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ABSTRACT

The use of welded mesh as transverse reinforcement in reinforced concrete beams has gained increasing interest due to its potential advantages over traditional stirrups. This study investigates the strength behaviour of RC beams with welded mesh as transverse reinforcement through experimental approaches. Usage of welded wire mesh results in stress-free and quicker assembly, and better budget and superiority control. One Control beam with conventional reinforcement with five other beams with vary welded mesh were cast and tested under two point loading. The results were used to study the flexural behaviour. It is obtained that the beam with continuous weld mesh and longitudinal bar given the maximum load carrying capacity. The test results are analysed to determine the load-carrying capacity, deflection characteristics, and failure modes of the specimens. The study aims to provide valuable insights into the applicability and effectiveness of welded mesh as transverse reinforcement in RC beams, offering potential benefits such as cost-efficiency, ease of construction, and improved structural performance. The findings will contribute to enhancing the understanding of welded mesh behaviour in RC structures and aid in the development of optimized and sustainable construction practices for reinforced concrete beams.

1 Introduction

Reinforced concrete beams have been widely used as essential structural elements in buildings, bridges, and various infrastructures due to their ability to efficiently resist bending and shear forces. The performance of RC beams primarily relies on the proper design and placement of longitudinal and transverse reinforcement, which ensures their ability to withstand applied loads and provide the necessary ductility to prevent sudden failure. Traditionally, steel stirrups have been employed as the most common form of transverse reinforcement in RC beams.

The fabrication and installation of stirrups can be time-consuming and labour-intensive, leading to increased construction costs and potential inaccuracies in positioning. Moreover, achieving proper confinement and maintaining the desired spacing of stirrups in heavily reinforced beams can be challenging, affecting the overall structural behaviour and performance. In recent years, there has been growing interest in exploring alternative forms of transverse reinforcement to address these challenges and improve the strength and ductility characteristics of RC beams. One such alternative is the use of welded mesh as transverse reinforcement. Welded mesh consists of interconnected steel bars welded together to form a



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grid-like structure, offering advantages in terms of ease of handling, accurate placement, and reduced construction time compared to conventional stirrups. The objective of this study is to investigate and evaluate the strength behaviour of RC beams with welded mesh as transverse reinforcement. The research aims to understand the performance of these beams in comparison to conventionally reinforced beams, shedding light on the potential benefits and drawbacks of using welded mesh in RC structures. A total of 6 Beam specimens to made in this study. Five of the specimens with weld mesh at various longitudinal section as transverse reinforcement, while the other specimen is with conventional reinforcement. The parameters are to be investigated in this research included the spacing and grid configuration of Weld mesh reinforcement, and the distribution of longitudinal reinforcement. The outcomes of this research hold significant implications for the construction industry, as understanding the strength behaviour of RC beams with welded mesh reinforcement can potentially lead to more efficient and cost-effective design practices. By offering an alternative to conventional stirrups, welded mesh has the potential to streamline construction processes and enhance the overall performance and durability of RC structures.

2 Literature Review

Anju Mary Elias, Binu.P (2016): Repair and strengthening of RC beam is now becoming more and more important in the field of structural strengthening. In this thesis work, investigate the flexural behaviour of reinforced concrete beams strengthened with a new type of strengthening material, namely wire mesh-epoxy composite. The flexural performance of the beam specimens bonded with wire mesh layers will compare with the beam specimens bonded with fibre reinforced polymer (FRP) sheet. It was concluded that the mid-span deflection, crack pattern and load deflection behaviour of the tested beams will record and compare. But even though both methods (1 layer, 3mm wire mesh and 3 layer 4mm wire mesh) enhances flexural strength, decreasing size of wire mesh is found to be more economical than increasing layers of wire mesh. The strength for 1 layered beam is 16.7MPa and for the 3 layered beam is 25.5MPa.

Yao.z.h, yao.q.l, huang.s.m (2016): Rehabilitation with SMPM (high-strength steel wire mesh and polymer mortar) is a new technique of structural strengthening with a series of obvious advantages comparing with other traditional ones. Experiments were conducted to investigate the flexural behaviour of 5 RC beams including 4 strengthened specimens and comparative beam. The mode of failure, cracking behaviour, stress of reinforced bars and steel wires, load versus deflection curves and ultimate load-carrying capacity of the strengthened specimens were analysed. It was concluded that the strengthened beams have good strengthening effect and the working behaviour of the two sections is excellent. Based on the tests and numerical simulation results, the design formulae of the flexural load-carrying capacity and stiffness were supposed. The calculated results are in good agreement with the experimental ones.



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Ismail.M.Iqeshta, Payam (2016): This paper presents a study of an ongoing research project on the use of new composites for enhancement of the performance of concrete beams. A plain concrete beam was externally bonded with wire mesh– epoxy composite using one to five wire mesh layers. The flexural performance of the beam specimens bonded with wire mesh layers was compared with the beam specimens bonded with carbon fibre as well as a hybrid of wire mesh–epoxy–carbon. It was concluded that the test results show that the use of wire mesh with epoxy is an efficient way to improve the flexural performance of concrete beam specimens. The increase in wire mesh layers significantly enhances the flexural strength, cracking behaviour and energy absorption capability. In comparison with carbon fibre, wire mesh–epoxy composite is more efficient in flexural strength and ductility.

Ling Yuan Zhou and Qian li (2011): A efficient 3D reinforced-concrete beam element based on the flexibility method and distributed nonlinearity theory is proposed, The sections of the beam element are divided into the plane isoperimetric elements in this formulation, the section stiffness matrices are calculated through the integration of stress-strain relations of concrete including reinforcing steel effect in the section. The flexibility matrices of the sections are calculated by inverting the stiffness matrices, and the element flexibility matrix is formed through the force interpolation functions. The element stiffness matrix is evaluated through the element flexibility matrix. Finally, the buckling behaviours of a reinforced concrete beam under various eccentric loads are analysed with the proposed formulation to illustrate its accuracy and computational efficiency.

Jun Wu, Jian Long Xing (2011): This paper develops a new-typed high-durability RC structures in which the steel stirrups are replaced by mesh stirrups weaved with soft high performance fibre belt. The experiments are carried out to investigate the shear property of six beams with soft aramid fibre mesh stirrups and one common RC beam and the results show that the failure state in the slope sections of the RC beams with fibre belt mesh stirrups is similar to the common RC beam. It was also found the shear property of beams with lean fibre mesh stirrups is better than that with vertical and horizontal mesh stirrups, and with the high-elastic- modulus fibre stirrups better than the low elastic-modulus's. In addition, the distributions of fibre stirrups strain at slope section are also observed. Based the experimental results, a model for beams with fibre mesh stirrups was established and the formula of shear bearing capacity was suggested. In this paper concluded that the Aramid fibre mesh stirrups more strength in the aspect of flexural as well as durability and are also having the high resistance to the shear. Hence it was suggested.

Hua Ping Liao, Shi Sheng Fang (2011): Three reinforced concrete (RC) beams strengthened by high-performance fibrocement and two control specimens without strengthened are investigated when RC beams have low compressive strength. Flexural behaviours of strengthened RC beams with high-performance fibrocement are evaluated based on comparative analysis with RC beams. The strengthening results of steel meshes with U-shape (i.e. Ferro cements are put onto the tension face and two profile faces) are analysed. The



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flexural capacity, deflection and crack width of RC flexural beams are measured, and then comparative analysis is carried out for deformation performance and law of crack development. The test results show that fibrocement contributes greatly to increase the flexural capacity and raise crack-resisting capacity. The experimental results can provide a theoretical reference for actual engineering design.

Jian yang, qiang du, yi wang bao (2011):

Bond behaviour plays an important role in developing load carrying capacity and ductility for concrete structures. Studies on bond behaviour of single bars have been extensively conducted and whereas those on steel meshes are rather limited. This paper reports an experimental study on the bond behaviour of concrete blocks with steel meshes. By varying the rib pattern and bar size of the steel mesh, their influence was examined.

Ming Liu, Jian Ling Hou (2011): Rehabilitation of RC members with stainless steel wire mesh and permeability polymer mortar is a new method of structural strengthening with the advantages of resistance to fire, corrosion and ageing. Experiments were conducted to investigate the shear behaviour of eight strengthened RC rectangular beams and one comparative RC beam. The shear mechanism of strengthened beams was analysed, and the influences of the strengthening manners, bolts' amount, bolts' distance on the shear behaviour of strengthened beams were discussed.

Masoud Soltani ,Xuehui An(2006): The purpose of this study is to investigate the structural behaviour and cracking response of RC membrane elements reinforced with welded wire mesh subjected to general in-plane stresses. The response of RC elements is computed based on micro mechanisms of stress transfer in RC domain involving interaction of concrete and reinforcing bars, anchorage effect of longitudinal and transverse wires and stress transfer across cracks due to aggregate interlock. The effect of type and arrangement of longitudinal and transverse wires on the structural behaviour such as ductility, crack width and also on the spatial post cracking constitutive models of RC elements is described.

3 Experimental Methodology and Investigation

This section briefly explains the methodology adopted in this experimental work. It has already been discussed in the previous chapter about use of welded mesh as shear reinforcement in concrete and their effect on strength parameters of concrete in the core objective of this experimental work. The following methodology has been adopted to achieve above objective. In the first phase, physical, chemical and mechanical properties of all ingredient of concrete were found out. In the second phase, initially compressive strength of cubes and cylinders, split tensile strength were found out. Finally Reinforced beams were subjected under two-point loading to study the flexural behaviour and other salient features of concrete beams.

The current experimental program includes six beam specimens, the description of specimens are designated as follows,

SP 1: The Specimen is with stirrup and welded mesh.



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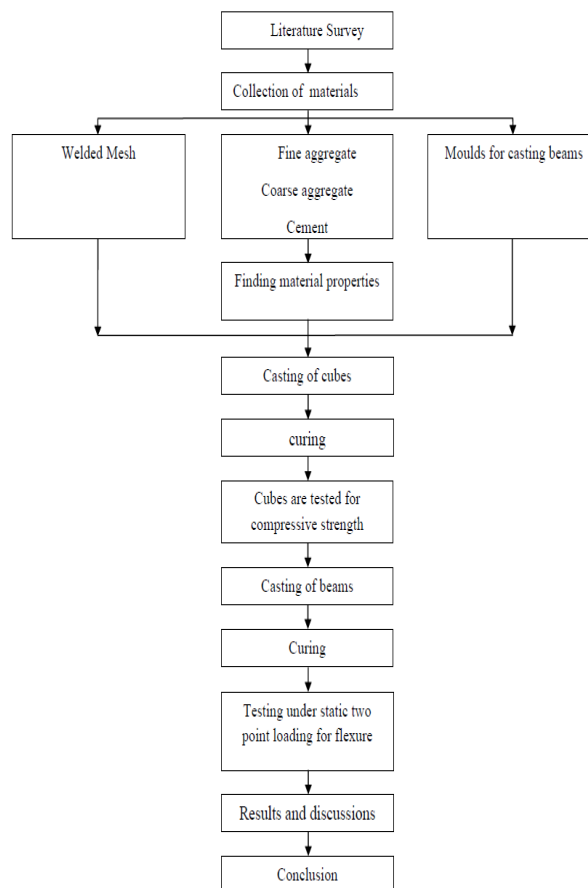
SP 2: From both the supports $L/4$ length of the specimen welded mesh as well as $L/2$ of the specimen conventional stirrups.

SP 3: From both the supports $L/4$ length of the specimen welded mesh and $L/2$ of specimen no stirrups.

SP 4: From both the supports $L/3$ length of the specimen welded mesh and $L/3$ of specimen conventional stirrups.

SP 5: From both the supports $L/3$ length of the specimen welded mesh and no stirrups for remaining length.

SP 6: Fully Conventional stirrups.



Flow chart 1

4 Result and Discussion

The results of the experimental investigation on six beam specimens are presented in this chapter. The behaviour of the specimens in terms of crack development, failure mode and ultimate loads were observed during the test. The salient test values of all beam specimens.



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Specimen	Initial Crack Load (KN)	Ultimate Load (KN)
SP 1	20	62
SP 2	18	58
SP 3	12	54
SP 4	10	52
SP 5	8	48
SP 6	16	56

SP 1 specimen has the highest load carrying capacity among the group. The beam specimen SP 5 performed in a poor manner with low load carrying capacity. The remaining beams can be grouped under the same class as their load carrying capacity or ultimate load is nearly same. Hence for better flexural performance fully Steel RC and welded wire mesh grid Beam with Reinforced overlay.

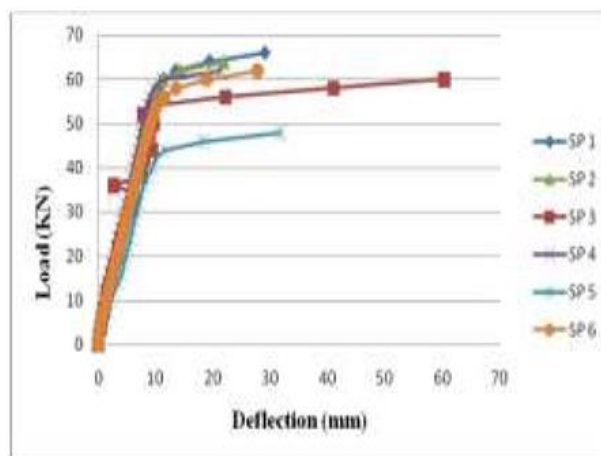


Figure 1: Load Vs Deflection Curve at L/2 for Specimen sp1 to sp 6

It is observed that mid span deflection of the specimens SP 1, SP 2, SP 4 and SP 6 are having more or less same deflections. Specimens SP 3 and SP 5 are having high deflections compared to that of other specimens.

Specimen SP 3 having high deflection at the mid span, it is due to the absence of shear reinforcement at the mid span section, it is less stiff than that of other beam specimens.

Specimen SP 5 is also having high deflection and compared to the specimen SP 5 it is observed that the flexural strength of the specimen SP5 is lower than the specimen SP 3.



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Flexural Failure of Beams

In the under reinforced section beam, the member approaches failure due to gradual reduction of compression zone, exhibiting and cracks, which develop at the soffit and progress towards the compression face.

All five specimens have suffered extensive flexural cracking near to midspan. The failure mode is shown in Figure

Flexural Failure of specimen

The Modes of failure of all beams are as follows,

- ☐ All Reinforced concrete beams failed in flexure zone.
- ☐ after the first crack load, the reinforcement started yielding and more number of cracks have formed in the flexure zone and extended towards the point loads with increment in loads.
- ☐ at the ultimate load, the failure of all concrete beam with welded mesh occurred with crushing of concrete in compression zone.
- ☐ In the Specimens SP 3 and SP 5 more number of cracks formed in flexure zone. This is due to the absence of shear reinforcement in the flexure zone at the mid span.

5 Conclusion

The study aimed to explore the potential advantages of welded mesh over traditional stirrups and evaluate its effectiveness in enhancing the performance of RC structures.

Through experimental testing, it has been established that RC beams reinforced with welded mesh exhibit favourable flexural strength characteristics. The welded mesh effectively resists bending moments and provides confinement to the concrete, resulting in improved load-carrying capacity. The load-deflection response of the beams with welded mesh reinforcement demonstrates enhanced ductility, allowing the structure to undergo significant deformations before reaching failure, which is a desirable feature in earthquake-prone regions. Furthermore, the crack resistance of RC beams with welded mesh as transverse reinforcement has proven to be commendable. The welded mesh efficiently distributes stresses and restrains crack propagation, contributing to the overall durability and longevity of the structure. This property is particularly valuable in maintaining structural integrity and serviceability over the lifetime of the RC beams.

The use of welded mesh as transverse reinforcement in RC beams offers numerous benefits, including improved construction efficiency, enhanced structural performance, and potential cost savings. It presents a viable option for engineers and designers seeking innovative and practical solutions for reinforced concrete structures. However, despite the many advantages, some limitations and challenges of using welded mesh as transverse reinforcement should be acknowledged. Proper detailing and connection between the welded mesh and longitudinal bars are critical to ensure adequate load transfer and prevent potential performance issues. Further research and guidelines are required to address these aspects comprehensively.



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