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Effect of different types of mixed water on stress strain behavior of RC beams with Glass Fiber bars

Magdy M.M. Genedy[1], Samy Akil Fawzy[2], Shaimaa Hamed[3], Nehal M. Ayash[4]

[1]Associated professor, Civil Engineering Department, Faculty of Engineering at Mataria, Helwan University, Cairo 11718, Egypt

[2]Head of Civil Department, Cairo Institute of Engineering, Computer Science and Management

[3]M.SC. student, Civil Engineering Department, Faculty of Engineering at Mataria, Helwan University, Cairo 11718, Egypt

[4]Assistant professor, Civil Engineering Department, Faculty of Engineering at Mataria, Helwan University, Cairo 11718, Egypt

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Abstract: **This paper presents the effect of different types of mixed water on stress strain behavior of reinforced concrete beams with Glass Fiber bars; three flexural reinforced concrete beams were tested. They were divided into three groups where the fresh water, sea water and mixed water are used in concrete mixing and curing. From decades ago they found that the concrete with steel is an ideal material for construction especially that they have the same values of thermal expansion coefficient and bond. But there have been some disadvantages for steel reinforcement such as corrosion which cause fall the concrete cover, which cost a lot at the maintenance. Different kinds of fibers have been discovered Glass, Carbon, Armid, and Basalt. Although the advantages of fibers reinforcement polymer has been recognized as, light weight, high tensile strength, excellent corrosion resistance. In order to improve the elastic modules to enhance the crack width and deflection through mixing different types of fiber material, Such as carbon and glass there for stress-strain characterized can be changed this method is effective but costly.**

Keywords: **Salt Water; Mixed Water; Glass Fiber Reinforced Polymer; concrete Beams.**

I. INTRODUCTION

In the world of construction, concrete has an important role as the main primary material commonly used. This is due to the advantages of the concrete itself, including production simplicity, high compressive strength and economic value in its manufacture and repair. Today’s concrete is constructed using Portland cement, coarse and fine aggregates of stone and sand and water. Admixtures are chemical materials applied to the concrete mix to regulate its setting properties and are mainly used during weather extremes when putting concrete, such as high or low temperatures, windy conditions and other usage, etc. It is difficult to find out alternative materials for construction which are suitable as that of such material from economic and toughness, Water plays an important role as in preparation of concrete. Water is the main component of concrete as it is actively participated in the chemical reactions with cement. Today’s building industry uses lot amount of drinking water. Investigation on saving fresh water is seriously needed. Around 80 percent of the surface of the earth are covered by oceans; therefore, a large number of structures are exposed to sea water with high salinity either directly, or indirectly when winds brings sea water spray up to a few miles inland from the coast. As a result, several coastal and offshore sea structures are exposed to the continuous action of physical and chemical deterioration processes.

Specifications of the mixing water used for mixing in concrete:

The water used to mix concrete must be clean and free from harmful substances such as oils, acids, sugars, salts and other organic materials that may have a destructive effect on the components of concrete or reinforcing steel. Drinking water, with the exception of bacteriological requirements, is suitable in all cases for mixing concrete. In the event that mixing water is used from a source other than drinking water sources, a sample of it with a volume of at least 5 liters must be taken and sent in a bottle that is completely applied to a certified testing laboratory for analysis and determination of the contents of each of - inorganic impurities, Chlorides, sulfates, alkaline carbonates, degree of pollution in industrial wastes and hydrogen (PH).

Sea water may be used when necessary to mix regular concrete without reinforcing, provided that the cement content in the mixture increases to reach the required resistance of normal concrete, Water that is suitable for mixing reinforced concrete is suitable for use in treating this concrete with which sea water is used after it has hardened.

II. PREVIOUS RESEARCH

Concrete, after freshwater, is the second-most consumed material on earth. Fresh water will be very difficult to obtain and a scarce threasure, The World Meteorological Organization predicts that over half of the world's population will have insufficient drinking water by 2025. Also, the United Nations and World Meteorological Organization are predicting that 5 billion people will be lacking of even drinking water. In order to wash aggregates and produce concrete, the building industry requires several billion tons of freshwater annually. Thus, replacing, where possible, the use of freshwater with saltwater for concrete production is an important step towards redefining sustainability in concrete. Concrete is one of the major building materials use in modern day construction such as construction of buildings, foundations, dams, highways, parking structure, pipes, towers, and others. It is a composite construction material composed of cement and other cementitious materials such as fly ash and slag cement, aggregate (generally a coarse aggregate made of gravels or crushed rocks such as limestone, or granite, plus a fine aggregate such as sand), water, and chemical admixtures [1].

A. The effect of sea water on concrete mixture

In accordance with the advancement of technology Construction and construction of concrete structures have also experienced very rapid growth. Construction of structures in difficult regional areas and the marine environment has been done a lot. Construction of concrete buildings in extreme Environmental areas, such as coastal areas, can result in a reduction in strength and even damage if maintenance and repairs are not carried out. This is due to the existence of chloride in coastal waters. Cement, mortar and concrete are the most commonly used building material all over the world. It is difficult to find out alternative material for construction which is as suitable as that of such material from durability and economic point of view. Extended use of concrete has increased the interest of scientists/researchers in using it in aggressive environments such as the marine environment. A well designed concrete structure can survive up to its design life without any significant repair / maintenance work in adverse surrounding environment. Good quality concrete offers outstanding protection against corrosion in the built-in steel reinforcement. Chemical protection is provided by the high alkalinity of the concrete and by the physical protection of the structure, which serves as a barrier to the access of aggressive species [2].

A variety of studies have shown the effects of seawater mixing and curing on the compressive strength of cement–sand mortars and corresponding concrete. Research suggested that seawater is not ideal for mixing and curing both plain and reinforced concrete under marine conditions [1].However, concrete made with seawater can have a higher early strength than standard concrete, and a decrease in strength with age may be compensated by a reduction in the water-cement ratio and by microstructural examination of concrete detected chloroaluminate salts in some cracks [3].

H. AL-Baijat[4] described that Associate Normal concrete is typically mixed and cured with fresh water in order to protect the concrete from alkali attacks, which can lead to expansion and corrosion and, eventually, to the loss of durability of the concrete. Compressive strength, absorption, corrosion of steel, bond stress and flexural stress were investigated in fresh and salt (Dead Sea) waters. Salt durability, compressive strength, flexural stress and bond stress substantially decreased after exposure of concrete to Dead Sea salt water.

F. Adeyemi et.al [5] suggested that concrete casting and seawater treatment should gradually increase for all curing days beyond the strength of the control casting (FF). The compressive strength of the concrete batches FF (fresh fresh) is consistent with the compressive strength of 1:2:4 mix at 28 days, approximately 20N/mm2. The strength of the concrete batches cast with salt water and cured with fresh water SF (salt fresh) has also been observed to increase at 28 days and 90 days respectively.

B. FRP

During the last twenty years, many studies have been carried out on FRP materials. It was found that these non-corroding composite materials can be applied in concrete construction effectively as alternative to steel reinforcement in three different forms namely externally bonded FRP sheets or plates for repair or strengthening of reinforced concrete structure, main reinforcement in the form of FRP bars, and FRP pre-stressing tendons in pre-stressed concrete structures [6].

Advantages and Disadvantages of FRP

FRPs possess some advantages and disadvantages. Their advantages include high resistance to corrosion, high strength-to-weight ratios (10–15 times greater than steel), excellent fatigue characteristics (about 3 times that of steel), electromagnetic neutrality and ease as well as speed of application leading to reduce construction costs[7] and their resistance to salt water is excellent. The resistance of FRPs to corrosion makes it particularly attractive for use in civil engineering applications, especially in reinforced concrete structures. On the other hand, the disadvantages include high material cost, low ductility with low strain at brittle failure, low shear strength due to poor mechanical properties of the matrix, rapid and severe loss of bond, strength and stiffness at elevated temperatures.

Application and use of FRP

FRP products are commonly used in aeronautical and other industries, but challenging problems their durability and long-term properties, such as fatigue quality and creep, have reduced their usage in civil engineering applications. However, structural FRP composites have recently made a transition from the aerospace and automotive industries to the construction industry. Applications include FRP reinforcement for concrete, external FRP sheets and panels for the strengthening and retrofitting of existing structures, large plate enclosures for steel bridges, and even structural components made entirely of FRP.

Many older buildings do not meet the requirements of modern seismic design codes and need to be retrofitted. FRP goods provide possible economic alternatives to carry out these projects. For example, bridges can be reinforced with internal or external FRP post-tension tendons. As an alternative to the bonding of steel plates, CFRP epoxy sheets may be used for the reconstruction of either concrete or steel structures by bonding single or multiple layers of such laminates. FRP fabrics and braided fiber stripes can also be used for the 'tvrapping' of building beams and columns, as well as for parking structures in seismic regions, thereby significantly enhancing their ductility and strength .FRP materials are available in several of configurations, such as reinforcement bars, pre-stressed tendons, two-and three-dimensional grids and loose fibers known as microfibers. In particular, designers are interested in FRP reinforcement for concrete structures because they provide a corrosion-resistant alternative to steel reinforcement.

The use of FRP in concrete for anti-corrosion purposes is supposed to find applications in structures in or near marine environments, in or near the ground, in chemical and other industrial plants, in areas where good quality concrete cannot be achieved and in thin structural elements. Most initial applications of FRP reinforcement in concrete were built in Japan, where many demonstration projects were developed in the early 91's, like floating marine structures, pontoon bridges, non-magnetic structures such as tracks for linear motors, Ribbon bridge decks [8].

III. EXPERIMENTAL WORK

Three reinforced concrete beams of 25 MPa concrete compressive strength. All the beams have a rectangular cross-section of 150 mm width and 300 mm height and were tested under one-point loading in bending test over a simple span of 1500 mm as shown in figure (1). All the tested beams were reinforced with main reinforcement was two GFRP bars of 12 mm diameter, the beam in **N1** were mixed and cured with sea water, beam **N2** were mixed and cured with fresh water, also beam in **N3** were mixed and cured with (fresh water + sea water) 50%. The strain gauges are placed in the lower glass fiber bar of 12 mm diameter as shown in figure (2).

Figure (1): Testing setup.

Figure (2): Position of reinforcement strain gauges.

IV. EXPERIMENTAL RESULTS

The load strain relation in the main longitudinal reinforcement glass FRP bars was measured at mid span for different beams tested under static load condition. The measured strain values were plotted against the applied load from zero loading up to failure as shown in Figure (3).

It is obvious that, the highest failure load is observed in case on beam mixed and cured with sea water and the lowest failure load is observed in case on beam mixed and cured with mixed water. The strain in GFRP reinforced bars are reach the maximum value in case on beam mixed and cured with fresh water and the minimum value in case on beam mixed and cured with mixed water.

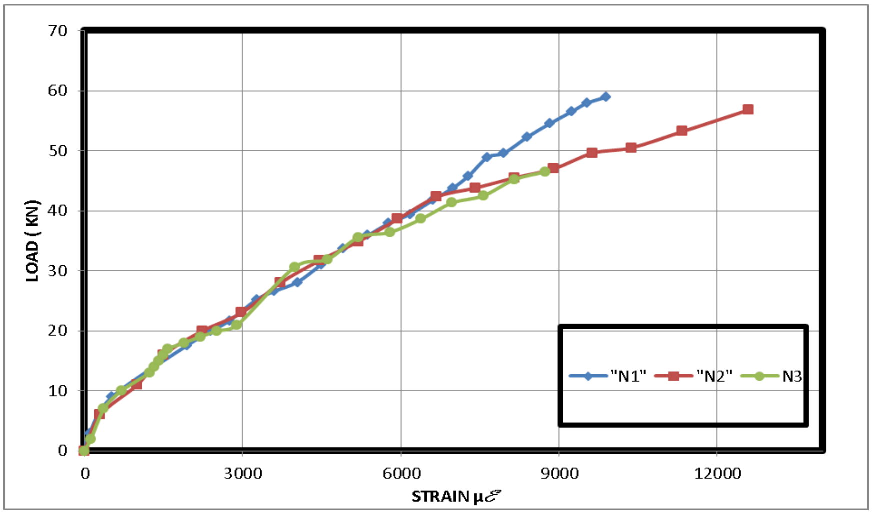

Figure (3): Strain in GFRP (Ø12 mm bars) in N1, N2 and N3

V. CONCLUSION

Based on the results of the experiments carried out on the beams reinforced longitudinally with GFRP and mixed and treated with sea water, fresh water and mixed water (fresh water + sea water), the main conclusions can be drawn as:

1) There is higher in the strength of concrete specimen cast & cured with salt water and mixed water as compared to those of cast & cured in fresh water through testing.

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