

ADAPTATION OF CORRUGATION WEB IN CELLULAR BEAMS WITH HOLLOW FLANGE

A PROJECT REPORT

Submitted by

ATHIRA RAMESH

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To

APJ Abdul Kalam technological university

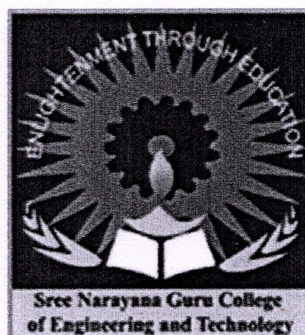
In partial fulfillment of the requirement for the award of the

Degree of

Master of technology

In

Computer Aided Structural Engineering



Department of Civil Engineering

**SREE NARAYANA GURU COLLEGE OF ENGINEERING &
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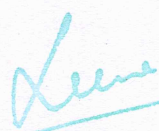
DECLARATION

I undersigned hereby declare that the project report “adaptation of corrugation web in cellular beams with hollow flange”, submitted for partial fulfillment of the requirements for the award of the degree of Master of Technology of the APJ Abdul Kalam Technological University, Kerala is a bonafide work done by me under supervision of Mr. Shibin B. This submission represents my ideas in my own words and where of others have been included; I have adequately and accurately cited and referenced the original sources. I also declare that I have adhered to ethics of academic honesty and integrity and have not misrepresented or fabricated any data or idea or fact or source in my submission. I understand that any violation of the above will be a cause for disciplinary action by the institute and/ or the University and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been obtained. This report has not been previously formed the basis for the award of any degree, diploma or similar title of any other University.

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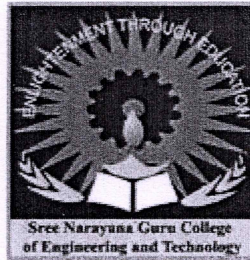
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CERTIFICATE

This is to certify that the project report entitled **“ADAPTATION OF CORRUGATION WEB IN CELLULAR BEAMS WITH HOLLOW FLANGE”** submitted by ‘**ATHIRA RAMESH**’ to the A.P.J Abdul Kalam Technological University in partial fulfillment of the requirements for the award of the Degree of Master of Technology in Computer Aided Structural Engineering, Department of Civil Engineering is a bonafide record of the project work carried out by her under my guidance supervision. This report in any form has not been submitted to any other University or Institute for any purpose.

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I extend my sincere gratitude to **Dr. Leena A V, The Principal, Sree Narayana Guru College of Engineering and Technology, Payyannur**, for her countenance towards the successful accomplishment of our course.

I express my deep fence of gratitude to **Mrs. B Mary Sonia George, Head of the Department of Civil Engineering**, for her kind co-operation and technical support rendered by her in making my project successful.

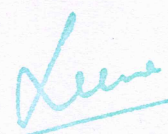
I express my heartfelt gratitude to my project coordinator **Mrs. Saritha Sasindran, Department of Civil Engineering** for her valuable guidance throughout my project.

I express my heartfelt gratitude to my project guide **Mr. Shibin B, Assistant Professor, Department of Civil Engineering** whose efficient guidance and direction encouraged me to make this effort successful.

Last but not least I express my gratitude to my parents, my friends, all staffs of the Civil Engineering Department who gifted me the necessary driving force and boost to remain positive always with high spirits.

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ABSTRACT

Nowadays Cold Formed Steel (CFS) sections are extensively used in structural engineering works replacing the conventional hot-rolled sections. It is due to the inherent advantages of the CFS. In industrial buildings and also in multi-storey buildings it is mandatory to provide web openings and they are generally provided in CFS roof and flooring systems to accommodate the pipelines and the building services, which leads to the reduction of floor heights. The disadvantage of placing web openings are, it will influence the shear behaviour reduce the strength and shear capacity significantly. The beam stiffness will decrease when web openings are placed, so it will buckle the beam easily when high seismic force or working loads are acted. Also shear failure will takes place. To prevent these hollow flanges are provided with straight beams. So very limited research studies have been conducted on hollow flange CFS beam with web openings. In this study to avoid shear buckling, use the method of implementation of corrugated webs. This study is about how strength and the shear capacity are improvising by implementing corrugated design in cellular beams. Two methods are used for improvising. First is with different type of corrugated shapes. They are dovetail type corrugation, rectangular type corrugation and trapezium type corrugation. Second is with varying the thickness of the web. In this method instead of stiffening the web externally, they are in-building it by these corrugation design. The test conducting are shear and flexural test. By this it is expected that the moment of inertia of web and strength will increase, also the possibility of shear buckling decreases. The complete study is carried out using a finite element method in ANSYS software. The results details that the corrugated web hollow flange cellular beams has less weight and more strength than the flat web hollow flange. So the corrugated web cellular hollow flange beams have better performance than the flat web cellular hollow flange beams.

Keywords: *Hollow Flange Beam, Web Openings, Corrugated Web, Cellular Beam*

CONTENTS

Contents	Page No.
ACKNWOLEDMENT	i
ABSTRACT	ii
LIST OF TABLES	vi
LIST OF FIGURES	vii
ABBREVIATIONS	ix
Chapter 1. INTRODUCTION	1
1.1 General	1
1.2 Web openings in CFS	2
1.3 Corrugated web beams	3
Chapter 2. LITERATURE SURVEY	5
2.1 General	5
2.2 Cold-formed hollow flange beam	5
2.3 Web openings	8
2.4 Corrugated webs	10
2.5 Summary	13
Chapter 3. OBJECTIVES, SCOPES AND METHODOLOGY	14
3.1 General	14
3.2 Objectives	14
3.3 Scope	14
3.4 Methodology	15
3.5 Summary	15
Chapter 4. FINITE ELEMENT ANALYSIS	16
4.1 General	16
4.2 Finite Element Modelling in ANSYS	16
4.3 Description of the Experimental Model	16
4.4 Finite Element Model	17

4.4.1 Geometry Modelling	17
4.4.2 Material Modelling	18
4.5 Meshing	18
4.6 Loads and Boundary conditions	19
4.7 Analysis of the Model	19
4.8 Result	20
4.9 Summary	22
Chapter 5. MODELLING OF CELLULAR BEAM AND PARAMETERS	23
5.1 General	23
5.2 Parametric Study	23
5.3 Description of the Flat Beam with Web Opening	23
5.4 Description of the Cellular Beam with Corrugated Web and with Hollow Flange	24
5.5 Material Modelling	24
Chapter 6. RESULT AND DISCUSSION	25
6.1 General	25
6.2 Analysis of Cellular Beam with Flat Flange	25
6.3 Analysis of Cellular Hollow Flange Beam with Corrugated Web	26
6.4 Study with Parameters	26
6.4.1 Effect on Varying Height Study with Flat Flange in Flat Web and Corrugated Web	27
6.4.2 Effect of Hollow Flange in Flat and Corrugated Web	31
6.4.3 Effect of Corrugation Height in Hollow Flange	35
6.4.4 Effect of Corrugation Web Width with Hollow Flange	41
6.4.5 Effect of Hole Diameter in Corrugation Web with Hollow Flange	44

6.5 Comparison of Result	47
6.5.1 Beam with Trapezoidal Corrugated Web	47
6.5.2 Beam with Rectangular Corrugated Web	48
6.5.3 Beam with Dovetail Corrugated Web	50
6.6 Ultimate Load Comparison	51
6.7 Summary	52
Chapter 7. CONCLUSIONS	53
7.1 Cellular Hollow Flange Beam with Corrugated Web	53
7.2 Summary	54
REFERENCES	55

LIST OF TABLES

No.	Title	Page No.
4.1	Comparison of results	22
5.1	Material Properties of Concrete	24
6.1	l/d ratio of beams	27
6.1.	Analysis result of flat flange in flat web and flat flange in corrugated web	29
6.2	Analysis result of the flat web cellular hollow flange beam	32
6.3	Analysis result of the different shaped corrugation web cellular hollow flange	33
6.4	Analysis result of corrugation web with different depth	38
6.5	Analysis result of different CHFCB with varying depth	40
6.6	Analysis result of the varying corrugation web width	42
6.7	Analysis result of the change in hole diameter in corrugation web	44
6.8	Comparison result of the analysis with trapezoidal corrugated web and flat web	47
6.9	Comparison result of the analysis with rectangular corrugated web and flat web	48
6.10	Comparison result of the analysis with dovetail corrugated web and flat web	50

LIST OF FIGURES

No.	Title	Page No.
1.1	Hollow flange beams	2
1.2	Service integration on beams through web openings	2
1.3	Trapezoidal corrugated web	3
1.4	Beam with sinusoidal, trapezoidal and triangularly corrugated web	4
4.1	Finite Element model of specimen	17
4.2	Meshed model	18
4.3	Model with boundary conditions	19
4.4	Total deformation of cellular beam at half cut section	20
4.5	Equivalent plastic strain of cellular beam at half cut section.	21
4.6	Load deflection curve of the result from the experimental with web openings.	21
4.7	Load deflection curve of the finite element analysis without web openings.	22
6.1	Geometry model of cellular beam with flat web and flat flange	25
6.2	Geometry model of cellular beam with corrugated web and flat flange	26
6.3	Meshed model of the cellular beam with flat flange and flat web.	28
6.4	Meshed model of the corrugated web cellular beam with flat flange.	28
6.5	Equivalent plastic strain diagram of TRA HT 100	29
6.6	Deformation diagram of TRA HT 100	30
6.7	Ultimate load graph of cellular beam with flat web and corrugated web	30
6.8	Geometry model of hollow flange cellular beam	31
6.9	Equivalent plastic strain diagram of HF 1.5mm	32
6.10	Deformation diagram of HF 1.5mm	33
6.11	(a) Equivalent plastic strain	34
	(b) deformation diagram of TRA HF 1.5mm	

6.12	(a) Equivalent plastic strain	34
	(b) deformation diagram of REC HF 1.5mm	
6.13	(a) Equivalent plastic strain	35
	(b) deformation diagram of DOVETAIL HF 1.5mm	
6.14	(a) Meshed geometry	36
	(b) wireframe diagram of trapezoidal CHFCB	
6.15	(a) Meshed geometry	37
	(b) wireframe diagram of rectangular CHFCB	
6.16	(a) Meshed geometry	37
	(b) wireframe diagram of dovetail CHFCB	
6.17	deformation diagram of TRA HF HT 200	39
6.18	Ultimate load graph of different CHFCB with varying depth	41
6.19	(a) Equivalent plastic strain	42
	(b) deformation diagram of REC HF C50mm	
6.20	Ultimate load graph of varying corrugation web width	43
6.21	Load verses deformation graph	43
6.22	(a) Equivalent plastic strain	45
	(b) deformation diagram of REC HF D50mm	
6.23	Ultimate load graph of changing hole diameter in different CHFCB	45
6.24	Load verses deformation curve	46
6.25	Load verses deformation curve of the cellular hollow flange with trapezoidal corrugated web and cellular hollow flange with flat web	47
6.26	Load verses deformation curve of the cellular hollow flange with rectangular corrugated web and cellular hollow flange with flat web	49
6.27	Load verses deformation curve of the cellular hollow flange with dovetail corrugated web and cellular hollow flange with flat web	50
6.28	Ultimate load diagram	51

ABBREVIATIONS

CFS	Cold Formed Steel
OATM	One Steel Australian Tube Mills
HFC	Hollow Flange Channel
LSB	Lite Steel Beam
RHFB	Rectangular Hollow Flange Beams
CFST	Concrete-filled steel tubes
CSW	Corrugated steel web
WSP	Web Side Plates
CHFCB	Corrugation web hollow flange cellular beam

STRUCTURAL PERFORMANCE OF GROOVED GUSSET PLATE DAMPER IN EBF AND CBF

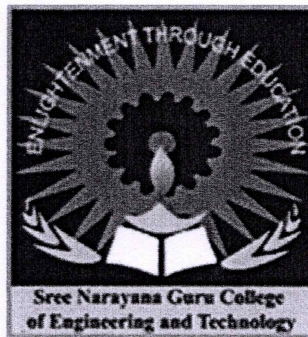
A PROJECT REPORT

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To

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In partial fulfilment of the requirement for the award of the
Degree of
Master of Technology
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DECLARATION

I undersigned hereby declare that the project report "Structural Performance of Grooved Gusset Plate Damper in EBF and CBF", submitted for partial fulfillment of the requirements for the award of degree of Masters of Technology of the APJ Abdul Kalam Technological University, Kerala is a bonafide work done by me under supervision of Mrs. B. Mary Sonia George. This submission represents my ideas in my own words and where ideas or words of others have been included; I have adequately and accurately cited and referenced the original sources. I also declare that I have adhered to ethics of academic honesty and integrity and have not misrepresented or fabricated any data or idea or fact or source in my submission. I understand that any violation of the above will be a cause of disciplinary action by the institute and/or the University and can also evoke penal action from the source which has thus not been properly cited or from whom proper permission has not been obtained. This report has not been previously formed the basis for the award of any degree, diploma or similar title of any University.

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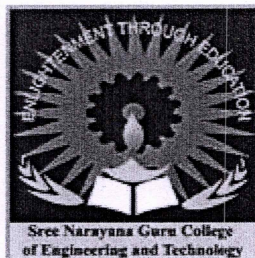
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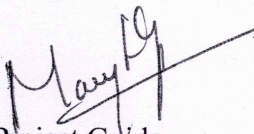
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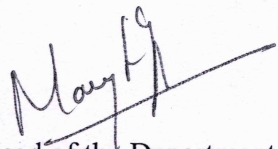
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ACKNOWLEDGEMENT

“First and foremost I thank almighty God for his blessings showered upon me to complete my project.

I extend my sincere gratitude to **Dr. Leena A V, The Principal, Sree Narayana Guru College of Engineering and Technology, Payyanur**, for her countenance towards the successful accomplishment of our course. I express my deep fence of gratitude to my project guide **Mrs. B Mary Sonia George, Head of the Department of Civil Engineering**, for her kind cooperation and technical support rendered by her in making my project successful. I express my heartfelt gratitude to my project coordinator **Mrs. Saritha Sasidran, Department of Civil Engineering** for her valuable guidance throughout my project.

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ABSTRACT

The purpose of this study is to modify the braces by installing some energy dissipation device that is added to braces, to absorb the energy and protect the structures from severe earth quakes. Here we use Eccentrically Braced Frame (EBF) and Centrally Braced Frame (CBF). It prevents all other member including beam, column, connection and also braces from seismic damages. Therefore it improves seismic performance of EBF and CBF. The proposed device includes a gusset plate which is grooved so that it yields in several places and also prevents the plastic action or buckling in the braces. This type of device is known as Grooved Gusset Plate Damper (GGPD). The damper is a small plated metallic element. It can be installed in a braced frame then it act as an energy dissipater. It dissipates the seismic energy through inelastic deformation at its steel strips and absorbs the complete shear. After that, the failure of the damper plate takes place rather than the bracings. In this study, an easily replaceable cost effective damper plate can be utilized on the EBF and CBF. It is expected that improve the performances of EBF and CBF when GGPD is installed. The complete studies have been carried out using a nonlinear finite element method in ANSYS software.

Keywords: Grooved Gusset Plate Damper, Eccentric Braced Frame, Concentric Braced Frame, Seismic performance.

CONTENTS

Contents	Page No.
ACKNOWLEDGEMENT	i
ABSTRACT	ii
LIST OF TABLES	vii
LIST OF FIGURES	viii
ABBREVIATION	xi
Chapter 1. INTRODUCTION	
1.1 General	1
1.2 Grooved Gusset Plate Damper	2
1.3 Braced Frame	2
Chapter 2. ANSYS WORKBENCH	
2.1 General	4
2.2 Static Analysis in ANSYS	4
2.3 Transient Analysis in ANSYS	4
Chapter 3. LITERATUTE REVIEW	
3.1 General	5
3.2 Braced Frame	5
3.3 Seismic Performance of Braced Frame	6
3.4 Concentrically Braced Frame	6

3.5 Eccentrically Braced Frame	8
--------------------------------	---

3.6 Dampers	9
-------------	---

Chapter 4. OBJECTIVES AND SCOPES

4.1 General	13
-------------	----

4.2 Objectives	13
----------------	----

4.2.1 Damper Optimization	13
---------------------------	----

4.2.2 Lateral Loading Performance	13
-----------------------------------	----

4.2.3 Time History Seismic Analysis	13
-------------------------------------	----

4.3 Scopes	13
------------	----

Chapter 5. FINITE ELEMENT ANALYSIS

5.1 General	14
-------------	----

5.2 Finite Element Modelling in ANSYS	14
---------------------------------------	----

5.3 Finite Element Method	14
---------------------------	----

5.3.1 Geometry of the Model	14
-----------------------------	----

5.3.2 Material Modelling	15
--------------------------	----

5.4 Meshing	15
-------------	----

5.4 Loads and Boundary Condition	16
----------------------------------	----

5.5 Analysis of the Model	17
---------------------------	----

5.6 Results	17
-------------	----

5.7 Summary	19
-------------	----

Chapter 6. MODELLING OF CBF WITH AND WITHOUT DAMPER

6.1 General	21
6.2 Description of Concentrically Braced Frame	21
6.3 Analysis of the Frame	22
6.4 Description of CBF with Damper	23
6.6 Parametric Study of GGPD	24
6.6.1 Thickness	25
6.6.2 Width of GGPD	27
6.6.3 Length of Slit	28

Chapter 7. TIME HISTORY SEISMIC ANALYSIS OF CBF

7.1 General	30
7.2 Concentrically Braced Frame	30
7.2.1 CBF without Damper in Multi Storied Frame	30
7.2.2 CBF with Damper in Multi Storied Frame	32

Chapter 8. MODELLING OF EBF WITH AND WITHOUT DAMPER

8.1 General	36
8.2 Analysis of EBF with and Without Damper	36

Chapter 9. TIME HISTORY SEISMIC ANALYSIS OF EBF

9.1 General	39
9.2 EBF without Damper in Multi Storied Frame	39
9.3 EBF with Damper in Multi Storied Frame	40

Chapter 10. RESULT AND DISCUSSION

10.1 Concentrically Braced Frame	44
10.2 CBF in Multi Storied Frame	44

10.3 Eccentrically Braced Frame	49
10.4 EBF in Multi Storied Frame	50
Chapter 11. CONCLUSION	
11.1 General	54
11.2 GGPD in CBF and EBF	54
11.3 Summary	55
REFERENCES	56



LIST OF TABLES

Table No	Title	Page No.
5.1	Comparison of the Result from the Literature and FEA	19
6.1	Properties of the Frame	22
6.2	Properties of the Brace	22
6.3	Result of the Model	23
6.4	Properties of GGPD	23
6.5	Analysis Result of the Model	26
6.6	Result of the Model When Width of the GGPD is changed	27
6.7	Result of the Model When Length of slit is changed	28
10.1	Analysis Result of the CBF	44
10.2	Result of CBF in Multi Storied Frame	46
10.3	Analysis Result of the EBF	49
10.4	Result of EBF in Multi Storied Frame	51

LIST OF FIGURES

Figure No	Title	Page No.
1.1	Grooved Gusset Plate Damper in X-Braced Frame	2
1.2	Chevron Braced Frame and Single Braced Frame	3
5.1	Grooved Gusset Plate Damper	15
5.2	Meshed Model	16
5.3	Loads and Boundary Condition	16
5.4	Deformation of the Model	18
5.5	Graph from the Literature	18
5.6	Graph from FEA	19
6.1	Load and Boundary Condition	21
6.2	Deformation of the Frame	22
6.3	Geometry of GGPD in CBF	24
6.4	Parameter of the GGPD	25
6.5	Deformation of the Model	25
6.6	Force Reaction Curve	26
6.7	Load Deformation Curve of Thickness	27
6.8	Load Deformation Curve of Width of GGPD	28
6.9	Load Deformation Curve of Length of Slit	29
7.1	Modelling of CBF without Damper in Multi Storied Frame	31
7.2	Modal Deformation and Transient Deformation of CBF	31
7.3	CBF M-1	32
7.4	CBF M-2	33
7.5	CBF M-3	33

7.6	CBF M-4	34
7.7	CBF M-5	34
7.8	CBF M-6	35
7.9	CBF M-7	35
8.1	Modelling of EBF without Damper	37
8.2	Modelling of EBF with Damper	37
8.3	Deformation of EBF without Damper	38
8.4	Deformation of EBF with Damper	38
9.1	Modelling of EBF without Damper in Multi Storied Frame	39
9.2	Modal Deformation and Transient Deformation of EBF	40
9.3	EBF M-1	40
9.4	EBF M-2	41
9.5	EBF M-3	41
9.6	EBF M-4	42
9.7	EBF M-5	42
9.8	EBF M-6	43
9.9	EBF M-7	43
10.1	Total Acceleration Graph of CBF	47
10.2	Storey Displacement Graph of CBF	47
10.3	Base Shear Graph (1)	48
10.4	Base Shear Graph (2)	48
10.5	Load Deformation Graph (compression) in EBF	49
10.6	Load Deformation Graph (tension) in EBF	50
10.7	Total Acceleration Graph of EBF	52

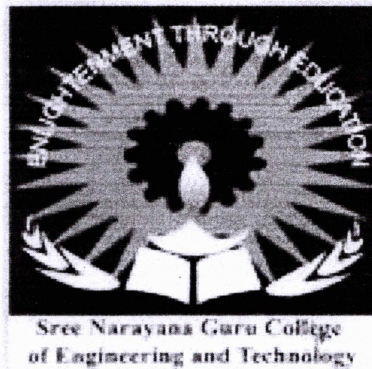
10.8	Storey Displacement Graph of EBF	52
10.9	Base Shear Graph	53

ABBREVIATION

GGPD	Grooved Gusset Plate Damper
CBF	Concentrically Braced Frame
EBF	Eccentrically Braced Frame

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Project Report on

PERFORMANCE OF 3D PRINTED AESTHETIC STRUCTURAL DUPLET COLUMN

Submitted in partial fulfillment for the award of the degree of the

Degree of Master of Technology In

In computer Aided Structural Engineering

Of

A.P.J Abdul Kalam Technological University

Submitted by

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DECLARATION

I undersigned hereby declare that the project report "Performance of 3D Printed Aesthetic Structural Duplet Column" submitted for partial fulfilment of the requirements for the award of degree of Master of Technology of the APJ Abdul Kalam Technological University, Kerala is a bonafide work done by me under supervision of Dr. Susan Abraham. This submission represents my ideas in my own words and where ideas or words of others have been included; I have adequately and accurately cited and referenced the original sources. I also declare that I have adhered to ethics of academic honesty and integrity and have not misrepresented or fabricated any data or idea or fact or source in my submission. I understand that any violation of the above will be a cause for disciplinary action by the institute and/or the University and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been obtained. This report has not been previously formed the basis for the award of any degree, diploma or similar title of any other University.

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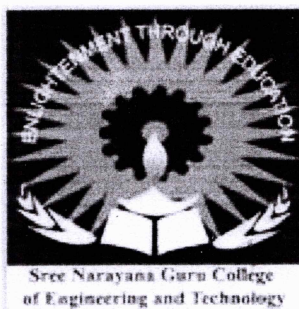
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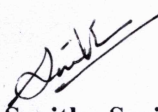
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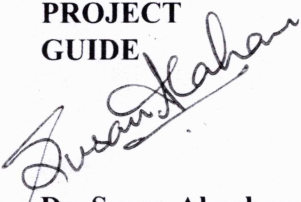
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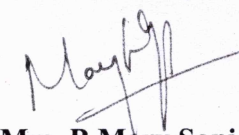
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"First and foremost I concede the surviving presence and the flourishing refinement of the Almighty God for his concealed hand yet substantial supervision all through the project.

I extend my sincere gratitude to **Dr. Leena AV, The Principal, Sree Narayana Guru College of Engineering and Technology, Payyanur**, for her countenance towards the successful accomplishment of our course. I express my deep sense of gratitude to **Dr. Susan Abraham, Dean of Sree Narayana Guru College of Engineering and Technology**, for her kind cooperation and technical support rendered by her in making my project successful.

I express my heartfelt gratitude to my project coordinator **Mrs. Saritha Sasindran, Department of Civil Engineering** for her valuable guidance throughout my project. Last but not the least I express my gratitude to my parents, my friends, all staff of the Civil Engineering Department who gifted me the necessary driving force to remain positive always with high spirits.

DRISHYA K.P



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ABSTRACT

The commercial finite element programme ANSYS is used to create a numerical model in order to examine the structural performance of 3D printing on attractive structural duplet columns. To create three-dimensional shapes, material is consecutively stacked while being controlled by a computer during 3D printing. It is highly useful for creating prototypes and geometrically challenging components. In this study, two I-shaped columns that are set up in series and parallel are taken into consideration. Let's examine the behaviour of the column at various rotational degrees in both series and parallel arrangements. The ANSYS software was used to create 18 models (nine parallel and nine perpendicular). After the performance study is completed, strengthen the chosen model to determine which of these models has the best structural performance. Both inside and externally, steel plates and engineered cement concrete can be used to strengthen structures.

Keywords- ANSYS software

CONTENTS

TITLE	PAGE NO.
Acknowledgement.....	i
Abstract	ii
List of Figures	v
List of Tables	vii
CHAPTER 1: INTRODUCTION.....	1
1.1 General.....	1
1.2 3D Printing.....	1
1.3 Pre-Twisted Columns.....	2
1.4 Duplet columns and cruciform sections.....	3
CHAPTER 2: LITERATURE REVIEW	4
2.1 General.....	4
CHAPTER 3: ANSYS SOFTWARE.....	17
3.1 Different types of ANSYS.....	17
3.2 Advantages of ANSYS.....	17
CHAPTER 4: OBJECTIVES, SCOPE AND METHODOLOGY.....	19
4.1 General.....	19
4.2 Objectives.....	19
4.3 Scope.....	19
4.4 Methodology.....	19
CHAPTER 5: VALIDATION.....	21
5.1 General.....	21
5.2 Finite Element Modelling in ANSYS.....	21
5.3 Description of experiment model.....	21
5.4 Finite element method.....	22
5.5 Meshing.....	23
5.6 Load and boundary conditions.....	24
5.7 Analysis of the model.....	24

PERFORMANCE OF 3D PRINTED AESTHETIC STRUCTURAL DUPLET COLUMNS

5.8 Result.....	25
5.9 Failure observations.....	28
5.10 Summary.....	29

CHAPTER 6: MODELING OF 3D PRINTED AESTHETIC

STRUCTURAL DUPLET COLUMN.....	30
6.1 General.....	30
6.2 Parametric study.....	30
6.2.1 Modelling and analysis	30
6.2.2 Strengthening.....	45

CHAPTER 7: CONCLUSION.....50

7.1 Parallel configuration.....	50
7.2 Perpendicular configuration.....	51

CHAPTER 8: REFERENCES.....52

LIST OF FIGURES

TITLE	PAGE NO
1.1 3D Printing.....	2
1.2 Coupled columns.....	3
1.3 Cruciform sections.....	3
5.1 Modelling of wall.....	22
5.2 Finite element model.....	23
5.3 Model with boundary condition.....	24
5.4 Total deformation.....	25
5.5 Equivalent plastic strain.....	26
5.6 Maximum principal stress.....	26
5.7 Failure in experiment.....	28
5.8 Failure in FEM.....	28
6.1 Duplet I section	31
6.2 Zero-degree rotation.....	31
6.3 45-degree rotation.....	32
6.4 90-degree rotation.....	32
6.5 135-degree rotation.....	33
6.6 180-degree rotation.....	34
6.7 225-degree rotation.....	34
6.8 270-degree rotation.....	35
6.9 315-degree rotation.....	36

PERFORMANCE OF 3D PRINTED AESTHETIC STRUCTURAL DUPLET COLUMNS

6.10 360-degree rotation.....	36
6.11 Result graph.....	37
6.12 Perpendicular twist.....	38
6.13 Zero-degree rotation.....	39
6.14 45-degree rotation.....	39
6.15 90-degree rotation.....	40
6.16 135-degree rotation.....	40
6.17 180-degree rotation.....	41
6.18 225-degree rotation.....	42
6.19 270-degree rotation.....	42
6.20 315-degree rotation.....	43
6.21 360-degree rotation.....	44
6.22 Result graph	45
6.23 Strengthening by Insertion of Steel.....	45
6.24 Deformation Curve of Insertion of Steel.....	46
6.25 Strengthening by External Plating.....	47
6.26 Deformation Curve of External plating.....	48
6.27 Infilling by ECC.....	48
6.28 Deformation Curve of Infilling.....	49

LIST OF TABLES

TITLE	PAGE NO
5.8 Comparison of result.....	27
6.1 Result of parallel twist.....	37
6.2 Result of Perpendicular twist.....	44
6.3 Result of Insertion of steel.....	46
6.4 Result of External plating.....	47
6.5 Result of Infilling.....	49

STRUCTURAL PERFORMANCE OF STEEL ENCASED COMPOSITE MULTILAYER CONCRETE BEAM

A PROJECT REPORT

Submitted by

NIKESH K (SNC21CECS05)

To

APJ Abdul Kalam Technological University

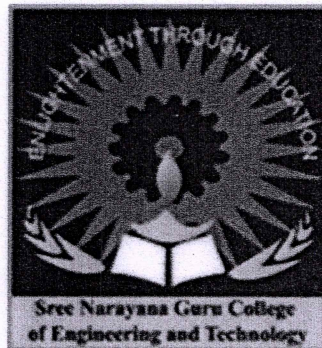
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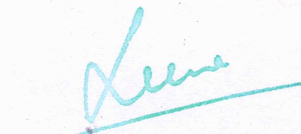


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DECLARATION

I undersigned hereby declare that the project report "Structural Performance Of Steel Encased Composite Multilayer Concrete Beam" submitted for partial fulfillment of the requirements for the award of degree of Master of Technology of the APJ Abdul Kalam Technological University, Kerala is a bonafide work done by me under supervision of Ms. Shamyia Sukumaran M. This submission represents my ideas in my own words and where ideas or words of others have been included; I have adequately and accurately cited and referenced the original sources. I also declare that I have adhered to ethics of academic honesty and integrity and have not misrepresented or fabricated any data or idea or fact or source in my submission. I understand that any violation of the above will be a cause for disciplinary action by the institute and/or the University and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been obtained. This report has not been previously formed the basis for the award of any degree, diploma or similar title of any other University.



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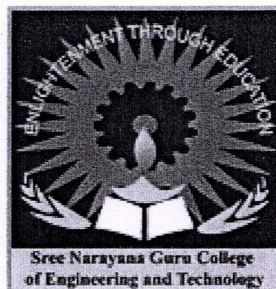
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CERTIFICATE

This is to certify that the project report entitled “**STRUCTURAL PERFORMANCE OF STEEL ENCASED COMPOSITE MULTILAYER CONCRETE BEAM**” submitted by ‘**NIKESH K**’ to the A.P.J Abdul Kalam Technological University in partial fulfillment of the requirements for the award of the Degree of Master of Technology in Computer Aided Structural Engineering, Civil Engineering is a bonafide record of the project work carried out by him/her under my/our guidance supervision. This report in any form has not been submitted to any other University or Institute for any purpose.

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First and foremost, I think almighty God for his blessings showered upon me to complete my project.

I am extremely grateful to our respected Principal **Dr. Leena A V**, for all the help and guidance given.

I express my deep and sincere gratitude to **Mrs. B Mary Sonia George**, Head of the Department, Department of Civil Engineering for her support, valuable suggestions and guidance in completing this paper.

I am also grateful to **Ms Shamyia Sukumaran M**, Assistant Professor, department of Civil Engineering and our project co-ordinator **Mrs. Saritha Sasindran** for providing me an opportunity to present this project.

I also extend my heartfelt thanks to the Department of Civil Engineering, SNGCET and all my friends and family for their support and co-operation.

NIKESH K

ABSTRACT

In this paper, a composite multilayered concrete beam is analyzed by using ANSYS workbench software. An I section which is partially encased with Ultra-High Performance Concrete [UHPC] and Ultra-Light weight Cement Concrete [ULCC]. These composite materials had been arranged horizontally and vertically along the I Section. Hot rolled wide flange beams [WB] was used as an I section. Multiple aspects were taken into consideration when conducting the investigation on the partially encased multi-layered concrete beam. Multiple specimens were cast based on the objective. Compressive strength of various multilayered composite beams has been compared. Instead of using conventional steel or reinforced concrete members, this form of beams offers greater strength and stiffness. To enhance the ductility of the beam shear connectors are provided. To enhance the strength of the beam stiffeners are provided. The compressive strength of partially encased steel multilayered composite beam with stiffeners is higher compared to other partially encased steel multilayered composite models.

Keywords:- *Ultra-High Performance Concrete [UHPC], Ultra-Light weight Cement Concrete[ULCC], ANSYS software, Hot rolled wide flange beams.*

TABLE OF CONTENTS

Contents	Page No.
ACKNOWLEDGEMENT	i
ABSTRACT	ii
LIST OF FIGURES	vi
LIST OF TABLES	viii
ABBREVIATIONS	x
CHAPTER 1. INTRODUCTION	
1.1 General	01
CHAPTER 2. LITERATURE REVIEW	03
2.1 General	03
2.2 Literature Review	03
2.3 Summary	13
CHAPTER 3. OBJECTIVE, SCOPE AND METHODOLOGY	14
3.1 Objective	14
3.2 Scope	14
3.3 Methodology	14
CHAPTER 4. FINITE ELEMENT ANALYSIS	16
4.1 General	16
4.2 Finite Element Modelling in ANSYS	16
4.3 Description of Experimental Model	16
4.4 Finite Element Method	17
4.4.1 Geometry Modelling	18
4.4.2 Material Modelling	18
4.5 Meshing	19
4.6 Loads and Boundary Conditions	19
4.7 Analysis of the Model	20
4.8 Results	20
4.9 Summary	24

CHAPTER 5. MODELLING OF STEEL ENCASED	25
MULTILAYERED COMPOSITE BEAMS	
5.1 General	25
5.2 Parametric Study	25
5.3 Description of Cementitious Material Horizontally	26
Horizontally Arranged Partially Encased Steel	
Composite Beams	
5.4 Description of Cementitious Material Vertically	27
Arranged Partially Encased Composite Beams	
5.5 Description of Cementitious Material Horizontally	29
Arranged Partially Encased Steel Composite	
Beams with Shear Connectors	
5.6 Description of Cementitious Material Horizontally	31
Arranged Partially Encased Steel Composite	
Beams with Stiffeners	
5.7 Material Modelling	32
CHAPTER 6. RESULT AND DISCUSSION	34
6.1 General	34
6.2 Hot Rolled Wide Flange Beams [WB225]	34
6.3 Steel Encased Composite Beams with	35
Cementitious Materials Horizontally Arranged	
6.3.1 Comparison of Loads of Uniform Layer	36
Model	
6.3.2 Comparison of Multilayered Composite	36
Model	
6.3.3 Comparison of ULU with I Section [WB225]	37
6.4 Steel Encased Composite Beams With	38
Cementitious Materials Vertically Arranged	

	39
6.4.1 Comparison of Multilayered Composite Model	
6.4.2 Comparison of LU-LU with I Section [WB225]	40
6.5 Comparison of Cementitious Material Vertically Arranged Model & Horizontally Arranged Model	41
6.6 Load & Deflection of Various Models with Shear Connectors	41
6.7 Comparison of Models with and without Shear Connectors	43
6.8 ULU Model with Stiffeners Arranged in Various Position	43
6.9 Comparison of ULU & ULU with Stiffeners	44
6.10 Comparison of Multilayer Model with I Section	45
6.11 Summary	46
CHAPTER 7. CONCLUSIONS	47
REFERENCES	49

LIST OF FIGURES

Fig. No.	Title	Page No.
4.1	Cross-Section of ECC-75[from Journal]	17
4.2	Cross-Section of ECC-75[from ANSYS]	17
4.3	Finite Element Model of specimen	18
4.4	Mesh Model of Specimen	19
4.5	Model with Boundary Condition	20
4.6	Total Deformation	21
4.7	Maximum Principle Stress	21
4.8	Equivalent Stress	22
4.9	Load vs Deflection Chart of Experimental Model	22
4.10	Load vs Deflection Chart of FEM Model	23
5.1	Cross Section of Model with Layers Arranged Horizontally	26
5.2	Cross Section of Model ULU	27
5.3	Cross Section of Model with Layers Arranged Vertically	28
5.4	Cross Section of LU-LU Model	28
5.5	Shear Connector Details [From ANSYS]	29
5.6	Cross Section of Model with Shear Connectors	30

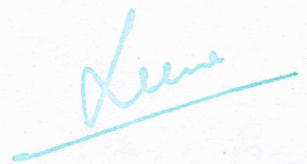
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5.7	Finite Element Model with Shear Connectors	30
5.8.1	Stiffener ULU	31
5.8.2	Web Stiffeners ULU	31
5.8.3	Flange Stiffener ULU	32
5.8.4	Compression Zone Stiffener ULU	32
5.8.5	Tension Zone Stiffener ULU	32
6.1	Cross Section of I Section [WB225]	34
6.2	Load vs Deflection Chart of Cementitious Material Horizontally Arranged Models	35
6.3	Finite Element Model of ULU	37
6.4	Load vs Deflection Chart of Cementitious Material Vertically Arranged Models	39
6.5	Finite Element Model of LU-LU	40
6.6	Load vs Deflection Graph of Models with Shear Connectors	42
6.7	Load vs Deflection Curve of ULU with Stiffeners	44

LIST OF TABLES

Table No.	Title	Page No.
4.1	Comparison of experimental load with finite element model load	23
5.1	Material properties of STEEL, UHPC & ULCC	33
6.1	Load and deflection of I section	34
6.2	Load and deflection of cementitious material horizontally arranged model	35
6.3	Comparison of loads of uniform layer models	36
6.4	Comparison of multi-layered composite models	36
6.5	Comparison of ULU with I section	37
6.6	Load and deflection of composite models with layers arranged vertically	38
6.7	Comparison of multilayer composite model	39
6.8	Comparison of LU-LU with I section	40
6.9	Comparison of vertically arranged model with horizontally arranged model	41
6.10	Load & deflection of various models with shear connectors	42
6.11	Comparison of models with and without shear connectors	43
6.12	Comparison of ULU model with stiffeners	44

6.13	Comparison of ULU with Stiffener ULU	45
6.14	Comparison of multilayer model with I section	45



ABBREVIATIONS

UHPC	Ultra-High Performance Concrete
ULCC	Ultra-Light Weight Cement Concrete
	ULCC-ULCC-ULCC Layer
ECC	Engineered Cementitious Concrete
LWC	Light Weight Concrete

PERFORMANCE OF INTEGRATED ORTHOGONAL COLUMNS WITH AND WITHOUT FRP WRAPPING SUBJECTED TO LOCALIZED CORROSION

A PROJECT REPORT

Submitted by

SNEHA C RAJ (SNC21CECS06)

To

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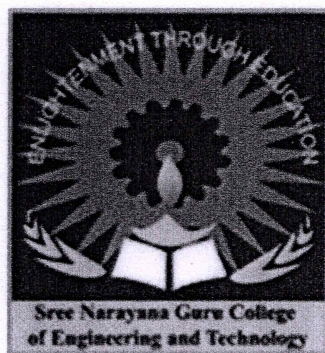
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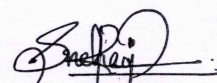
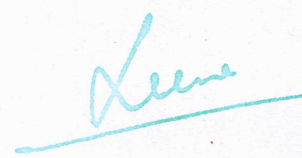
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I undersigned hereby declare that the project report "Performance Of Integrated Orthogonal Columns With And Without FRP Wrapping Subjected To Localized Corrosion" submitted for partial fulfillment of the requirements for the award of degree of Master of Technology of the APJ Abdul Kalam Technological University, Kerala is a bonafide work done by me under supervision of Mrs. Shilpa Valsakumar. This submission represents my ideas in my own words and where ideas or words of others have been included; I have adequately and accurately cited and referenced the original sources. I also declare that I have adhered to ethics of academic honesty and integrity and have not misrepresented or fabricated any data or idea or fact or source in my submission. I understand that any violation of the above will be a cause for disciplinary action by the institute and/or the University and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been obtained. This report has not been previously formed the basis for the award of any degree, diploma or similar title of any other University.

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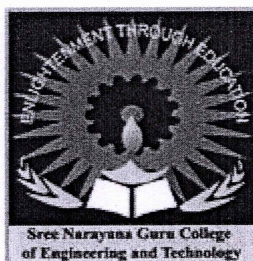
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ACKNOWLEDGEMENTS

First and foremost, I think almighty God for his blessings showered upon me to complete my project.

I am extremely grateful to our respected Principal **Dr. Leena A V**, for all the help and guidance given.

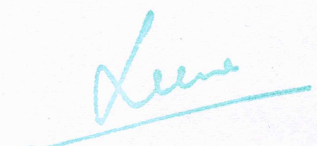
I express my deep and sincere gratitude to **Mrs. B Mary Sonia George**, Head of the Department, Department of Civil Engineering for her support, valuable suggestions and guidance in completing this paper.

I am also grateful to **Mrs. Shilpa Valsakumar**, Assistant Professor, department of Civil Engineering and our project co-ordinator **Mrs. Saritha Sasindran** for providing me an opportunity to present this project.

I also extend my heartfelt thanks to the Department of Civil Engineering, SNGCET and all my friends and family for their support and co-operation.

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ABSTRACT

In reinforced concrete constructions, steel corrosion results in loss of reinforcing area and damage to the surrounding concrete. Increases in deflections, crack widths, and stresses may result as a result, and the structural design and redundancy may also cause a loss in the bearing capacity. The study aims to investigate the impact of local corrosion on the ability of orthogonal concrete filled steel tube (CFST) columns to support loads under axial and eccentric loads. Because of its many advantages, such as improved strength owing to confinement generation, superior ductility due to the high steel ratio, and reduced construction cost and time as compared to encased reinforced concrete, concrete filled steel tube (CFST) columns have been employed extensively in the engineering field. A T-shaped column is used to satisfy the structural design specifications. It is frequently used in bridge construction. In the corners of boundary walls, the L-shaped column, which resembles a square or rectangular column, is widely used. The L and T shaped columns are examples of non-symmetrical columns. If a column is damaged, corrosion is very likely to occur since they are not symmetrical. Corrosion impacts are checked on each column's face and corner. Similarly, figuring out where in the column damage appears when corrosion is near the middle. The same corrosion rate was used to show how an orthogonal CFST column's capacity to support weight decreased. Analyze how the CFST column will eventually respond to corrosion and a linked sustained load. In the event of the same corrosion rate, CFST columns with localized corrosion at the face had higher axial and eccentric load carrying capacities than those at the corner. A carbon fibre reinforced polymer (CFRP) system can be layered all around the structure to strengthen it. The test results show that utilizing CFRP improves a column's capacity to support loads.

Keywords: CFST L- shaped column, T- shaped column, Localized corrosion, ANSYS software, BFRP, CFRP.

TABLE OF CONTENTS

Contents	Page No.
ACKNOWLEDGEMENT	i
ABSTRACT	ii
LIST OF FIGURES	viii
LIST OF TABLES	xi
ABBREVIATIONS	xiii
CHAPTER 1. INTRODUCTION	
1.1 General	01
1.2 Orthogonal Column	01
1.3 Fibre Reinforced Polymer	03
1.4 Localized Corrosion	04
CHAPTER 2. LITERATURE REVIEW	
2.1 General	06
2.2 Summary	15
CHAPTER 3. OBJECTIVE, SCOPE AND METHODOLOGY	
3.1 Objective	16
3.2 Scope	16
3.3 Methodology	17
CHAPTER 4. FINITE ELEMENT ANALYSIS	
4.1 General	18
4.2 Finite Element Modelling in ANSYS	18
4.3 Description of Experimental Model	19
4.4 Finite Element Method	19

4.4.1 Geometry Modelling	19
4.4.2 Material Modelling	20
4.5 Meshing	20
4.6 Loads and Boundary Conditions	21
4.7 Analysis of the Model	21
4.8 Results	22
4.9 Summary	24

CHAPTER 5. MODELLING OF ORTHOGONAL COLUMNS AND PARAMETERS

5.1 General	25
5.2 Parametric Study	25
5.3 Description of T&L-shaped CFST Column	25
5.4 Material Modelling	31
5.5 T- shaped Column-Axially loaded	32
5.5.1 Grooved Corrosion	32
5.5.1.1 Corroded Axially Loaded T-shaped CFST Column- Faces	32
5.5.1.2 Corroded Axially Loaded T-shaped CFST Column- Corners	34
5.5.2 Surface Corrosion	35
5.6 T- shaped Column-Eccentrically loaded	36
5.7 L- shaped Column- Axially & Eccentrically loaded	37

5.7.1 Grooved Corrosion	38
5.7.1.1 Corroded Axially&Eccentrically Loaded L-shaped CFST Column Faces & Corners	38
5.7.2 Surface Corrosion	39

CHAPTER 6. RESULT AND DISCUSSION

6.1 General	40
6.2 T- shaped Column-Axially loaded	40
6.2.1 Grooved Corrosion	41
6.2.1.1 Corroded Axially Loaded T-shaped CFST Column- Faces	41
6.2.1.2 Corroded Axially Loaded T-shaped CFST Column- Corners	44
6.2.2 Surface Corrosion	46
6.3 T- shaped Column-Eccentrically loaded	49
6.3.1 Grooved Corrosion	50
6.3.1.1 Corroded Eccentrically Loaded T- shaped CFST Column- Faces	50
6.3.1.2 Corroded Eccentrically Loaded T- shaped CFST Column- Corners	52
6.3.2 Surface Corrosion	54
6.4 L- shaped Column- Axially & Eccentrically loaded	56

6.4.1 Grooved Corrosion	59
6.4.1.1 Corroded Axially&Eccentrically Loaded L-shaped CFST Column Faces & Corners	59
6.4.2 Surface Corrosion	62

CHAPTER 7. STRENGTHENING OF CORRODED ORTHOGONAL COLUMNS

7.1 General	65
7.2 T- shaped Column	66
7.2.1 Grooved Corrosion	66
7.2.1.1 Strengthening of Corroded Axially Loaded T-shaped CFST Column (Faces & Corners)	66
7.2.1.2 Strengthening of Corroded Eccentri- cally Loaded T-shaped CFST Column	68
7.2.2 Surface Corrosion	70
7.2.2.1 Strengthening of Corroded Axially Loaded T-shaped CFST Column	70
7.2.2.2 Strengthening of Corroded Eccentri- cally Loaded T-shaped CFST Column	71
7.3 L-shaped Column	72
7.3.1 Grooved Corrosion	72
7.3.1.1 Strengthening of Corroded Axially & Eccentrically Loaded L-shaped CFST Column	72

7.3.2 Surface Corrosion 73

7.3.2.1 Strengthening of L-shaped CFST 73
Column

CHAPTER 8. CONCLUSIONS

8.1 General 65

REFERENCES 67

LIST OF FIGURES

Fig. No.	Title	Page No.
1.1	L-shaped column	2
1.2	T-shaped column	2
1.3	FRP wrapping	3
1.4	Surface corrosion	5
1.5	Grooved corrosion	5
4.1	Finite element model of specimen	19
4.2	Meshed model	20
4.3	Model with boundary conditions	21
4.4	Deformation diagram	22
4.5	Failure mode of T-shaped column	23
4.6	Load Deflection curve	24
5.1	Details of T&L-shaped CFST column	26
5.2	Surface number of T-shaped CFST column	27
5.3	Surface number of L-shaped CFST column	27
5.4	Corner number of specimen	27
5.5	Geometry of TUAL specimen	32
5.6	Geometry of corroded axially loaded T-shaped CFST column (Faces)	33
5.7	Geometry of corroded axially loaded T-shaped CFST column (Corners)	34
5.8	Geometry of the strengthened corroded axially loaded T-shaped CFST column	36

5.9	Geometry of TUEL	36
5.10	Geometry of LUAL	37
5.11	Geometry of LUEL	38
5.12	Geometry of the corroded L-shaped column	39
5.13	Geometry of the surface corroded L-shaped column	39
6.1	TUAL specimen	40
6.2	Load Deformation curve of TUAL	41
6.3	Deformation pattern of corroded axially loaded T-shaped CFST column (Faces)	42
6.4	Load Deformation curve of axially loaded T-shaped CFST column without and with corrosion	43
6.5	Deformation pattern of corroded axially loaded T-shaped CFST column (Corners)	45
6.6	Load Deformation curve of axially loaded T-shaped CFST column without and with corrosion	46
6.7	Deformation pattern of corroded axially loaded T-shaped CFST column	47
6.8	Load Deformation curve of axially loaded T-shaped CFST column without and with corrosion	48
6.9	TUEL specimen	49
6.10	Load Deformation curve of TUEL	50
6.11	Deformation pattern of corroded eccentrically loaded T-shaped CFST column (Faces)	52
6.12	Deformation pattern of corroded eccentrically loaded T-shaped CFST column (corners)	53

6.13	Deformation pattern of corroded eccentrically loaded T-shaped CFST column	55
6.14	LUAL specimen	57
6.15	Load Deformation curve of LUAL	57
6.16	LUEL specimen	58
6.17	Load Deformation curve of LUEL	58
6.18	Deformation of L-shaped specimen	60
6.19	Load comparison graph of corroded axially & eccentrically loaded L-shaped CFST column	62
6.20	Deformation of surface corroded L-shaped specimen	63
7.1	Geometry of the strengthened corroded axially loaded T-shaped CFST column (Face)	66
7.2	Geometry of the strengthened corroded axially loaded T-shaped CFST column (Corner)	67
7.3	Geometry of the strengthened surface corroded axially loaded T-shaped CFST column	70
7.4	Load comparison graph (Faces)	73
7.5	Load comparison graph (Corners)	73
7.6	Geometry of the strengthened L-shaped CFST column	74
7.7	Load comparison graph	74

LIST OF TABLES

Table No.	Title	Page No.
4.1	Comparison of results	24
5.1	Description of axially loaded T-shaped CFST column	28
5.2	Description of eccentrically loaded T-shaped CFST column	29
5.3	Description of axially and eccentrically loaded L-shaped CFST column	30
5.4	Material properties of concrete	31
5.5	Material properties of steel	31
6.1	Load values of corroded axially loaded T-shaped CFST column (faces)	43
6.2	Load values of corroded axially loaded T-shaped CFST column (corners)	45
6.3	Load values of corroded axially loaded T-shaped CFST column	46
6.4	Load values of corroded eccentrically loaded T-shaped CFST column (faces)	52
6.5	Load values of corroded eccentrically loaded T-shaped CFST column (corners)	54
6.6	Load values of corroded eccentrically loaded T-shaped CFST column	56
6.7	Load values of corroded axially loaded L-shaped CFST column (faces and corners)	61
6.8	Load values of corroded eccentrically loaded L-shaped CFST column (faces and corners)	61

6.9	Load values of corroded axially loaded L-shaped CFST column	64
6.10	Load values of corroded eccentrically loaded L-shaped CFST column	64
7.1	Material properties of CFRP	65
7.2	Load values of strengthened corroded axially loaded T-shaped CFST column (faces)	67
7.3	Load values of strengthened corroded axially loaded T-shaped CFST column (corners)	68
7.4	Load values of strengthened corroded eccentrically loaded T-shaped CFST column (faces)	69
7.5	Load values of strengthened corroded eccentrically loaded T-shaped CFST column (corners)	69
7.6	Load values of strengthened surface corroded axially loaded T-shaped CFST column	71
7.7	Load values of strengthened surface corroded eccentrically loaded T-shaped CFST column	71

ABBREVIATIONS

CFSTs	Concrete Filled Steel Tubular structures
CFRP	Carbon Fibre Reinforced Polymer
FRP	Fibre Reinforced Polymer
FEA	Finite Element Analysis
DCM	Displacement Control Method

PROGRESSIVE COLLAPSE MITIGATION STUDY ON BOX COLUMN AND STEEL BEAM WITH CORRUGATED WEB RBS

A PROJECT REPORT

Submitted by

NANMA JAYARAJ E (SNC21CECS04)

To

APJ Abdul Kalam Technological University

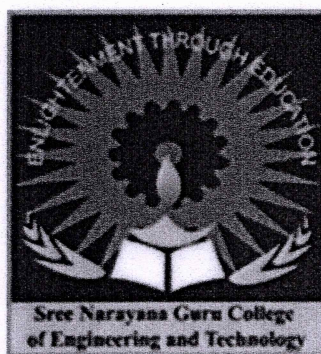
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In

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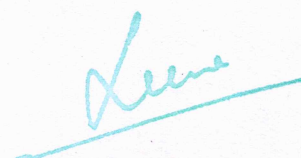
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DECLARATION

I undersigned hereby declare that the project report "Progressive Collapse Mitigation Study on Box Column and Steel Beam with Corrugated Web RBS", submitted for partial fulfillment of the requirements for the award of degree of Master of Technology of the APJ Abdul Kalam Technological University, Kerala is a bonafide work done by me under supervision of Mrs.Saritha Sasindran. This submission represents my ideas in my own words and where ideas or words of others have been included, I have adequately and accurately cited and referenced the original sources. I also declare that I have adhered to ethics of academic honesty and integrity and have not misrepresented or fabricated any data or idea or fact or source in my submission. I understand that any violation of the above will be a cause for disciplinary action by the institute and/or the University and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been obtained. This report has not been previously formed the basis for the award of any degree, diploma or similar title of any other University.

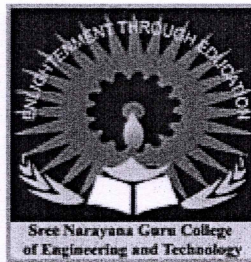
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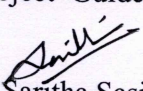
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CERTIFICATE

This is to certify that the project report entitled “**PROGRESSIVE COLLAPSE MITIGATION STUDY ON BOX COLUMN AND STEEL BEAM WITH CORRUGATED WEB RBS**” submitted by ‘**NANMA JAYARAJ E**’ to the A.P.J Abdul Kalam Technological University in partial fulfillment of the requirements for the award of the Degree of Master of Technology in Computer Aided Structural Engineering, Civil Engineering is a bonafide record of the project work carried out by him/her under my/our guidance supervision. This report in any form has not been submitted to any other University or Institute for any purpose.

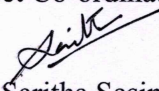
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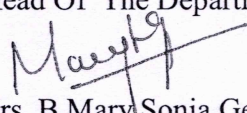
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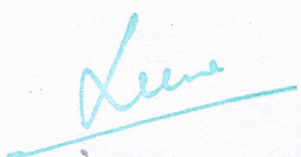
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ABSTRACT

Steel frame constructions using traditional weld connections frequently experience brittle breakdowns. To mitigate this issue, steps were taken to incorporate plastic hinges and improve the ductility of the steel connections. The beam-to-column connection has been identified as a key element for steel frame structures to maintain the structural integrity during progressive collapse phenomenon. In this study box column and steel beams subjected to progressive loading are considered with two types of corrugated web RBS connection, called the curved cell web RBS (CW-RBS) and hexagonal cell web RBS (HW-RBS). In the case of conventional RBS a portion of beam is being cut from the web and flanges so that plastic hinge gets relocated to the portion which is weak and this prevents welding failure at the end of beam and failure in column but this reduces the stiffness of beam. In the proposed connection CW-RBS and HW-RBS are implemented on the beam that is web of the beam is cut in an area near the column and the cut-out section is replaced by a cell made with two corrugated plates, this increases the stiffness which in turn increases the moment capacity and time of progressive collapse. Thus failures on box column completely gets relocated to CW-RBS and HW-RBS and makes the box column and joint safe thereby preventing welding failures at the joint. Through this progressive capacity of column can be increased. These are done according to FEMA 350. Modelling and analysis is carried out using ANSYS software. In this study we obtain ultimate load capacity, moment capacity, drift angle, ultimate deflection.

Keywords: Progressive Collapse Mitigation, RBS, CW-RBS, HW-RBS, Corrugated Web RBS

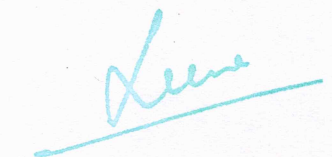


TABLE OF CONTENTS

ACKNOWLEDGEMENT	i
ABSTRACT	ii
LIST OF FIGURES	vi
LIST OF TABLES	ix
ABBREVIATIONS	x
CHAPTER 1. INTRODUCTION	1
1.1 General	1
1.2 Proposed Connection	2
CHAPTER 2. LITERATURE REVIEW	4
2.1 General	4
CHAPTER 3. OBJECTIVES, RESEARCH GAP AND METHODOLOGY	12
3.1 General	12
3.2 Objectives	12
3.3 Research gap	12
3.4 Methodology	13
CHAPTER 4. VALIDATION	14
4.1 General	14
4.2 Displacement control method	14
4.3 Description of experimental model	14
4.4 Finite Element Method	14
4.4.1 Dimension and material properties of I beam and I column	15
4.4.2 Geometry modelling	16
4.5 Meshing	17
4.6 Load and boundary conditions	18
4.7 Analysis of the model	18
4.8 Results	19

4.9 Discussion	22
CHAPTER 5. MODELLING OF BOX COLUMN AND BEAM	23
5.1 General	23
5.2 Description of box column and I beam	23
5.3 Material modelling	23
5.4 Design of RBS	23
CHAPTER 6. ANALYSIS OF MODEL	25
6.1 General	25
6.2 Analysis of beam column without RBS	25
6.3 Analysis of beam column with flange cut RBS	26
6.4 Analysis of beam column with web cut RBS	28
6.5 Analysis of beam column with CWRBS	29
6.6 Analysis of beam column with HWRBS	32
6.7 Analysis of beam column with flange cut CWRBS	34
6.8 Study with parameters	36
6.8.1 Thickness	36
6.8.2 Curved Cell Web RBS	37
6.8.2.1 CWRBS A168.75-B260-C45-T5	38
6.8.2.2 Results of CWRBS	42
6.8.3 Hexagonal Cell Web RBS	43
6.8.3.1 HWRBS A168.75 -B260-C56.25-T5	43
6.8.3.2 Results of HWRBS	47
6.8.4 Flange Cut CWRBS	47
6.8.4.1 Results of flange cut CWRBS	52
6.9 Comparison of results	53

CHAPTER 7.CONCLUSION

55

REFERENCES

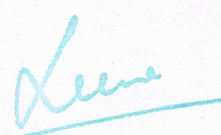
56



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LIST OF FIGURES

Fig No.	Title	Page no.
1.1	RBS SECTION	2
1.2	CW and HW RBS	3
4.1	Test specimen with support [20]	15
4.2	Test specimen from journal [20]	16
4.3	I section column and I section beam with support	17
4.4	Meshed mode	
4.5	Model with boundary condition	18
4.6	Total deformation	19
4.7	Equivalent plastic strain	19
4.8	Equivalent stress	20
4.9	a) Load Deflection Curve from journal	20
4.9	b) Load deflection curve from FEA	21
5.1	Geometric dimensions of the RBS zone [8]	24
6.1	Total deformation of No RBS	25
6.2	Equivalent Plastic Strain of No RBS	26
6.3	Equivalent Stress of No RBS	26
6.4	Flange Cut RBS	27
6.5	Total Deformation of Flange cut RBS	27
6.6	Equivalent Plastic Strain of Flange cut RBS	28
6.7	Web Cut RBS	28
6.8	Total Deformation of Web Cut RBS	29
6.9	Equivalent Plastic Strain of Web Cut RBS	29
6.10	Curved Cell Web RBS	30
6.11	Total Deformation of CWRBS	30
6.12	Equivalent Plastic Strain of CWRBS	
6.13	Load deflection curve	

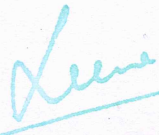

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6.14	HWRBS	32
6.15	Total Deformation of HWRBS	33
6.16	Equivalent Plastic Strain of HWRBS	33
6.17	Equivalent Stress of HWRBS	33
6.18	Load deflection curve	34
6.19	Flange cut CWRBS	35
6.20	Load deflection curve	35
6.21	Total Deformation of CWRBS	36
6.22	Equivalent Plastic Strain of CWRBS	37
6.23	Total deformation of CWRBS	37
	A168.75-B260-C45-T5	
6.24	Equivalent Stress on beam of CWRBS	38
	A168.75-B260-C45-T5	
6.25	Equivalent Stress on column of CWRBS	39
	A168.75-B260-C45-T5	
6.26	Equivalent Plastic Strain on beam of CWRBS	39
	A168.75-B260-C45-T5	
6.27	Equivalent Plastic Strain on column of	40
	CWRBS A168.75-B260-C45-T5	
6.28	Load deflection curve of 8 models of CWRBS	42
6.29	Total deformation of HWRBS	43
	A168.75 –B260-C56.25-T5	
6.30	Equivalent Stress on beam of HWRBS	44
	A168.75 –B260-C56.25-T5	
6.31	Equivalent Stress on column of HWRBS	44
	A168.75 –B260-C56.25-T5	
6.32	Equivalent Plastic Strain on beam of HWRBS	45
	A168.75 –B260-C56.25-T5	
6.33	Equivalent Plastic Strain on column of	45
	HWRBS A168.75 –B260-C56.25-T5	
6.34	Load deflection curve of 8 models of HWRBS	

6.35	Total deformation of flange cut CWRBS	47
6.36	Equivalent Stress on beam of flange cut CWRBS	48
6.37	Equivalent Stress on column of flange cut CWRBS	48
6.38	Equivalent plastic strain on beam of flange cut CWRBS	48
6.39	Equivalent Plastic Strain on column of flange cut CWRBS	49
6.40	Total deformation of flange cut CWRBS	49
6.41	Equivalent stress on beam of flange cut CWRBS	50
6.42	Equivalent stress on column of flange cut CWRBS	50
6.43	Equivalent plastic strain on beam of flange cut CWRBS	50
6.44	Equivalent plastic strain on column of flange cut CWRBS	51
6.45	Load deflection curve of flange cut CWRBS with T5 and T10	51
6.46	Load deflection curve of CWRBS ,HWRBS and flange cut CWRBS	53

LIST OF TABLES

Table No.	Title	Page No.
4.1	Maximum load and deflection	21
5.1	Equations from FEMA 350	23
5.2	Equations for the design of RBS	24
6.1	Results of CWRBS	41
6.2	Results of HWRBS	46
6.3	Results of flange cut CWRBS	52
6.4	Comparison of CWRBS ,HWRBS and flange cut CWRBS	53


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ABBREVIATIONS

RBS	-	Reduced Beam Section
CWRBS	-	Curved Cell Web RBS
HWRBS	-	Hexagonal Cell Web RBS
FEMA	-	Federal Emergency Management Agency
w _{max}	-	Max vertical displacement
P _{max}	-	Ultimate load carrying capacity
M _{max}	-	Ultimate moment capacity
$\theta_{\max}$	-	Rotational capacity