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A REVIEW ON EXPERIMENTAL ANALYSIS OF FLEXURAL BEHAVIOUR OF RC BEAMS BY USING HIGH STRENGTH STEEL

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Abstract – *This review paper is related to the study of RCC beam by using high strength steel TMT bars. Reinforced cement concrete is a general material which is widely used for various types of constructions and structural elements. The quality of steel has an important role in deciding the quality of concrete and also high grade steel in building construction, would help in decreasing the quantity of steel. In this paper objective of work and their methodology is suggested. The outcomes may lead to change a practice of material as reinforcement other than steel in RCC beam.*

***Key Words*: TMT bars, High Strength Steel, Fe 600, Earthquake Resistance, and Mix Design.**

1. INTRODUCTION

Concrete is very strong in compression but comparatively weak in tension. Steel is very strong in tension and provides tensile strength to concrete. The properties of thermal expansion for both steel and concrete are approximately the same; this along with excellent flexural property makes steel the best material for reinforcement in concrete structure. Another reason steel works effectively as reinforcement is that it bonds well with concrete. For decades, methods of design and analysis for concrete members reinforced with normal strength steel have been developed. Recently, reinforcing steel with strength higher than conventional steel has become commercially available. The introduction of high strength reinforcing steel can be useful to reduce the quantity of reinforcement required, thereby lessening reinforcement congestion and improving constructability. Steel is the time proven match for reinforced concrete structures. Reinforced concrete structure is designed on the principle that steel and concrete act together to withstand induced forces. Concrete is established to be a universal building material because of its high compressive strength and it's adoptability to take any form and shape. The low tensile strength of concrete is offset by the use of steel reinforcement the resulting combination of the two being known as reinforced concrete, although the steel reinforcement provides the cracked concrete beam with flexural strength. It does not prevent cracking and loss of stiffness due to cracking, since in order to satisfy serviceability requirements, the increased strain capacity offered by high strength steel. .

Reinforce cement concrete is a general material which is widely used for various types of constructions and structural elements. For the efficient use of RCC it is necessary to know the properties and the behavior of RCC elements under various constrains. To estimate and analyse the basic properties and behavior of RCC an experimental study is needed. In the present study an experiment in which flexural behavior of RCC under various constrains was the major criteria. For the experimental analysis simply supported beams of under reinforced sections are considered. When the beam is simply supported and is subjected to some external loading the corresponding deflections are examined such that the flexural behavior of the RCC beams of under reinforces sections analyses. When in an RCC beam, if the steel tends to fail before the stress in concrete reaches the maximum permissible stress such beams are known as under reinforced sections. In order to study the flexural behavior of any material one had need some basic constant conditions as their limitations. In the present study stress-strain behavior of Concrete and steel are taken as a base and the flexural behavior of the material in various fibers. Many methods were adopted to increase the strength and flexural behavior of the structure. Flexural strength provides two useful parameters, namely: "the first crack strength, which is primarily controlled by the matrix", and "the ultimate flexural strength or modulus of rupture, which is determined by the maximum load that can be attained." Flexural properties of structural materials are generally important to design engineers to guide appropriate selection of materials. This work gives the review of work done by various researchers who investigated the flexural capacity of steel and concrete beams. The review revealed the advantages of construction & the most effective utilization of steel and concrete. They also have improved fire and corrosion resistance.

Thermo mechanically treated (TMT) bars were introduced in India during 1980- 1985. Thermo mechanical treatment is an advanced heat treatment process in which hot bars coming out of last rolling mill stand are rapidly quenched through a series of water jets. Rapid quenching provides intensive cooling of surface resulting in the bars having hardened surface with hot core. The bars are then allowed to cool in ambient conditions. During the course of such slow cooling, the heat released from core tempers the hardened surface while core is turned in to ferrite-pearlite aggregate composition. TMT process thus changes the structure of material to a composite structure of ductile ferrite pearlite composition with tough surface rim of

tempered marten site providing an optimum combination of high strength, ductility, flexural and other desirable properties. TMT bars of grade Fe415, Fe500 and Fe550 are now available in India. Fe600 can be used in building bridges, marine facilities and many others to create leaner structures with lesser steel congestion improving construction quality and saving cost.

2. RELEVANCE

The rapid development of economic construction, people are increasingly looking for more and more new materials for building construction. This is an essential part of human life. Reinforced concrete is widely used in modern engineering structures as a kind of excellent traditional building material. This is because first of all, the steel bar is protected by concrete and has the characteristics of durability and fire resistance. Secondly, its integrity is better. Fe 550 and Fe 600 are not introduced in design engineering codes till now, coupled with the above mentioned factors, very less private client/contractor projects and none of public government projects are able to propose for using these higher grades of reinforcement in their technical specification. It is likely that in near future Fe550 or Fe600 or even higher grades might come up and find place in construction industry, with the huge infrastructure development/construction happening in India. It is very useful to reduction of steel consumption. TMT steel means Thermo Mechanically Treated steel. TMT reinforcement steel is used in reinforced concrete construction to provide better strength in tension, bending and shear as well as in compression. TMT manufacturing process is expected to improve properties such as yield strength, ductility and toughness of TMT bars. With above properties, TMT steel is highly economical and safe for use. TMT steel bars are more corrosion resistant than Tor steel. TMT bars are earthquake resistant.

3. LITERATURE REVIEW

Prabir C. Basu, Shylamoni P, Roshan A.D (2004): Steel is the time proven match for reinforcing concrete structures. Reinforced concrete structure is designed on the principle that steel and concrete act together to withstand induced forces. The properties of thermal expansion for both steel and concrete are approximately the same; this along with excellent flexural property makes steel the best material as reinforcement in concrete structures. Another reason steel works effectively as reinforcement is that it bonds well with concrete. When passive reinforcement (steel bars) is employed, the structure is known as reinforced concrete (RC) structure. Passive steel reinforcing bars, also known as rebars, should necessarily be strong in tension and, at the same time, be ductile enough to be shaped or bent. Now-a-days, alloy steels are also being introduced as reinforcing steel. Three grades of rebar are presently available in India for structural use. The rebars are graded according to their specified yield strength. These are Fe415, Fe500 and Fe550. CTD rebars of grade more than Fe415 are scarcely available in market. However, TMT rebars of Fe500 grade are easily available in the market.

Robert F. Mast, Mina Dawood, Sami H. Rizkalla, Paul Zia (2008): this paper present a methodology for the flexural strength design of concrete beams reinforced with high-strength reinforcing steel that conforms to the requirements of ASTM A1035-07. The design method is based on simple analysis techniques that satisfy fundamental principles of equilibrium and compatibility. Strain limits for tension-controlled sections and compression-controlled sections are proposed that are consistent with the approach of the current and past ACI 318 Codes. The proposed method is compared with experimental results previously reported by others. The stress-strain characteristics of the reinforcement are quite different from conventional Grade 60 (400 MPa) steel reinforcement. The new steel is considerably stronger than conventional reinforcing steel and lacks a well-defined yield point. There are several practical advantages to using this new high strength material, including reduction of congestion in heavily reinforced members, improved concrete placement, savings in the cost of labor, reduction of construction time and, in some cases, enhanced resistance to corrosion. The flexural behavior of concrete beams reinforced with high-strength reinforcing bars has been investigated experimentally by a number of researchers. The available research indicates that, when properly designed, beams reinforced with high-strength reinforcing bars will achieve similar strength characteristics to beams reinforced with conventional steel reinforcements.

Saifullah, M. Nasir-uz-zaman, S.M.K. Uddin, M.A. Hossain, M.H. Rashid (2011): Experimental based analysis has been widely used as a means to find out the response of individual elements of structure. To study these components finite element analyses are now widely used & become the choice of modern engineering tools for the researcher. In the present study, destructive test on simply supported beam was performed in the laboratory & load-deflection data of that under-reinforced concrete beams was recorded.. Finally results from both the computer modeling and experimental data were compared. From this comparison it was found that computer based modeling is can be an excellent alternative of destructive laboratory test with an acceptable variation of results. In addition, an analytical investigation was carried out for a beam with ANSYS, SAS 2005 with different reinforcement ratio (under, balanced, over). The observation was mainly focused on reinforced concrete beam behavior at different points of interest which were then tabulated and compared. From these observation it shows that 1st cracking location is 0.43L ~ 0.45L from the support. Maximum load carrying capacity at 1st cracking was observed for over reinforced beam but on the other it was the balanced condition beam at ultimate load. Maximum deflection at failure was also observed for the beam that balanced reinforced.

D.N. Shinde, Pudale Yojana M, Nair Veena V (2014): Existing concrete structures may, for a variety of reasons, be found to perform unsatisfactorily. This could manifest itself by poor performance under service loading, in the form of excessive deflections and cracking, or there could be inadequate ultimate strength. Additionally, revisions in structural design and loading codes may render many structures previously thought to be satisfactory, noncompliant with current provisions. In the present economic climate, rehabilitation of damaged concrete structures to meet the more stringent limits on serviceability and ultimate strength of the current codes, and strengthening of existing concrete structures to carry higher permissible loads, seem to be a more attractive alternative to demolishing and rebuilding. This paper investigates the Flexural behavior of R.C.C. beam wrapped with GFRP (Glass Fiber Reinforced Polymer) sheet. Beams, with (150×150) mm rectangular cross section and of span 700 mm were casted and tested. Three main variables namely, strength, ductility and damage level of R.C.C. under reinforced beam and R.C.C. beam weak in flexure were investigated. In first set of four R.C.C. under reinforced beams to were strengthened with GFRP sheet in single layer from tension face which is parallel to beam axis subjected to static loading tested until failure; the remaining two beams were used as a control specimen. In second set of four beams weak in flexure two were strengthened with GFRP sheet tested until failure; the remaining two were used as a control specimen. Flexural retrofitting also increases the shear strength of concrete. The beam failure mode was as expected that is beam weak in flexure produced flexural mode of failure and R.C.C. balanced section also exhibited flexural cracks.

S Tejaswi, J Eeshwar Ram (2015): Concrete is the material which is rapidly used in various conditions to sustain the compression loads and the corresponding bending and shear stress due to the applied compressive loads. The major drawback in concrete is that it is poor in tension though it is very efficient in compression. Hence to overcome this major drawback the concrete must be reinforced such that to make a homogeneous substance which can sustain both tension and compression. Steel is the material use as reinforcement for concrete. The stress strain behavior for both concrete and steel are mostly similar. Hence in the combination of both that is in reinforced cement concrete the maximum stress point within the elastic will reach simultaneously. Reinforce cement concrete is a general material which is widely used for various types of constructions and structural elements. For the efficient use of RCC it is necessary to know the properties and the behavior of RCC elements under various constrains. To estimate and analyse the basic properties and behavior of RCC an experimental study is needed. In the present study an experiment in which flexural behavior of RCC under various constrains was the major criteria. For the experimental analysis simply supported beams of under reinforced, balanced and over reinforced sections are considered. When the beam is simply supported and is subjected to some external loading the corresponding deflections are examined such that the flexural behavior of the RCC beams of under reinforce, balanced and over reinforced sections analysed. In order to study the flexural behavior of any material one had need some basic constant conditions as their limitations. In the present study stress-strain behavior of Concrete and steel are taken as a base and the flexural behavior of the material in various fibers.

Sharandeep Singh, Dr.Hemant Sood (2015), This paper presents a comparison of DOE, ACI, BIS and USBR methods of concrete mix design, combining the test results of these methods. The M35 and M40 grades of concrete have been designed for comparison using crushed aggregates. Designing same standard mixes by all these methods resulted in complete comparison in terms of proportioning parameters of different mix design methods, thus defining the effect of variation in proportion on the properties of concrete. In this experimental study the strength, durability and other mechanical properties of concrete, designed as per different mix design methods are compared. The study indicates that the outcomes of concrete designed as per USBR method are relatively a lot more eminent than that of the rest of the methods used for comparison. Whereas, the ACI method was failed to achieve the target mean strength in case of M40 and it was redesigned with an increased quantity of cement. However, the results of DOE method cannot be overlooked. M35 and M40 grades of concrete were used to carry out the comparison based on the mechanical properties of concrete. It was observed that all the methods achieved the target mean strength either, in case of M40 or M35 except the ACI method in case of M40 for which the cement content has to be raised to fulfill the minimum requirements of strength. The overall comparison shows that the USBR method comes out with the best results among the four mix design methods compared in terms of strength, toughness and durability, but the method is little more expensive than DOE method. The DOE method has been recognized for delivering optimum performance in a relative economic budget except when toughness of concrete is not a mandatory concern. So in daily concrete practice where only strength and durability is required in a comparatively low budget, DOE method of concrete design should be practiced with the stipulation that the toughness of concrete is not a prime requirement, and where site conditions require strength, toughness and durability side by side irrespective of the budget, the USBR method can be practiced for optimum results.

Er. N. K. Roy, Er. R. R. Sandhwar (2015): Thermo mechanically treated (TMT) bars were introduced in India during 1980-1985. Thermo mechanical treatment is an advance heat treatment process in which red hot bars coming out of last rolling mill stand are rapidly quenched through a series of water jets. Rapid quenching provides intensive cooling of surface resulting in the bars having hardened surface at top, while core remained red hot. The rebars are then allowed to cool in ambient conditions. During the course of such slow cooling, the heat released from core tempers the hardened surface while core is turned into ferrite-pearlite aggregate composition. TMT process

thus changes the structure material to a composite structure of ductile ferrite-pearlite composition with tough surface rim of tempered marten site providing an optimum combination of high strength, ductility, bendability and other desirable properties. Ductility of TMT bars are same as that of mild steel Hence it is very suitable for making hooks, vibrating structures subjected to reversible stresses as in case of machine foundation and for high rise structures subjected to strong earthquake and wind forces. TMT bars of grade Fe 415, Fe500 and Fe550 are now available in India. Most of steel companies in India like SAIL, TATA TISCO and RINL are now a day's producing Fe500 or Fe 550 grade of TMT bars and not Fe-415 grade of steel bars. Design Engineers should accordingly make calculations and drawings taking actual strength of steel into account.

Keertika Sharma, S. S. Kushwah, Aruna Rawat (2016): the present paper explores the flexural performance of fiber reinforced polymer (FRP) fortified in reinforced concrete (RC) beams. The RC beams are designed and analyzed for an effective span of 3 m. The beam is subjected to linear action of three different live loads acting as two point loads on RC beam. In all nine beams, three each are strengthened with carbon FRP, glass FRP and aramid FRP bars, respectively. The three different percentage of reinforcement ratios are taken for steel bars and FRP bars. More three beams are used as control specimens are strengthened with steel reinforcement bars designed as under-reinforced RC beam. Static responses of all the beams are evaluated in terms of strength, deflection and compositeness between FRP bars and concrete. The linear and non-linear FE analysis of steel reinforcement and FRP bars beams are carried out in finite element method ANSYS software. The finite element (FE) results are verified using linear analysis method using IS 456-2000 code for steel reinforcement bars and ACI 440-2006 for FRPs bars. The results show that the FRP strengthened beams exhibit increased flexural strength. The non-linear analysis of the beams shows more deflection at centre and load point as compared to linear FEM of the RC beams strengthened with FRPs and steel bars.

Peddi Hema Arpitha Chowdary, Sreenu Bhuvanagiri (2016): In the present study, destructive test on simply supported beam was performed in the laboratory & load-deflection data of that under-reinforced concrete beams was recorded. After that finite element analysis was carried out by ABAQUS ACE 6.10 by using the same material properties. Finally results from both the computer modeling and experimental data were compared. From this comparison it was found that computer based modeling is can be an excellent alternative of destructive laboratory test with an acceptable variation of results. In addition, an analytical investigation was carried out for a beam with ABAQUS ACE 6.10 with different reinforcement ratio (plain, under, balanced, over). The observation was mainly focused on reinforced concrete beam behavior at different points of interest which were then tabulated and compared. Maximum load carrying capacity was observed for over reinforced beam but on the other it was the balanced condition beam at ultimate load.

3. OBJECTIVE

The main objectives of this work is summarised as below,

1. The main aim of this investigation is to examine the possibility and feasibility of high grade steel as reinforcement for beam.
2. The objective of this work is to carry out the investigation of RC beams using high strength steel.
3. To study the flexural behavior of reinforced concrete beams.
4. To evaluate the ultimate load carrying capacity of beams reinforced with high strength steel as reinforcement.
5. To compare the experimental results of high strength steel i.e. Fe 500 and Fe 600.

4. METHODOLOGY

For carrying out proposed work following methodology was adopted:

1. Collection of required data to carry out the analysis from journals, technical magazines, reference books and web source.
2. Mix design was prepared for M40 and m50 grade concrete according to IS 10262-1982.
3. Casting cube by using M40 and M50 grade concrete.
4. Casting of RC beam by using M40 and M50 grade concrete with high grade steel Fe500 for analysis of parameters.
5. Casting of RC beam by using M40 and M50 grade concrete with high grade steel Fe600 for analysis of parameters.
6. Preparation of RC beams with three number of specimen for each material.
7. Various test like Compressive Strength, Flexural Strength on casted specimens were performed.
8. Comparison to be made between these analysis to know possibility and feasibility.
9. Drawing final conclusion from the analysis of result.

5. CONCLUSIONS

It is expected that study gives such an analytical data which helps for determination of Possibility and feasibility of high strength.

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BIOGRAPHIES

She is an excellent academic person and PG with intend in Research work.

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