Experimental Investigation of castellated with and without stiffener.

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Abstract— This research paper presents a comprehensive experimental investigation into the behavior of castellated beams featuring diverse openings. Castellated beams have attracted a lot of attention in modern structural engineering due to its reputation for effective material usage and aesthetic versatility. This study aims to investigate how such modifications affect the mechanical properties and performance characteristics of the beams by inserting openings of various configurations. The paper discusses the effects of various openings on load-bearing capacity, stiffness, and deformation patterns through a series of carefully planned experiments, including load tests and deflection measurements. The results not only advance knowledge of the behavior of castellated beams but also offer helpful insights for developing new and efficient structural designs. This study lays the path for future research by bridging the gap theoretical analysis and practical application

Index Terms—*Castellated Beam, Viredaal Mechanism, Load deflection, ANSYS.*

I. INTRODUCTION

The search for ideal designs that combine strength, efficiency, and cost-effectiveness continues in the field of structural engineering. Castellated beams, a remarkable development in structural engineering, serve as an example of this approach to improving the load-bearing capacity of steel beams while maintaining their lightweight nature by utilizing the principles of cellular design. The process creates multiple rectangular openings repeatedly spaced apart down the length of the beam, resembling the battlements of a mediaeval castle, hence the name "castellated." These openings not only reduce the beam's self-weight but also establish a new paradigm for distributing forces, allowing beams to carry more weight and span farther compared to their Parent section.

This study explores the experimental exploration of castellated beams with various openings. By combining lower weight, higher load-bearing capability, and architectural versatility, castellated beams—notable for their characteristic holes and serrated profiles—have emerged as a feasible alternative. This study lays the path for future research by bridging the gap between theoretical analysis and practical results.

APPLICATION:

- Bridge construction: as their interlocking design provides added stability and strength.
- Residential construction: providing a cost-effective and efficient solution for building homes.
- Commercial construction: for commercial buildings, including office buildings and shopping centres.

OBJECTIVES:

- To learn different types of castellated beam
- Analysis and design of castellated beam
- To investigate strength of castellated beam
- To determine the strength of the castellated beams
- To compare the strength of the castellated beam with stiffeners

II. PROBLEM STATEMENT

The study is to evaluate Castellated beams with various aperture configurations in order to understand their structural behavior under load. The primary goal is to test the strength of castellated beams with various hole patterns and diameters to identify which configuration provides the best effectiveness, durability, and strength for industrial and other applications. This study aims to give useful insights into selecting the best castellated beam design to improve structural performance and assure safety in a variety of engineering and construction projects through extensive experimental evaluations.

III. EXPERIMENTAL PROGRAM

1. Process of fabrication of castellated beam
2. Cutting
3. Welding
4. Coloring

IV. TEST RESULTS AND DISCUSSION

1. Beam without Stiffener

A. TESTING OF PARENT BEAM

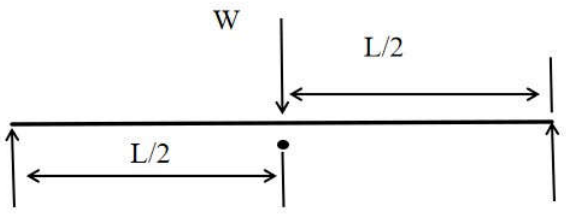
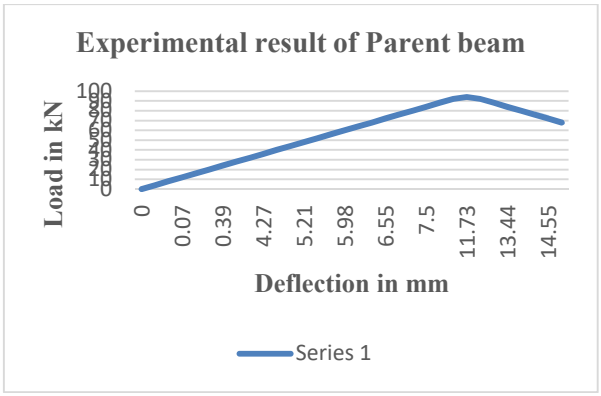


Fig.No:-1 UTM machine with Parent section

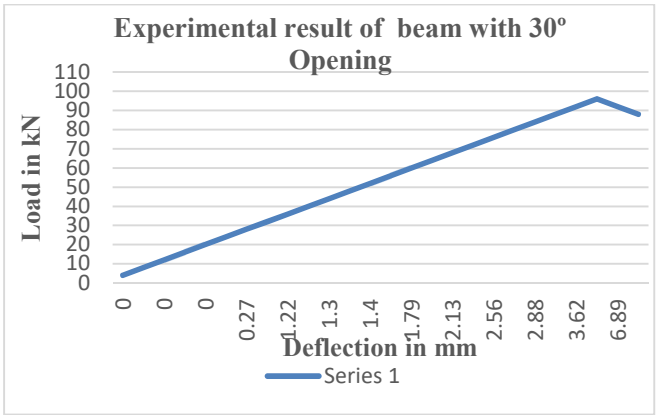


Graph No:-1 Load vs Deflection graph (Parent section)

The ISMB 150 parent section of 1.2m length was tested, and the highest load bearing capability of the beam was 94kN, with a deflection of 11.73 mm.

B. TESTING OF CASTELLATED BEAM WITH 30º OPENING:

Fig. No:-2 Testing of Castellated beam with 30º Opening

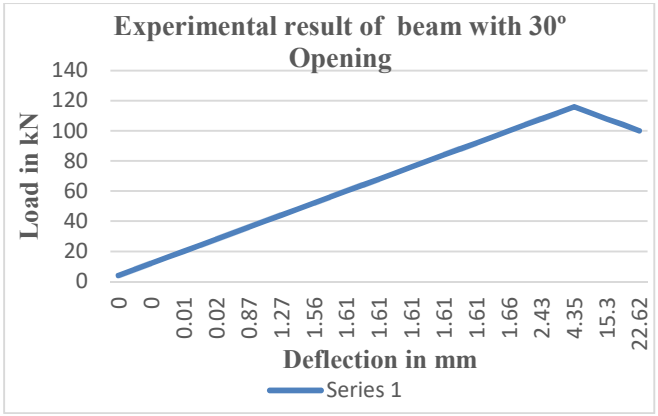


Graph No:-2 Load vs Deflection graph (Castellated beam with 30º Opening)

A 1.2m long Castellated beam with a 30º aperture demonstrated a maximum load bearing capability of 96kN and a 6.47mm deflection during testing.

C. TESTING OF CASTELLATED BEAM WITH 45º OPENING:

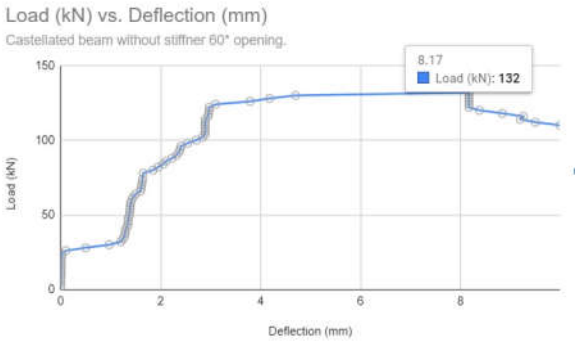
Fig. No:-3 Testing of Castellated beam with 45º Opening



Graph No:-3 Load vs Deflection graph (Castellated beam with 45º Opening)

A 1.2m long Castellated beam with 45º openness demonstrated a maximum load-bearing capability of 116kN and a deflection of 4.35mm during testing.

D. CASTELLATED BEAM WITH 30º OPENING:



Graph No:-4 Load vs Deflection graph (Castellated beam with 60º Opening)

A 1.2m long Castellated beam with a 60º aperture was tested and has a maximum load bearing capability of 132kN with an 8.17mm deflection.

2. TESTING OF CASTELLATED BEAM WITH STIFFNERS

A. Testing of Castellated beam with stiffener & 30º Opening

Fig. No:-4 Testing of Castellated beam with stiffners & 30º Opening

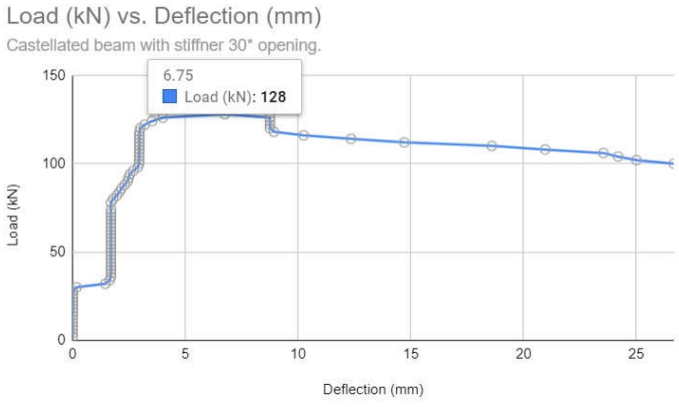


Fig.No:-16 Load vs Deflection graph (Castellated beam with stiffners & 30º Opening)

A 1.2m long Castellated beam with stiffener30º opening was evaluated, having a maximum load bearing capability of 128kN and a 6.75mm deflection

B. Castellated beam with stiffener & 45º Opening

Fig. No:-17 Testing of Castellated beam with stiffners & 45º Opening

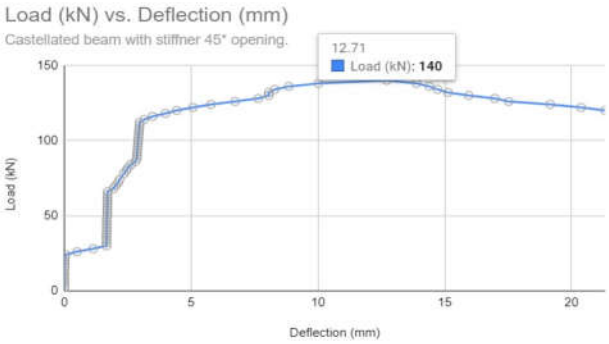


Fig. No:- 18 Load vs Deflection graph (Castellated beam with stiffners & 45º Opening)

A 1.2m long Castellated beam with stiffener 45º opening was tested, with a maximum load bearing capability of 140kN and a deflection of 12.71mm.

C. Castellated beam with stiffener & 60º Opening

Fig. No:-19 Testing of Castellated beam with stiffners & 60º Opening

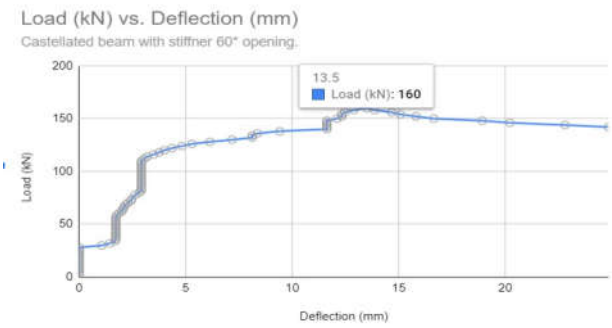


Fig. No:- 20 Load vs Deflection graph (Castellated beam with stiffners & 60º Opening)

A 1.2m long Castellated beam with stiffener 60º opening was tested, having a maximum load bearing capability of 160kN and a deflection of 13.5mm.

V. RESULT ANALYSIS

Table No:- 8 Result Analysis

Sr. No.	Max Load on Parent Section	Angle of Opening	Max Load on Beam without Stiffener	Max Load on Beam with Stiffener	Percentage of strength achieved
1	94kN	30º	96kN	128kN	36%
2		45º	116kN	140kN	49%
3		60º	132kN	160kN	71%

VI. CONCLUSION

1. The Parent Section when Castellated with hexagonal 30º opening the load bearing capacity increased more 3% and when transverse stiffener were added to the section the the **load bearing capacity increased up to 36%**

2. The Parent Section when Castellated with hexagonal 45º opening the load bearing capacity increased more 24% and when transverse stiffener were added to the section the the **load bearing capacity increased up to 36%**

3. The Parent Section when Castellated with hexagonal 60º opening the load bearing capacity increased more 41% and when transverse stiffener were added to the section the the load bearing capacity increased up to 36%

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