Students

Department of Civil Engineering, Don Bosco College of Engineering, Fatorda, Goa, India.

ABSTRACT

A large quantity of ceramic materials changes into wastage during processing, transporting and fixing due to its brittle nature. Therefore, using these wastes in concrete production could be an effective measure in maintaining the environment and improving the properties of concrete. The increasing demand of construction material and degradation of environment, there is need to explore alternative construction material from industrial as well as household waste and recyclable materials. In this project control concrete is cast for M25 grade and the partial replacement of waste ceramic tiles 0f 10%, 20%, 30% by weight of coarse aggregate. Glass fiber-reinforced concrete consists of high-strength glass fiber embedded in a cementitious matrix. The inclusion of fiber reinforcement in concrete, mortar and cement paste can enhance many of the engineering properties of the basic materials, such as fracture toughness, flexural strength. An experimental investigation of compressive strength will be undertaken by partial replacement of coarse aggregate by waste ceramic tiles and glass fiber.

Keywords: Glass Fibers, Waste Ceramic Tiles, Compressive Strength

RESUMEN

Una gran cantidad de materiales cerámicos se convierten en residuos durante su procesamiento, transporte y fijación debido a su naturaleza quebradiza. Por tanto, utilizar estos residuos en la producción de hormigón podría ser una medida eficaz para mantener el medio ambiente y mejorar las propiedades del hormigón. Debido a la creciente demanda de materiales de construcción y la degradación del medio ambiente, es necesario explorar materiales de construcción alternativos a partir de residuos industriales y domésticos y materiales reciclables. En este proyecto se hormigonado de control grado M25 y reposición parcial de residuos de baldosas cerámicas de 10%, 20%, 30% en peso de agregado grueso. El hormigón armado con fibra de vidrio consiste en fibra de vidrio de alta resistencia incrustada en una matriz cementosa. La inclusión de refuerzo de fibra en el hormigón, el mortero y la pasta de cemento puede mejorar muchas de las propiedades técnicas de los materiales básicos, como la tenacidad a la fractura y la resistencia a la flexión. Se llevará a cabo una investigación experimental de la

resistencia a la compresión mediante la sustitución parcial del árido grueso por baldosas cerámicas de desecho y fibra de vidrio.

Palabras clave: Fibras de Vidrio, Residuos de Baldosas Cerámicas, Resistencia a la Compresión

INTRODUCTION

Concrete is the most versatile construction material because it is designed to withstand the harsh environments, with adequate strength and durability. Due to over usage of the concrete materials it become scared, and also the production at larger rate create many hazardous to the environment. On the other side the waste exposed to our environment is an impact to ecology cycle, among all industrial waste is the major source of waste, which will affect the environment. To overcome the issues these industrial waste can be recycled and reused for any useful purpose with acceptance levels. Ceramic broken tiles, slurry waste etc., which is disposed to landfill create pollution at larger rate. In India, ceramic production is 100 million ton per year and about 15-30% of ceramic waste is generating from the total production. Nearly 30% of waste is generated during the manufacturing, transportation and usage of ceramic products. Concrete is one of the major construction material being used worldwide. Reuse the solid waste from construction again as a material in the concrete to decrease the land fill of solid waste and decrease the scarcity of natural aggregates like gravel and sand. In particular, Construction and Demolition (C&D) wastes contribute the highest percentage of wastes worldwide about 75%. Furthermore, ceramic materials contribute the highest percentage of wastes within the C&D wastes about 54%. The crushed waste ceramic as coarse aggregate had a number of improvements like good workability, low cost and eco- friendly when compared to usual conventional concrete, including better compressive strength.

Glass fiber is a recent introduction in making fiber concrete. Glass fiber reinforced concrete (GFRC) consists of high strength glass fiber embedded in cementitious matrix. Fiber reinforced concrete is concrete containing fibrous material which enhances its structural integrity. So we can define fiber reinforced concrete as a composite material of cement concrete or mortar and discontinuous discrete and uniformly dispersed fiber. The cost of deposition of ceramic waste in landfill will be saved and, on the other, raw materials and natural resources will be replaced, thus saving energy and protecting the environment. Hence concrete is very well suitable for a wide range of applications.

Fiber reinforced concrete is a composite material which consists of fibrous material which increases its structural integrity. Fibers are used in concrete to control cracking due to plastic shrinkage and to drying shrinkage. They reduce the permeability of concrete and hence reduce the bleeding of water. Fiber reinforced concrete is useful where high tensile strength and reduced cracking is desirable. It improves the impact strength of concrete, limits the crack growth and leads to greater strain capacity of the composite material. Adding fibers to the concrete will increase resistance to plastic shrinkage during curing. The addition of fibers also increase fatigue strength.

Bikash Subedi, Dhurba Kumar Wagle[1], this paper emphasizes on “Utilization of Crushed Ceramic Tile Wastes as Partial Replacement of Coarse Aggregate in Concrete Production”. An accurate investigations concerning the behaviour of crushed tile as coarse aggregate in concrete mixes. Gradation (sieve analysis) of 20 mm down waste ceramic tile aggregate was obtained within a permissible value as per IS 383, when tiles were crushed with manual hammering method.20 mm down tile crushed aggregate had better flakiness and elongation index than natural crushed aggregate. Ceramic tile aggregate had lower specific gravity, higher water absorption ratio than that of natural aggregate. There was no significant difference obtained on impact value of tile and natural aggregate. Up to 30% replacement of natural aggregate by tile aggregate showed better 7 and 28 days compressive strength than that of 0% tile aggregate. With addition of tile aggregate, split tensile strength was increased.

Ugonna M. C., Adewale A. K.[2] this paper engages in “Partial Replacement of Coarse Aggregate with Broken Ceramic Tiles in Concrete Production”. The replacement of 40% or less crushed granite with broken ceramic tiles showed positive response in reinforced concrete production. A similar trend in the variation of properties such as workability, unit weight and strength of concrete was observed with an increase in the percentage replacement of crushed granite with broken ceramic tiles. There was a potential reduction in the cost of concrete production by replacing crushed granite with broken ceramic tiles’.

M. Sekar[3], this paper talks about “Partial Replacement of Coarse Aggregate by Waste Ceramic Tile in Concrete”. The main focus of this research is to study the strength of concrete with ceramic waste as coarse aggregate. In this study an attempt has been made to find the suitability of ceramic coarse aggregate as a possible substitute for conventional aggregate in concrete.

Parminder Singh, Dr.Rakesh Kumar Singla[4], talks about the “Utilisation of waste ceramic tiles as coarse aggregate in concrete” which observed the mechanical properties of ceramic aggregate are similar to the natural aggregate and its behaviour is similar but not same and water absorption, crushing value and impact value, are higher than natural coarse aggregate and lower by specific gravity.

Tavakolia, A. Heidari and M. Karimianb[5], presents experimental study that deal with the investigation of possibility of using waste ceramic tile in concrete .Using ceramic wastage in concrete production causes no remarkable negative effect in the properties of concrete. The optimal case of using tile wastage as sand are amounts of 25 to 50 percent, besides, the best case of their use as coarse aggregate are as amounts of 10 to 20 percent.

Yogesh Iyer Murthy, Apoorv Sharda, Gourav Jain[6], talks about “Performance of Glass Fiber Reinforced Concrete” which observed the compressive strength, flexural strength and workability of concrete containing varying proportions of glass fiber as replacement of fine aggregates.

MATERIAL AND METHODS

Portland Pozzolana Cement (PPC) of Ultratech cement brand was used in the preparation of concrete mixes used in the experimental investigation. The cement used was fresh and free from any lumps. Course

aggregates of 20 mm and 12 mm obtained from a local quarry are used in this experimental investigation. The aggregates were mixed in the ratio of 50:50 (percentagewise).Natural sand obtained from local sources was used in this experimental work. Aggregate which passes through 4.75mm IS sieve and retained on 75micron IS sieve is known as fine aggregate. The use of waste ceramic tiles in concrete effects the properties of fresh and hardened concrete, and makes it economical and also solves some of the disposal problems. It is a lightweight material, reinforcement corrosion free and structural deterioration free. Glass fibers are relatively inexpensive and have high flexural strength. Water used for mixing and curing of concrete during the course of the project was clean potable water free from all the impurities like oil, grease, salts.The procedure of research involved carrying out a detailed Literature Review. Coarse aggregateand fine aggregate required for this experimental research work were collected. Floor tiles and wall tiles from tile supplier and site dump were collected and then it was crushed by manual hammering method to make it coarse aggregate. Cement used for the test is Ultratech Portland Pozzolana Cement. Preliminary test were carried to obtain required results. Using the results obtained after carrying out preliminary test mix design was efficiently carried out. Based on the Mix Design, trials were performed. The fresh concrete mixes were tested for workability, slump, and compacting factor. Cubes of size (150mm x 150mm x 150mm) were casted and tested after 7&28 days to determine the compressive strength of the cubes.

RESULTS AND DISCUSSION

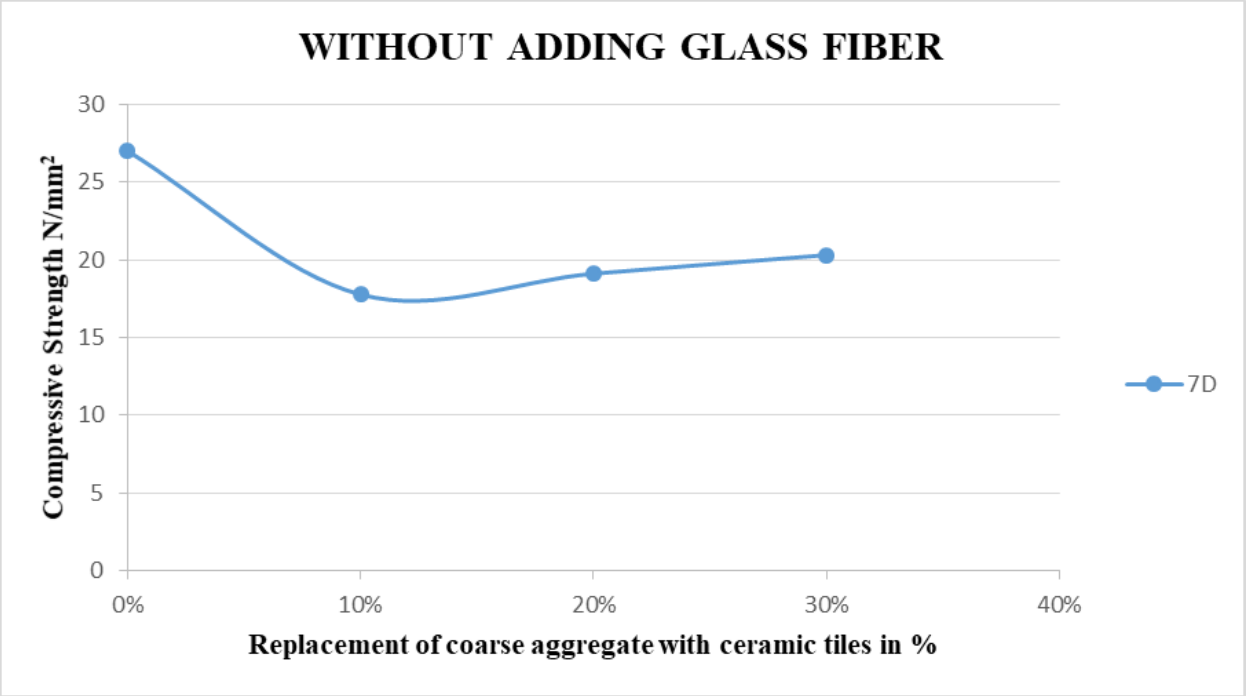

Figure 1: Compressive strength without adding glass fiber (7Days)

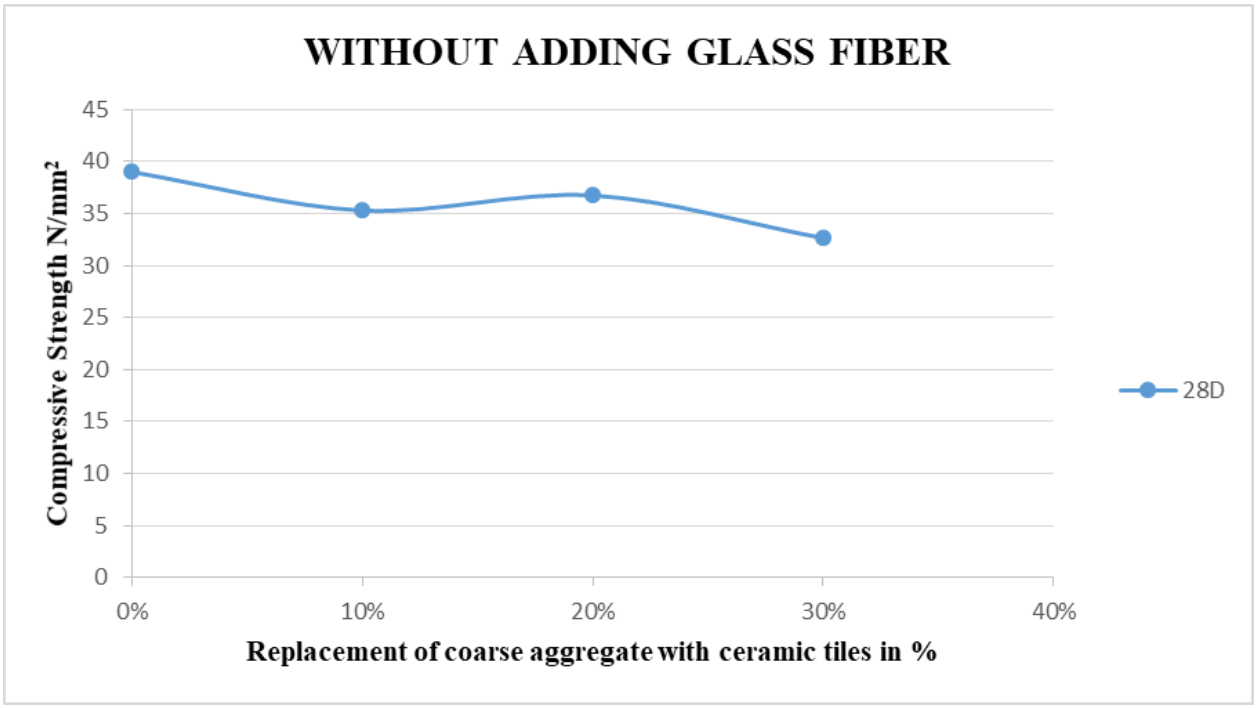

Figure 2: Compressive strength without adding glass fiber (28 Days)

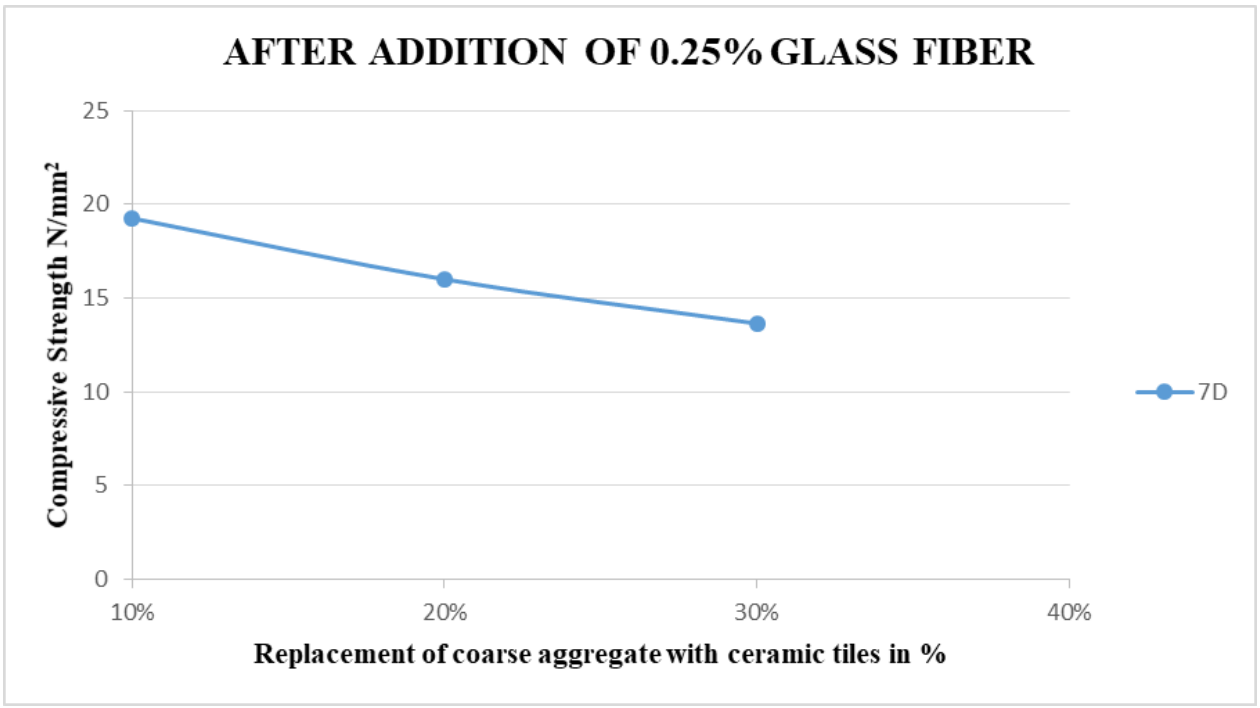

Figure 3: Compressive strength with addition of 0.25% glass fiber (7 Days)

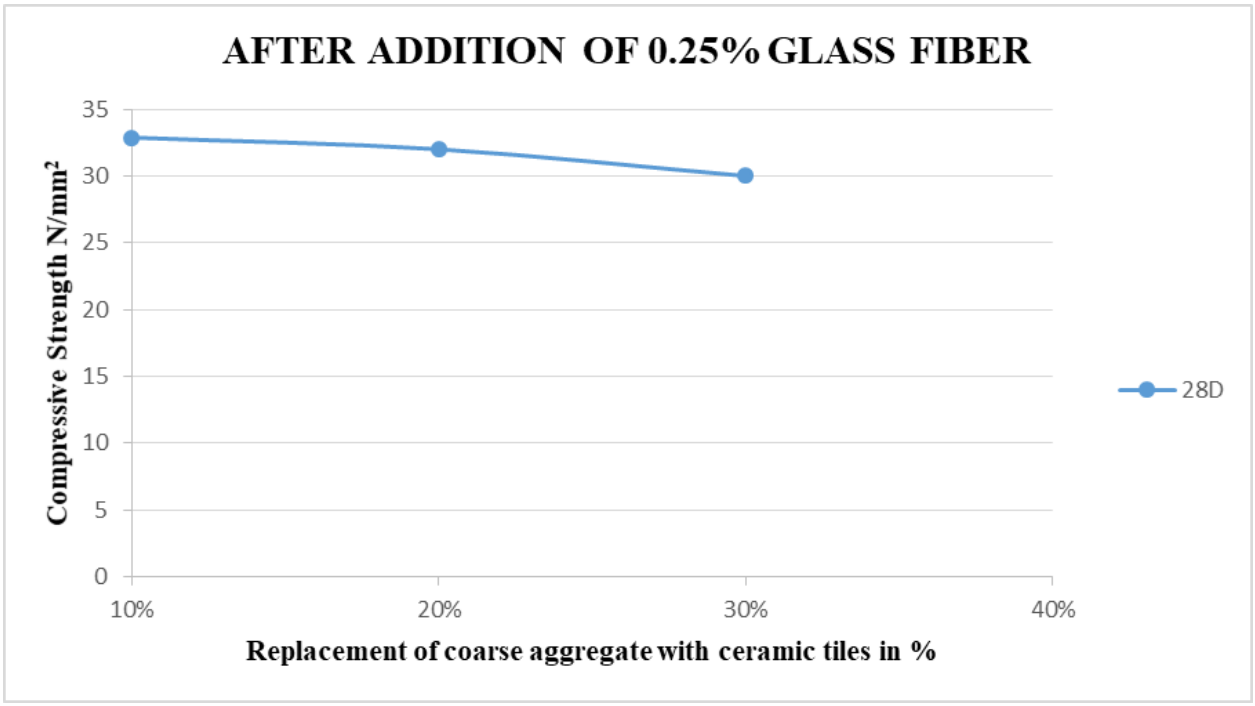

Figure 4: Compressive strength with addition of 0.25% glass fiber (28 Days)

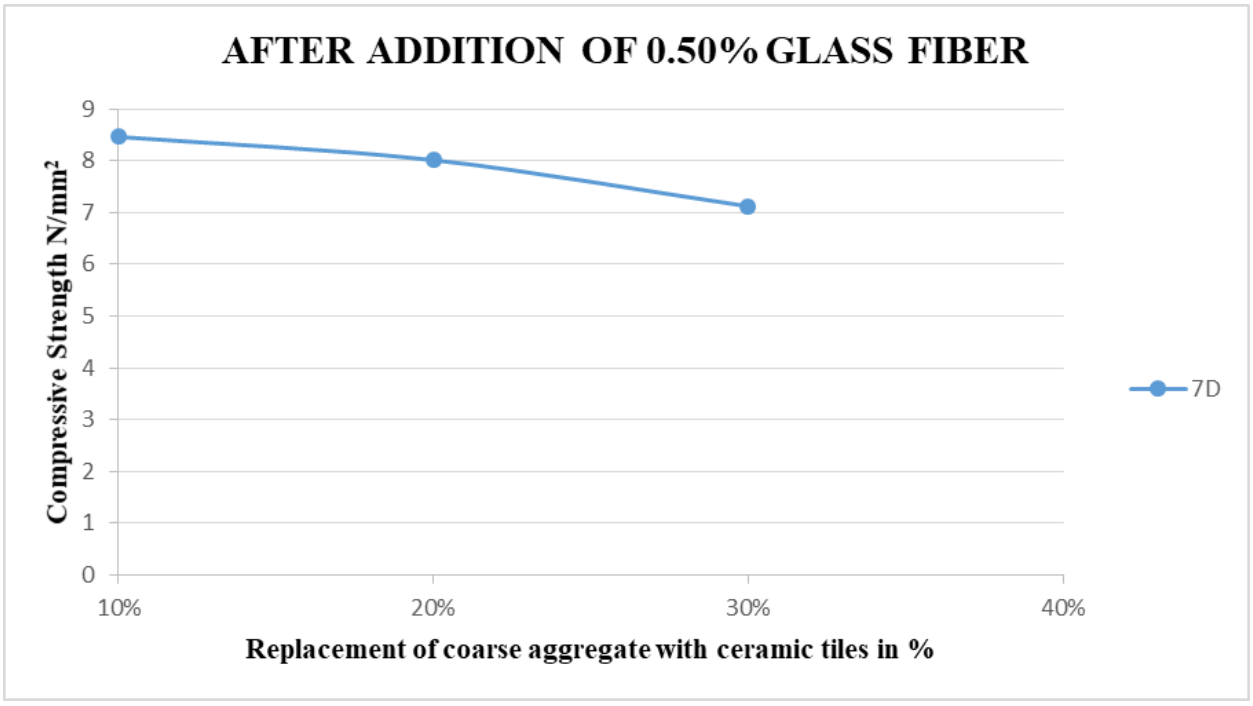

Figure 5: Compressive strength with addition of 0.50% glass fiber (7 Days).

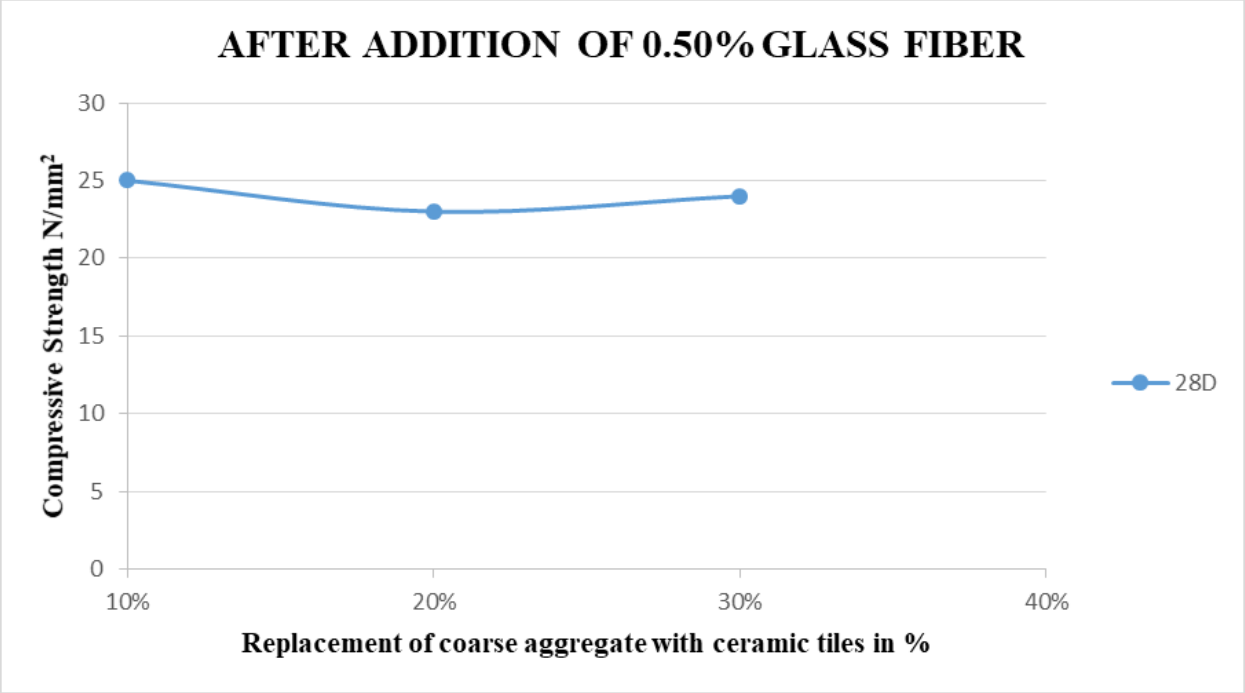

Figure 6: Compressive strength with addition of 0.50% glass fiber (28 Days)

It was found that 20% replacement of coarse aggregates with ceramic tiles produced best result. With addition of 0.25% glass fiber, with replacement of coarse aggregate with waste ceramic tiles minute decrease in compressive strength was observed. With addition of 0.50% glass fiber with replacement of coarse aggregate with ceramic tiles major decrease in compressive strength was observed. Best performing batch of 20% replacement of coarse aggregate with ceramic tiles was found to be economical as it was 5.3% cheaper than the conventional concrete batch.

Compressive strength of conventional concrete cube at 28 Days was found out to be 39N/mm².Compressive strength of conventional concrete cube at 7 Days was found out to be 27N/mm². Maximum compressive strength was obtained at 20% replacement of coarse aggregates with ceramic tiles in 28 Days, but it was less than the compressive strength of conventional concrete cube at 28 Days. Maximum compressive strength was obtained at 30% replacement of coarse aggregates with ceramic tiles in 7 Days, but it was less than the compressive strength of conventional concrete cube at 7 Days. Maximum compressive strength was obtained at 10% replacement of coarse aggregates with ceramic tiles in 28 Days with addition of 0.25% glass fiber, but it was less than the compressive strength of conventional concrete cube at 28 Days. Maximum compressive strength was obtained at 10% replacement of coarse aggregates with ceramic tiles in 7 Days with addition of 0.25% glass fiber, but it was less than the compressive strength of conventional concrete cube at 7 Days. Maximum compressive strength was obtained at 10% replacement of coarse aggregates with ceramic tiles in 28 Days with addition of 0.50% glass fiber, but it was less than the compressive strength of conventional concrete cube at 28 Days.

Maximum compressive strength was obtained at 10% replacement of coarse aggregates with ceramic tiles in 7 Days with addition of 0.50% glass fiber, but it was less than the compressive strength of conventional concrete cube at 7 Days.

REFERENCES

[1] Bikash Subedi, Dhurba Kumar Wagle (2020), "Utilization of Crushed Ceramic Tile Wastes as Partial Replacement of Coarse Aggregate in Concrete Production", International Journal of Engineering Research & Technology, Volume 9, Issue VII, ISSN (Online): 2278-0181, DOI: 10.17577/IJERTV9IS070674.

[2] Ugonna M. C., Adewale A. K. (2018), "Partial Replacement of Coarse Aggregate with Broken Ceramic Tiles in Concrete Production", International Journal of Scientific & Engineering Research, Volume 9, Issue 8, ISSN: 2229-5518.

[3] M. Sekar (2017), "Partial Replacement of Coarse Aggregate by Waste Ceramic Tile in Concrete", International Journal for Research in Applied Science & Engineering Technology, Volume 5, Issue III, ISSN: 2321-9653, pp. 472-479.

[4] Parminder Singh, Dr. Rakesh Kumar Singla (2015). "Utilisation of waste ceramic tiles as coarse aggregate in concrete", Journal of Multidisciplinary Engineering Science and Technology, ISSN: 3159-0040 Volume 2, Issue 11, pp. 3294-3300.

[5] D. Tavakolia, A. Heidari and M. Karimianb (2013), "Properties of concretes produced with waste ceramic tile aggregates", Asian Journal of Civil Engineering, ISSN: 1563-0854

[6] Yogesh Iyer Murthy, Apoorv Sharda, Gourav Jain (2012), "Performance of Glass Fiber Reinforced Concrete", International Journal of Engineering and Innovative Technology (IJEIT) Volume 1, Issue 6, ISSN: 2277-3754, pp. 246-248

[7] IS 10262-2019 [7], "Concrete mix proportioning- guidelines".

[8] IS 383-2016 [8], "Coarse and fine aggregate for concrete – specification".

[9] IS 456-2000 [9]," Plain and reinforced concrete – code of practice ".

Received: 31th August 2023; Accepted: 06th January 2024; Distribution: 10th February 2024.