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STRENGTHENING OF STRUCTURE BY USING FRP & MS PLATE

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Abstract : This study has been undertaken to investigate the performance of FRP sheet & MS plate for the strengthening of structure. Strengthening is the process of upgrading the structure and increasing the load resisting capacity of structure, Strengthening is the process of reinforcing these structures to enhance their load-bearing capacity, durability, and overall performance. errors Structural strengthening is a critical practice in the fields of civil and structural engineering, aimed at fortifying existing buildings, bridges, and infrastructure to endure changing demands and evolving safety standards. Steel and FRP composites are the most used material in strengthening process of existing concrete structures. Near surface mounting techniques for strengthening of existing structures will be discussed. The NSM technique has provided a significant increment of the load at serviceability limit state, as well as, the stiffness after concrete cracking. Many of the reinforced concrete structures are being damaged by the frequent earthquakes and they need to be retrofitted using external retrofitting materials. Finite element method (FEM) has become a source for analyzing by simulating a model and predicting the physical behavior of complex engineering models.
In this work t we are using standard mix M25 And cast 9 beams (150x150x700mm)as well as cast 9 cube (150x150x150)for getting strength of concrete. Use cement , sand , aggregate in form of (1:1.5:3) after that we test cube for 7,28,56 days. We use E tabs for design of beam load calculation which is impact on MS plate and FRP . After 56th day we are use MS plate and FRP For strengthening. After completing strengthening we conduct test on it and get difference in their failure and load caring capacity.

Keywords: *Simply supported beam, Retrofitting, MS steel plates, adhesive, fiber reinforced polymer (FRP), failure mode, finite element, RC beam, strengthening.*

I. INTRODUCTION

"Structural strengthening in civil engineering involves the process of reinforcing existing buildings or infrastructure to enhance their stability, load-bearing capacity, and overall durability". This is often necessary due to factors such as aging, increased loads, or the need to meet updated safety standards. Various methods, including reinforcement with materials like steel or polymers, overlay applications, and foundation modifications, may be employed based on the specific requirements of the structure. Before implementing any strengthening measures, a thorough structural assessment is conducted to identify weaknesses and determine the optimal approach. This meticulous process ensures that the strengthened structures can effectively withstand both anticipated and unforeseen loads, contributing to their longevity and resilience. Structural strengthening is the process of upgrading structures to improve performance under existing loads or to increase the strength of structural members to carry additional loads. The need for structural strengthening is commonly driven by building codes, deterioration, change in use, or deficiencies caused by design and/or construction errors. Structural strengthening is a critical practice in the fields of civil and structural engineering, aimed at fortifying existing buildings, bridges, and infrastructure to endure changing demands and evolving safety standards. Over time, structures can deteriorate due to factors like aging, wear and tear, seismic activity, or increased loads. Strengthening is the process of reinforcing these structures to enhance their load-bearing capacity, durability, and overall performance.

II. LITERATURE REVIEW

Bashir H. Osman Department of civil engineering (12 May 2023)1 in this paper we study the influence of fiber reinforcement (FRP) on shear behavior of reinforcement concrete (RC) beam with various guideline. The theoretical prediction of ultimate shear strength, as derived from the methods employed in this study, consistently yields results that tend to overestimate when compared with values outlined in other design guidelines. Across a majority of the examined beams, the predicted shear strength exceeds the values recommended by established design standards. The discrepancy between the predicted shear strength and established guidelines underscores the importance of ongoing research and validation to ensure the accuracy and reliability of structural design methodologies.

F.A Megahed and M.H Seleem (13 Sep 2023)2 This paper introduces about modes of failure in RC beam which is strengthened with FRP sheet. After reading this paper we understand that the FRP composite materials had many advantages as compare to the metallic material for the strengthening. FRP composites are highly durable and can withstand harsh environmental conditions without degradation over time. This durability ensures a longer service life for the strengthened structure, reducing the need for frequent maintenance and repair, ultimately leading to cost savings over the structure's lifespan. FRP materials can be easily customized and tailored to the specific requirements of the structure being strengthened. They can be molded into various shapes and sizes, allowing for precise reinforcement of critical areas without the need for extensive modifications to the existing structure.

Diamaluddin and R. Irmawaty (Jan 2023)3 This study aims to examine the flexural capacity of reinforced beams given hybrid Fiber Reinforced Polymer (FRP). This paper provides a review of the progress achieved in this area regarding applications to both reinforced concrete and FRP members. Hybrid FRP systems can also improve the ductility of reinforced beams, allowing them to deform and absorb energy more effectively before failure. This enhanced ductility is crucial for structures subjected to dynamic loads or seismic events, as it can help prevent sudden and catastrophic failure, providing a higher level of safety and resilience. they can offer cost-effectiveness in terms of overall project performance and lifecycle benefits. The increased strength, durability, and resilience provided by hybrid FRP reinforcement can lead to long-term savings by reducing maintenance costs, prolonging the service life of structures, and minimizing the risk of unexpected failures or downtime.

Abdelaziz Ayman Elbrmawy and Tarek Mohamed (July 2021)4 this study we learn the several advantages of FRP sheet which is gives the more benefits as compare to MS plate. When the flexural test conduct on beam that time more elongation observed in FRP sheet as compare to the other straightening material. Overall, the advantages of FRP sheets, including corrosion resistance, lightweight construction, high strength-to-weight ratio, ease of customization, compatibility with concrete, reduced maintenance requirements, and environmental sustainability, make them a preferred choice for reinforcing and strengthening beams in various structural applications. The observed elongation during flexural testing further underscores the superior performance and ductility of FRP sheets compared to traditional MS plates, highlighting their suitability for enhancing the flexural capacity and resilience of reinforced concrete beams.

Pratik M. Patil, Savita N. Patil and Piyush P. Desai (July 6th2023)5 This study suggest practical and optimum solution for strengthening the hole existing structure as well as this paper gives the information about loading condition The study proposes practical and optimized solutions for strengthening existing structures, considering detailed information about loading conditions. Through thorough structural health assessments, tailored strengthening strategies are recommended, encompassing techniques such as FRP sheet application or steel plate reinforcement, aligned with safety factors and design criteria stipulated by structural standards. The analysis incorporates a comprehensive understanding of static, dynamic, and environmental loads, ensuring the strengthened structure's ability to withstand anticipated forces while maintaining safety and serviceability. Cost-benefit analyses inform decision-making processes, balancing initial investments with long-term benefits and construction methodologies that prioritize efficiency, site logistics, and safety.

Jinkun Sun and Zhaorong Zeng (1 April 2019)6 This study aims the strengthening method the exterior-wrapping u-shaped steel plate is very economic solution for the structure. U shaped steel plate gives the several advantage for the structure stability and increase the load resisting capacity. Firstly, the U-shaped configuration provides structural stability by distributing external loads more efficiently, thereby reducing the risk of deformation or failure. Additionally, the U-shaped steel plates act as a protective shield, shielding the underlying structure from environmental factors such as corrosion or abrasion. This protective barrier extends the service life of the structure and minimizes maintenance requirements, contributing to long-term cost savings. Moreover, the installation process for U-shaped steel plates is relatively straightforward and requires minimal disruption to ongoing operations, making it a practical choice for retrofitting existing structures.

Muhammad Hammad, Alireza Bahrami, Sikandar Ali Khokhar and Rao Arsalan Khushnood (19 march 2024)7 in this paper we study the advance strengthening techniques and new material which is mostly used in construction industries like CFRP . this material gives the more strength for the structure and reduce the shear failure problem in structure. In this study we reported that is by using FRP material we improve the performance of structure. These materials offer exceptional strength, notably reducing shear failure risks while enhancing structural performance. CFRP, in particular, provides significant flexural strength, corrosion resistance, and shear capacity improvement. Its lightweight nature, coupled with remarkable fatigue resistance, makes it an ideal choice for dynamic load scenarios. Moreover, CFRP retrofitting seamlessly integrates with existing structures, offering a sustainable solution that minimizes environmental impact and lifecycle costs.

Hesham Marzouk and Emad Rizk (March 2012)8 the current paper presents the design guideline for the strengthening of structure by using the MS plate or shear bolts. In this paper they experiment on beam and investigate the performance of MS plate for the shear failure load, from their understands the requirement of shear bolt and thickness of MS plate for the existing structure Through experimental investigation focused on beams, the study assesses the performance of MS plates in resisting shear failure loads. By analyzing the experimental data, the researchers derive crucial insights into the requisite specifications for shear bolts and the optimal thickness of MS plates necessary for reinforcing existing structures effectively. This experimental approach not only sheds light on the practical application of MS plates but also provides valuable data for establishing standardized design protocols in structural engineering. Additionally, the paper explores the structural behavior under varying load conditions and identifies key parameters influencing the efficacy of MS plate strengthening techniques. By elucidating these factors, the research contributes significantly to the development of robust, evidence-based strategies for enhancing the resilience and load-bearing capacity of structures in real-world scenarios.

Kushlendra Lal Kharwar (Jan 2016)9 this paper says the MS plate is suitable for the strengthening, if we add number of plate on beam in one or more layers then the load resisting capacity increases but the dead load also increase The applied load is perpendicular to the width of plates retrofitted with plates top and bottom of the beam is higher strengthening However, it's essential to acknowledge the trade-off involved, as the additional plates contribute to an increase in dead load on the structure. This consideration is crucial for structural engineers and designers, as it impacts overall structural performance and must be carefully balanced with other design considerations such as material costs, construction feasibility, and long-term maintenance requirements. Moreover, the study emphasizes that the applied load is perpendicular to the width of the plates retrofitted onto the beam, ensuring optimal load distribution and maximizing the effectiveness of the strengthening technique.

III. THEORETICAL BACKGROUND

structure strengthening is a process employed to enhance the load-carrying capacity, durability, and overall performance of existing structures. This method becomes necessary when structures show signs of deterioration, experience increased loads, or need to meet updated safety standards. The primary advantage of structural strengthening lies in its ability to prolong the lifespan of buildings and infrastructure, thus maximizing their utility and reducing the need for costly replacements. By reinforcing weak components or adding new materials, structures can better withstand environmental factors, seismic activity, or heavier usage, ensuring safety for occupants and minimizing the risk of failure.

However, there are some disadvantages associated with structural strengthening. One notable drawback is the potential for increased costs and disruption compared to regular maintenance. Strengthening projects often require meticulous planning, specialized materials, and skilled labour, which can drive up expenses. Moreover, the addition of new elements may alter the aesthetics or architectural integrity of the original structure, posing challenges in preserving its historical or cultural significance.

Advancements in technology and engineering have led to the development of innovative techniques for structural strengthening. For instance, fibre-reinforced polymers (FRPs) offer a lightweight and corrosion-resistant alternative to traditional materials like steel or concrete. These composites can be bonded to existing structures to improve their strength and stiffness without adding significant weight. Additionally, techniques such as externally bonded reinforcement and post-tensioning allow for targeted strengthening of specific areas, reducing the need for extensive modifications

Certainly! Structural strengthening is not just about reinforcing existing structures; it's also about improving their performance in innovative ways. One unique aspect is the use of advanced materials like shape memory alloys (SMAs) or carbon fiber-reinforced polymers (CFRPs) in strengthening techniques. Shape memory alloys have the fascinating property of returning to their original shape after being deformed, which can be utilized to provide self-healing capabilities to structures. For example, SMAs embedded in concrete can help repair cracks by closing them when triggered by temperature changes or mechanical stress.

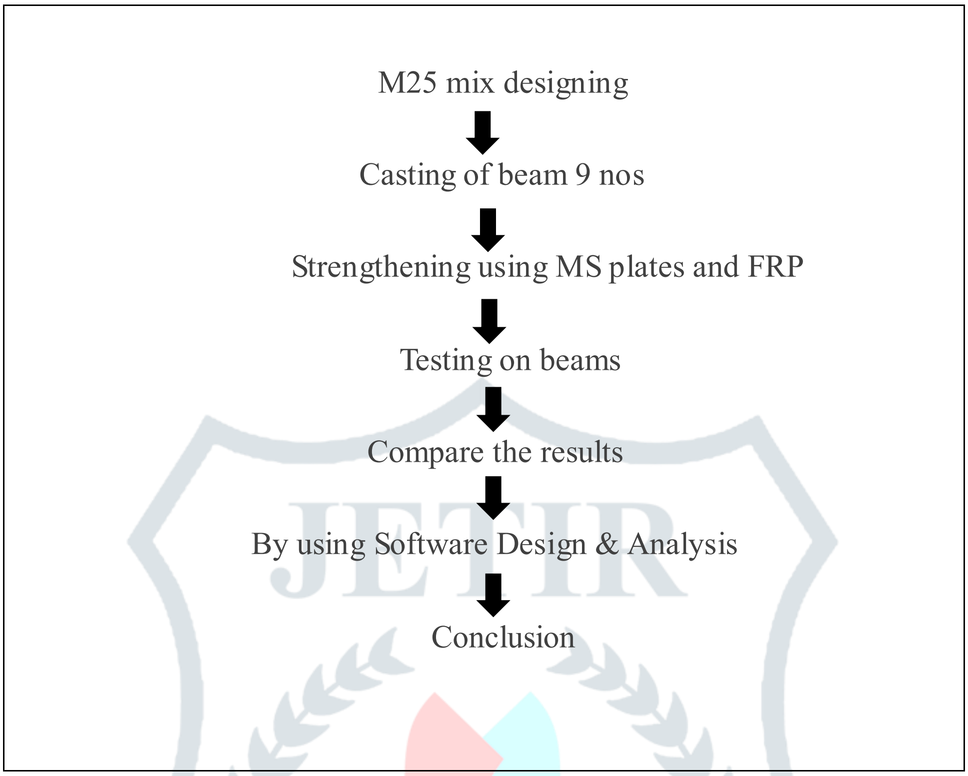
Shape memory alloys have the fascinating property of returning to their original shape after being deformed, which can be utilized to provide self-healing capabilities to structures. For example, SMAs embedded in concrete can help repair cracks by closing them when triggered by temperature changes or mechanical stress. Carbon fibre-reinforced polymers, on the other hand, offer exceptional strength-to-weight ratios and corrosion resistance. They are increasingly being used in structural strengthening applications due to their versatility and ease of installation. By bonding CFRP sheets or strips to concrete or steel elements, engineers can effectively enhance the load-carrying capacity of buildings, bridges, and other infrastructure.

Furthermore, with the growing emphasis on sustainability, there's a trend towards incorporating eco-friendly materials and techniques in structural strengthening projects. For example, bio-based resins derived from renewable sources are being explored as alternatives to traditional epoxy adhesives for bonding FRP materials. Additionally, techniques like retrofitting with green roofs or vertical gardens not only strengthen structures but also provide environmental benefits such as improved air quality, energy efficiency, and biodiversity. These innovative approaches demonstrate the evolving nature of structural strengthening, where cutting-edge materials, technologies, and sustainability considerations converge to create safer, more resilient, and environmentally friendly built environments

In summary, while structural strengthening offers numerous benefits in terms of safety and longevity, it also presents challenges such as cost implications and aesthetic considerations. Nevertheless, ongoing research and the adoption of new technologies continue to expand the capabilities of this essential practice, ensuring that existing structures can meet the demands of modern society in a sustainable and efficient manner.

IV. RESEARCH METHODOLOGY

Conduct a thorough assessment of the existing structure, including visual inspections, historical data review, and identification of weak points.



(Methodology Flow Chat)

In this project, the focus lies on enhancing the strength and durability of concrete structures using a systematic approach. The choice of using a standard mix of M25 concrete ensures consistency and reliability in the material properties. By casting nine beams and cubes of specified dimensions, the aim is to accurately assess the concrete's strength through cube testing at different curing periods of 7, 28, and 56 days. This comprehensive testing protocol allows for a thorough understanding of the concrete's performance over time, providing valuable insights into its long-term behaviour under varying conditions.

To design the beams for load calculation, E tabs are utilized, ensuring structural integrity and safety by accounting for factors such as material properties, load distribution, and potential impact forces. The incorporation of MS plates and FRP materials for strengthening post-testing demonstrates a proactive approach to address any deficiencies identified during the evaluation phase. Upon completion of the strengthening process, further testing is conducted to evaluate the effectiveness of the intervention. By comparing the failure modes and load-carrying capacities before and after strengthening, the project aims to quantify the improvements achieved and validate the efficacy of the chosen strengthening techniques

This project exemplifies a holistic approach to structural enhancement, encompassing material testing, design optimization, and performance evaluation. By systematically analysing and addressing the structural deficiencies, it seeks to ensure the longevity and resilience of the concrete elements, thereby enhancing the safety and reliability of the overall infrastructure.

V. MATERIAL USED FOR TEST

(Table No 01)

Sr No.	Material Used	Picture	Description
1.	MS Plate		• Grade Fe 250 • Size 600x150x4mm • Elongation 20%
2.	FRP Sheet		• High Strength-to-Weight Ratio • Flexibility and Malleability • Fire resistance
3.	Epoxy adhesive		• Resistance to chemicals, particularly alkaline environments • Heat resistance • Adhesion to a variety of substrates
4.	Fastener		• Size 10mm Dia • Head stile: Hex • Tensile strength: 36300 psi • Socket size 17mm • Thread pitch 1.50

VI. ACKNOWLEDGEMENT

It gives me an immense pleasure and satisfaction to present this dissertation report on**"STRENGTHENING OF STRUCTURE BY USING FRP AND MS PLATE"** which is the result of unwavering support, expertguidance and focused direction of my guide **Prof. Manoj Deosarkar** to whom I express my deep sense of gratitude and humble thanks, for her valuable guidance throughout the presentation work. The success of this dissertation has throughout depended upon an exact blend of hard work and unending co-operation and guidance Last but not the least, I sincerelythank to my colleagues, the staff and all others who directly or indirectly helped me and madenumerous suggestions which have surely improved the quality of my work.

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