"BUCKLING BEHAVIOUR OF COMPRESSION REINFORCEMENT REPLACED BY ANGLE SECTION IN FLEXURE"

A PROJECT REPORT

submitted in partial fulfilment of the requirements for the award of the degree of

BACHELOR OF TECHNOLOGY

in

CIVIL ENGINEERING

by

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CERTIFICATE

This is to certify that the work which is being presented in the project report titled ***"BUCKLING BEHAVIOUR OF COMPRESSION REINFORCEMENT REPLACED BY ANGLE SECTION IN FLEXURE"*** in partial fulfillment of the requirements for the award of the degree of Bachelor of Technology in Civil Engineering and submitted to the Department of Civil Engineering, Jaypee University of Information Technology, Waknaghat is an authentic record of work carried out by **Kunal Mahajan(141614); Rashiv Gandotra (141627) and Rohaan Wani (141631),** during a period from July 2017 to May 2018 under the supervision of Dr. Gyani Jail Singh (Assistant Professor), Department of Civil Engineering, Jaypee University of Information Technology, Waknaghat.

The above statement made is correct to the best of our knowledge.

Date: - 10-05-2018

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DECLARATION

This is to declare that this report has been written by us. No part of the report is plagiarized from other sources. All information included from other sources have been duly acknowledged. We aver that if any part of the report is found to be plagiarized, we are shall take full responsibility for it.

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(Kunal Mahajan; Rashiv Gandotra; Rohaan Wani)

ABSTRACT

Traditional steel ties reinforcement cannot provide superior confinement for reinforced concrete (RC) beams due to the constraints on tie spacing and disturbance of concrete continuity. The proposed transverse reinforcement, with various volumetric ratios of ties, was investigated in sixteen RC beams specimens categorized in two groups according to their warping. The specimens were cast in horizontal position simulating the construction field and they will be tested under concentric compression till failure.

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LIST OF ABBREVATIONS, SYMBOLS AND NOMENCLATURES

Symbols/ Abbreviations/ Nomenclatures	Meaning
MPa	Mega Pascal (unit of pressure) = N/mm^2
Mm	Millimetre
Cm	Centimetre
w/c	Ratio of Water to Cement
OPC	Ordinary Portland Cement
HYSD	High Yielding Strength Deformed bars
ASTM	American Standard for Testing and Materials

LIST OF TABLES

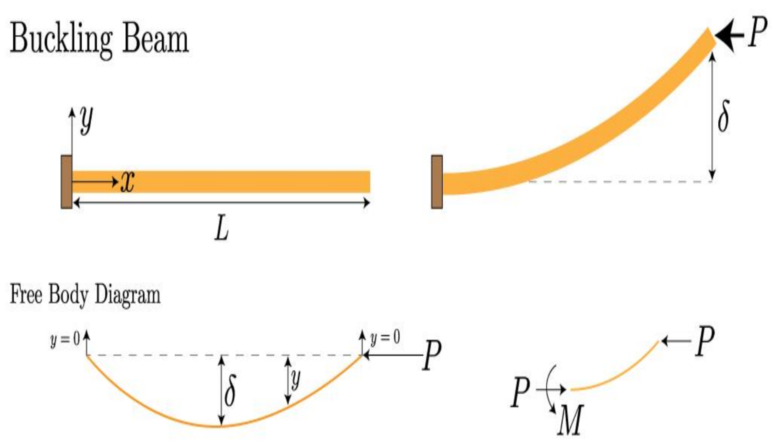
CHAPTER 1: INTRODUCTION

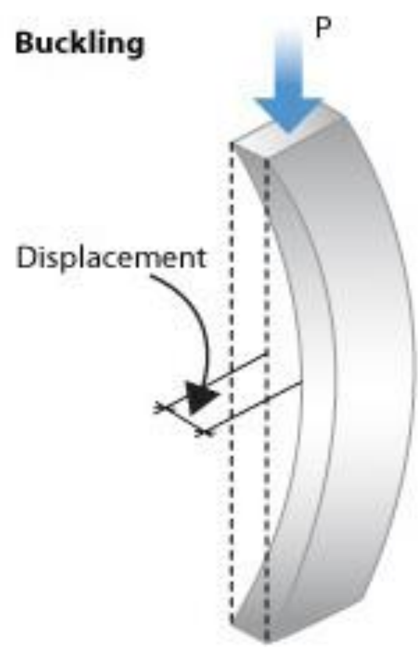
What is buckling?

Under compressive stress buckling may occur. Buckling is defined by a side deflection of a structural unit. This occurs when the stresses are well below the needed for failure. Further loading will cause significant deformations, possibly leading to complete loss of the member's load carrying capacity.

Buckling of a beam:

In the earlier section the response of a piece of rubber to a force is described. It becomes much more interesting when we look at it. In this thesis a rectangular cuboid piece is used. This piece is called a beam, see figure below





Theory of Buckling of Beams:

In this chapter we will select a model that shows the deflection and the f-s curve of a beam. Bending moment theory is used in this model.

An important note that we make is that the deflection and its derivative are small. This limits the use of the model in such a way that we can only use it before and after buckling. A second condition will be that the beam is thin.

Moment of the beam:

A bended beam has a capacity to bend back to a straight beam again. The quantity that tells how strong this capacity is known as the BM of the beam. Firstly, how we can calculate the moment in general and why a bended beam will have moment, and after that we will calculate the moment of a beam

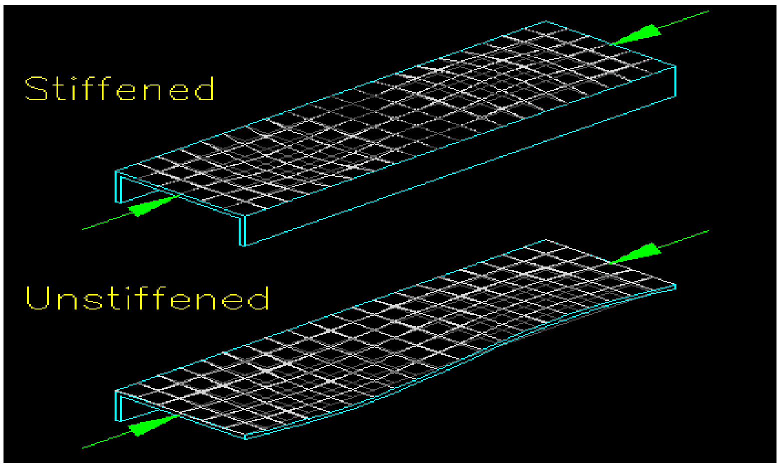
Euler-Bernoulli, force and moment balance:

Using the phenomenon of the balance of force and the moment a theory for buckled beams has been developed in the past. The beam is in equilibrium as a result of which the net force and the moments have to be zero.

Various forms of Buckling

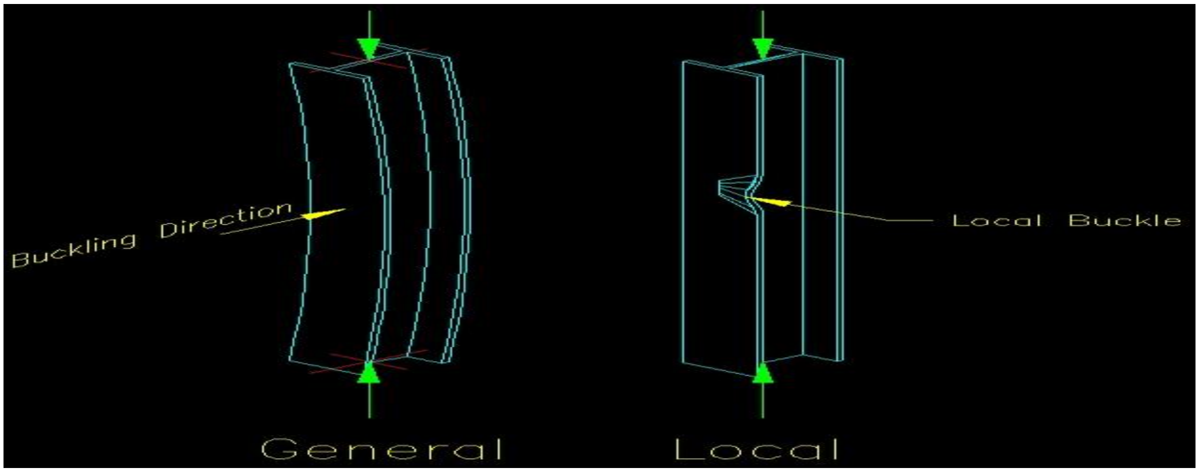
Plate Buckling

A plate is a 3-D structure having a breadth of similar to its length, with a thickness very small in comparison to its length and breadth. Similar to columns, thin plates experience o buckling deformations when they are under the action of critical loads; however, different from the column buckling, plates can continue to carry loads under buckling and is known as local buckling. This method is incredibly useful in numerous system and it allows systems to provide higher loading rates.



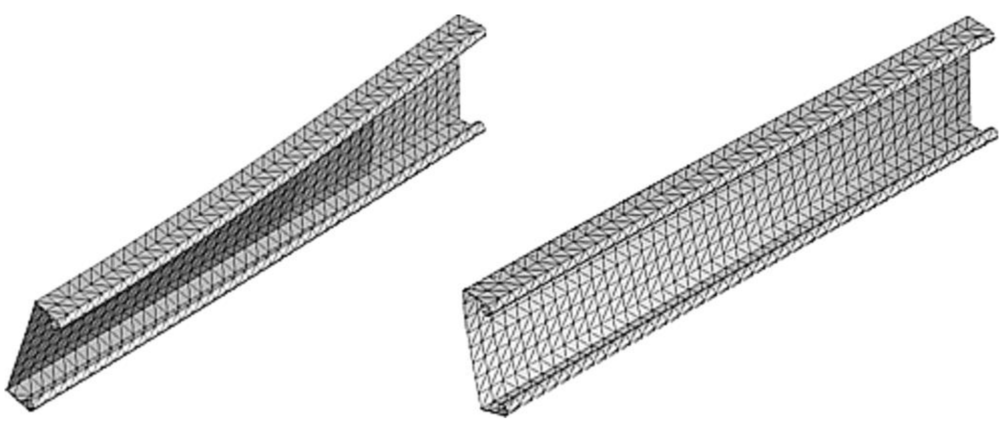
Flexural - Torsional buckling

When bending and twisting occurs simultaneously in a structural member which is already in compression is known as flexural torsional buckling. This type of deflection mode can be adopted for designing purposes. This mostly happens in columns with "open" cross-sections and due to this they have a low torsional stiffness, such as channels, double-angle shapes, and single angles. This type of buckling doesn't occur in circular cross sections .



Lateral-torsional buckling

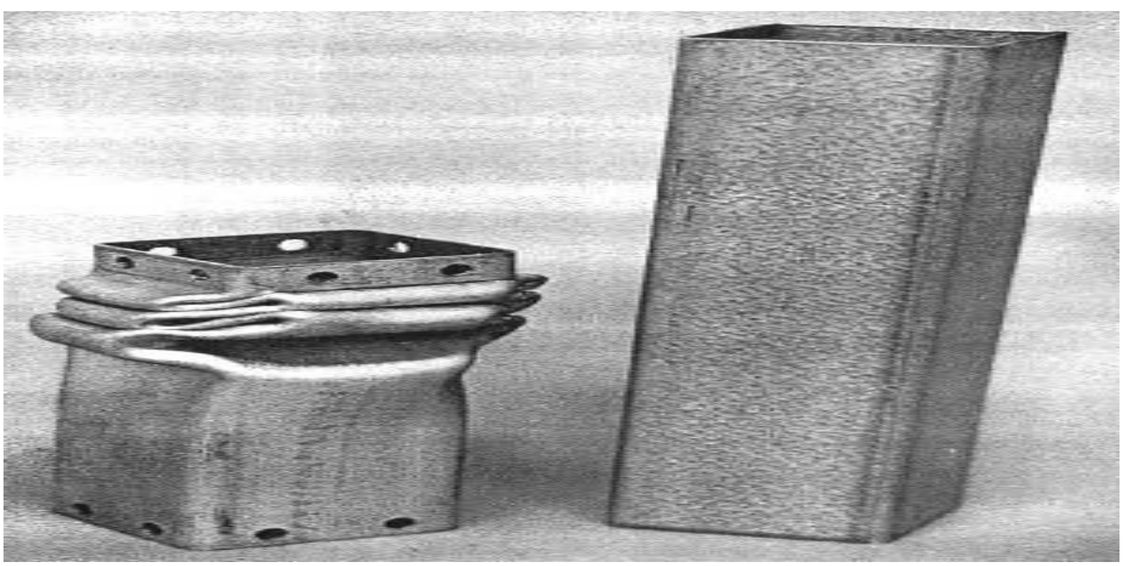
When a simply supported beam is under the action of flexure, the top side is in compression, and the lower side undergoes tension. If the beam is not supported in the direction and the flexural load increases then the beam will experience a deflection of the compression flange. The deflection of the compression flange is restricted by the beam web and tension flange, whereas in the case of open section the twisting mode is more flexible, hence the beam both twists and deflects in a failure mode known as lateral-torsional buckling. In wide-flange sections the deflection mode will be mostly twisting. The bending will be lower in the case of narrow flange sections and the column's deflection will be closer to that of deflection mode.



Plastic buckling

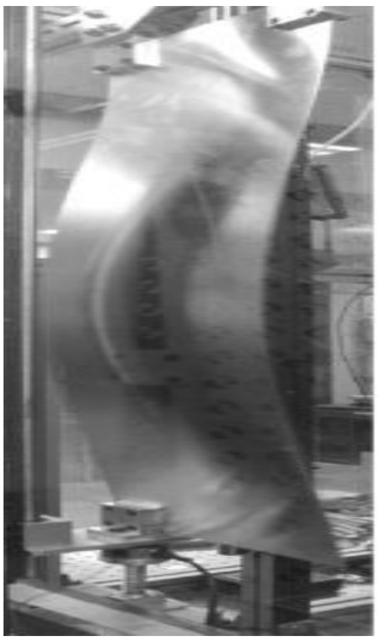
The buckling strength of a member is less than the elastic buckling strength of a structure if the material of the member is stressed beyond the elastic material range and into the non-linear (plastic) material behaviour range. When the compression load is near the buckling load, the structure will bend significantly and the material of the column will diverge from a linear stress-strain behaviour. This reduces the material rigidity and also leads to a decrease in the buckling strength of the structure and as a result of which a bucking load less than that predicted is obtained.

The tangent modulus of elasticity can be used as an accurate approximation method for calculating buckling load and modulus of elasticity. The tangent is almost equal to the elastic modulus and then decreases. It is a line drawn tangent to the stress-strain curve at a fixed value of strain.



Dynamic Buckling

When a significant load is suddenly applied and then released, the column will sustain a much higher load than its desired capacity. This happens in a long, unsupported column which is used as a drop hammer. The time of compression at the impact end is the time required for the stress to travel along the column to the free end and back. Maximum buckling occurs near the impact end of the column.



CHAPTER 2: LITERATURE REVIEW

S No.	Title	Date of Publishing	Name of Author	Review
1.	Buckling of Beam (The force- engineering strain curve)	November 7, 2013	PK. Luhart Prof M van Hecke and Dr. Vendetta	For a small force the coagulation of a straight beam is stable. For a large force the straight beam is an unstable conguration and a bended buckled, beam is the stable conguration. This is described by a fork bifurcation with the force as bifurcation parameter.

2.	Strength and Serviceability Design of Reinforced Concrete Deep Beams	December 2108, Rev. 2009: March, April	David Ferer Robin Tucherer Matt HuizingaOguzhan Bayrak, Sharon Wood and James Jirs	An experimental study was conducted in which 37 deep beam specimens were tested. The Specimens are some of the largest deep beams ever tested in the history of shear research. The data from the experimental program and from a database of 179 deep beam tests in the literature were used to address eight Tasks associated with the strength and serviceability design and performance of deep beams.
S No.	Title	Date of Publishing	Name of Author	Review
3.	Design of Steel Structures	2015	Prof. Satish Kumar And Prof.antha Kumar	Laterally stable steel beams can fail only by (a) Flexure (b) Shear or (c) Bearing, assuming the local buckling of slender components does not

				occur. These three conditions are the criteria for limit state design of steel beams. Steel beams would also become unserviceable due to excessive deflection and this is classified as a limit state of serviceability.
4.	Behaviour of reinforced concrete beams with confined concrete related to ultimate bending and shear strength	Engineering International Conference (EIC) 2016	Horng Hean Tee1 a) Kousay Al b) Jeffrey Choong Lun Chiang1	This research is to investigate the behaviour of over-balanced High Strength Reinforced Concrete Beams with the compression zone confined with spiral / helical steel reinforcements. The study covered beam behaviour with respect to flexural strength, shear strength, deflection and cracking related to confined concrete.
S No.	Title	Date of Publishing	Name of Author	Review

4.	Behavior of confined concrete beams.	Proceed Engineering 141627	Y Boraa M Shah A Mir	In order to provide higher mechanical effectiveness of confined concrete beam, the new technique proposed in this work consists to design at the ends of the steel reinforcement.

CHAPTER 3: AIM AND OBJECTIVES

Our aim from the project is to successfully cast the samples of beams and test the sample under the effect of subsequent loading and check for the effect of buckling on the beams.

First set of casting will be done by using {12mm} mild steel bars and in the other set these bars will be replaced by the angle sections of {20X20X3} whose cross-sectional area matches with that of the 12mm steel bars used in the samples.

After the casting we will check for the comparison in the strength of the structure by using two different reinforcement materials and analyze the nature of beams for buckling behavior of compression reinforcement, cracking and its failure in shear.

CHAPTER 4: PROCUREMENT OF RAW MATERIALS AND CONSTRUCTION OF MOULDS

For the project we have constructed six moulds of dimensions 150X150X700 as per the ASTM standards in which the entire casting will be done.

For the buckling behavior of the compression reinforcement we have used mild steel bars of 12mm which were procured from a retailer in Chandigarh as they were not easily available in local areas nearby.

WHY MILD STEEL?

We have opted for the use of mild steel bars as it's a cheaper alternative and moreover its material properties fit into many product applications.

Mild steel has a relatively low tensile strength, but it's easily malleable and its surface hardness can be increased by carburizing.

It has yield strength of 250MPa and is cold rolled.

Due to its low carbon content it can be bent easily rather than leading it to break and in turn making it far more tensile and less brittle.

After the first set of casting completed, we will replace the mild steel bars with the angle sections of 20X20X3 as these angle section's cross-sectional area matches exactly with that of that of the mild steel bars and there centre also lies at a similar height of 5.95 or 6mm from the periphery.

Ordinary Portland cement (OPC)

OPC of 43grade has been procured from the college campus as per the project requirement.

OPC has been preferred over other types of cements as it is highly durable and sound concrete due to very low percentage of alkalis, chlorides, magnesia and free lime in its composition.

Highly resistant to corrosion due to negligible amount of chloride content in its composition and provides higher strength as compared to the other types of cement.

Construction of stirrups for the binding of bars in the mould has been done by using 8mm HYSD steel bars which were available in college campus itself and rectangular stirrups of dimension 115X115mm has been made as per the requirement of the project.

CHAPTER 5: METHODOLOGY

CONSTRUCTION OF MOULDS:

Six moulds have been constructed of 150X150X700 in dimension in which the overall casting will be done.

OILING OF MOULDS:

Oiling of the moulds have been done so that the mould's surface can be made smoother for casting and after the casting is done, the sample can be easily taken out from the mould.

BINDING OF STEEL BARS:

The steel bars are bind together by the use of stirrups so as to provide proper reinforcement in the structure.

In the first set two stirrups are placed at the either ends of the bar and two more stirrups are placed at a spacing of approximately 215mm.

For the future sets of casting we will only alter the spacing of the stirrups and bind the bars together which will act as the reinforcement.

WELDING OF ANGLE SECTIONS:

Angle sections of length 890mm have been cut at 120mm length from both of the ends and welded vertically to the ends of the angle section so that they can be placed easily during the casting of the beams.

CASTING OF BEAMS:

This shows the concreting of mould.

TO CHECK THE STRENGTH OF THE CONCRETE USED IN SAMPLES:

CHAPTER 6: WORK PLAN ESTIMATE

As per the scheduled work plan, the first set of casting will be done by the end of December and the testing of the samples casted will be done after 28days.

Testing of the samples under 3point loading will done so as to check the strength properties of the sample and similar tests will be performed on the sample when the reinforcement will be replaced by the angle section.

Our plan is to cast a total of 6 set of samples by varying the spacing of the stirrups used and also varying the reinforcement used in the sample and checking the samples for variation in their strength and other characteristics like cracking, buckling under the effect of loading.

Beam Angle Confinement								
Set No.	Unconfined Sample	Confined	No of bar (12 mm 2) HYSD	No of bar (12 mm)	No of Angle Section (20x20x3 mm 2)	Stirrups 115 mm	No of Stirrups Per Sample	W/C
1	3	3	12	6	6	48	8	0.62
2	3	3	12	6	6	36	6	0.62
3	3	3	12	6	6	24	4	0.62
4	3	3	12	6	6	12	2	0.62
5	3	3	12	6	6	24	4	0.7
6	3	3	12	6	6	24	4	0.55
7	3	3	12	6	6	24	4	0.48

Mix Design of Beams

W/C	Slump	Water Content (Kg)	Actual Water (Kg)	Cement (Kg.)	Coarse Agreegate (Kg)	Fine Sand	Correction (Water Absorption in Kg)		Specific Garvity Sand (2.8)	Dry Density (CA)	%Correction	
							CA	FA			CA	FA
0.7	150-180	210	241.13	300.0	961	884.0	13.45	17.68	0.62	1.55	0.014	0.02
0.62	150-180	210	240.36	338.7	961	845.3	13.45	16.91	0.62	1.55	0.014	0.02
0.55	150-180	210	239.50	381.8	961	802.2	13.45	16.04	0.62	1.55	0.014	0.02
0.48	150-180	210	238.38	437.5	961	746.5	13.45	14.93	0.62	1.55	0.014	0.02
Adjustment in Cement Consumption												
0.7	150-180	245.1	274.50	350.1	961	798.8	13.45	15.98	0.62	1.55	1.167	
0.62	150-180	217.4	247.33	350.6	961	826.1	13.45	16.52	0.62	1.55	1.035	
0.55	150-180	210.0	239.50	381.8	961	802.2	13.45	16.04	0.62	1.55	1	
0.48	150-180	210.0	238.38	437.5	961	746.5	13.45	14.93	0.62	1.55	1	

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