Analytical Study Of T Beam Column Joint Using FEM Software

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Abstract: ***Beam and column where intersects is called as joint or junction. The different types of joints are classified as corner joint, exterior joint, interior joint etc. on beam column joint applying quasi-static loading on cantilever end of the beam. and study of various parameters as to be find out on corner and exterior beam column joint. The focus of our project is T-shaped concrete frame connection. There was minimum damage on the concrete column and joint panel zone. For a specimen with strong beams-weak columns, there was local buckling fracture on steel tube above and below the joint panel zone. It was found that both axial forces and beam to column linear stiffness ratio had impacts on joint capacity and ductility behavior of the specimens. However, addressed beam-column joints of substandard RC frames with weak columns, poor anchorage of longitudinal beam bars and insufficient transverse reinforcement. The behavior of exterior beam column joint is different than the corner beam column joint.***

Keywords: Analytical Study, T Beam, Column Joint, FEM Software

1.INTRODUCTION

1.1 General

In our country, deformed reinforcing steel bars which have ribs as thread of screw have been frequently used for reinforced concrete construction (hereinafter referred to as screw steel bar). At the same time both connecting reinforcements together and anchoring them into concrete have been also executed putting splice nuts and anchor nuts on the 'screw' steel bars instead of laps and hooks. Super high-rise reinforced concrete buildings higher than 60 m should be designed using high strength material, such as steel bars as strong as 390 N/mm^2 at yield point and concrete as stronger than 36 N/mm^2 of compressive strength. The high strength steel bar with larger than 38 mm of diameter won't be bent in a smaller radius. Figure 1shows Internal Force and Joint.

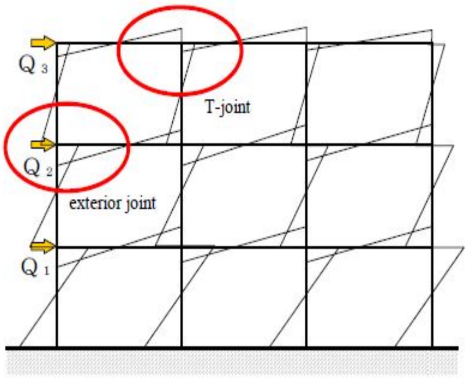

Figure 1 Internal Force and Joint

1.2 Preamble

Many natural disasters, earthquake being the most affecting of all, have produced a need to increase the present safety levels in buildings. The knowledge of understanding of the earthquakes is increasing day by day and therefore the seismic demands imposed on the structures need to be revised. The design methodologies are also changing with the growing research in the area of seismic engineering.

1.3 Need For The Project

The experimental investigation carried out for evaluating the seismic response of RC wide T beam-column joints under cyclic load and for exploring the potential of improving the seismic performance of the same joints without introducing significant changes in the design and construction practices.

2.FRAMED CONNECTIONS

Beam column joints can be critical regions in reinforced concrete frames designed for inelastic response to severe seismic attack. The reversal in moment across the joint also means that the beam reinforcement is required to be in compression on one side of the joint and at tensile yield on the other side of the joint. The high bond stress required to sustain this force gradient across the joint may cause bond failure and corresponding degradation of moment capacity accompanied by excessive drift.

2.1 Criteria For The Desirable Performance Of Joints In Ductile Structures Designed For Earthquake Resistance

1. The strength of the joint should not be less than the maximum demand corresponding to development of the structural plastic hinge mechanism for the frame. This will eliminate the need for repair in a relatively inaccessible region and for energy dissipation by joint mechanisms, which as will be seen subsequently, undergo serious stiffness and strength degradation when subjected to cyclic actions in the inelastic range.
2. The Capacity of the column should not be jeopardized by possible strength degradation within the joint.

2.2 Performance Criteria

Because the response of joints is controlled by shear and bond mechanisms, both of which exhibit poor hysteric properties, joints should be regarded as being unsuitable as major sources of energy dissipation.

2.3 Shear Strength

Internal forces transmitted from adjacent members to the joint as shown in figure2. Result in joint shear forces in both the horizontal and vertical directions. These shear forces lead to diagonal compression and tension stresses in the joint core.

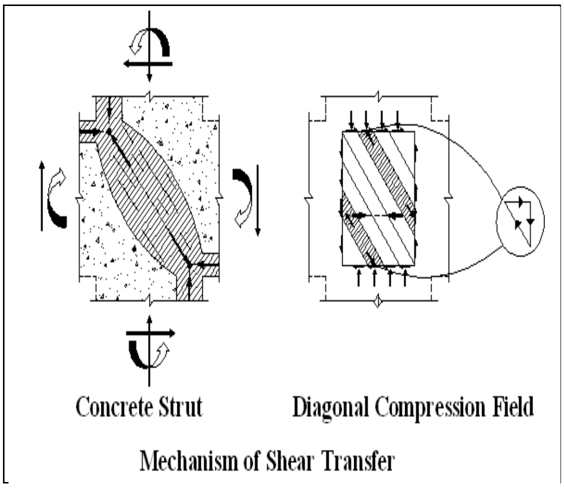

Figure 2 Mechanism of shear transfer

2.4 Bond Strength

At exterior column the difficulty in anchoring a beam bear of full strength can be overcome readily by providing a standard hook. At interior columns, however, this is impractical. Some codes require that beam bars at interior beam-column joints must pass continuously that bars may be anchored with equal if not greater efficiency using standard hooks within or immediately behind an interior joint.

Joint types According to geometrical configuration
I) Interior
II) Exterior
II) Corner
According to loading conditions and structural behavior
I) Type-I
II) Type-II
Type1- Static loading
I) Strength important
II) Ductility secondary
Type2-earthquake and blast loading
I) Ductility +strength
II) Inelastic range of deformation
III) Stress reversal

2.5 The Design Procedure Of Beam-Column Joints Consists Of The Following Steps:

1. Arrive at the preliminary size for members based on anchorage requirements for the chosen longitudinal bars.
2. Ensure adequate flexural strength of columns to get the desired beam yielding mechanism.
3. Arrive at the design shear force for the joint by evaluating the flexural over strength of the adjacent beams and corresponding internal forces. The simultaneous forces in the column that maintain joint equilibrium must also be determined. From these, the joint shear force demand can be calculated.
4. Obtain effective joint shear area from the adjoining member dimensions.
5. Ensure that the induced shear stress is less than the allowable stress limit. The allowable shear stress limit is expressed as a function of the compressive strength or diagonal tensile strength of concrete. If not satisfied, alter the associated member dimensions, viz., width of the beam or depth of the column.
6. Provide transverse reinforcements both as confining reinforcement and as shear reinforcement.
7. Provide sufficient anchorage for the reinforcement passing through or terminating in the joint.

3.MATERIAL

3.1 Cement

Cement is a material, generally in powered form, which can be made into a paste usually by the addition of water and, when molded or poured, will set into a solid mass. Numerous organic compounds used for an adhering, or fastening materials, are called cements, but these are classified as adhesives, and the term cement alone means a construction material. The most widely used of the construction cements is Portland cement. It is bluish-gray powered obtained by finely grinding the clinker made by strongly heating an intimate mixture of calcareous and argillaceous minerals. Portland Slag Cement (PSC) Konark Brand was used for this investigation. It is having a specific gravity of 2.96.

3.2 Fine Aggregate

Fine aggregate/sand is an accumulation of grains of mineral matter derived from disintegration of rocks. It is distinguished from gravel only by the size of the grains or particles, but is distinct from clays which contain organic material. Here, the fine aggregate/sand is passing through

4.75 mm sieve and having a specific gravity of 2.64. The grading zone of fine aggregate is zone III as per Indian Standard specifications IS: 383-1970.

3.3 Coarse Aggregate

Coarse aggregates are the crushed stone is used for making concrete. The commercial stone is quarried, crushed, and graded. Much of the crushed stone used is granite, limestone, and trap rock.

3.4 Water

Water fit for drinking is generally considered good for making the concrete. Water should be free from acids, alkalis, oils, vegetables or other organic impurities. Soft water produces weaker concrete. Water has two functions in a concrete mix. it serves as a vehicle or lubricant in the mixture of fine aggregates and cement. Ordinary clean portable tap water is used for concrete mixing in all the mix.

3.5 Reinforcing Steel

High-Yield Strength Deformed (HYSD) bars confirming to IS 1786:1985. The longitudinal steel reinforcing bars were deformed, high-yield strength, with 20 mm and 10 mm diameter. The stirrups were made from deformed steel bars with 8 mm diameter.

3.6 Mixing Of Concrete

Mixing of concrete is done thoroughly with the help of standard concrete mixer machine, to ensure that a uniform quality of concrete is obtained. First coarse and fine aggregates are fed alternately, followed by cement. The mixing is done for two minutes after all ingredients are fed inside the mixer as per IS: 456-2000. 40 Figure 3. Shows Mixing Of Concrete

Figure 3. Mixing Of Concrete

3.7 Compaction

All specimens were compacted by using 30mm size needle vibrator for good compaction of concrete, and sufficient care was taken to avoid displacement of the reinforcement cage inside the form work. Finally, the surface of concrete was leveled and smoothened by metal trowel and wooden float. After seven hours, the specimen detail and date of concreting was written on top surface to identify it properly. Figure 4. Shows Compacting.

Figure 4. Compacting

3.8 Curing Of Concrete

Curing is done to prevent the loss of water which is essential for the process of hydration and hence for hardening. Usually, curing starts as soon as the concrete is sufficiently hard. Here, curing is done by spraying water on the jute bags or by spending wet hessians cloth over the surface for a period of 28 days. Figure 5. Shows Curing Of Concrete

Figure 5. Curing Of Concrete

4.FINITE ELEMENT METHOD

The basic concept in this method is that a body or a structure may be divided into smaller elements of finite dimensions called „Finite Elements. The original body or the structure is then considered as an assemblage of these elements connected at a finite number of joints called „Nodes or „Nodal Points. The properties of the elements are formulated and combined to obtain the solution for the entire body or structure.

4.1 General Description Of The Fem

The basic concept behind FEM is that a body or structure is divided into smaller elements of finite dimensions called „finite elements. The original structure is then considered as an assemblage of these elements at a finite number of joints called „nodes.The properties of the elements are formulated and combined to obtain the solution for the entire structure.

4.2 Modeling Of Composite Beams

Finite Element Modeling of Composite beams in ANSYS consist of three stages, which are explained below.

- Selection of element type
- Assigning material properties
- Modeling and meshing the geometry

4.3 Element Types

Selection of proper element types is another important part in Finite Element Analysis. For composite beams, the C-R steel sheet trough and braces were modeled by using SHELL 63 element in ANSYS. The Concrete portion was modeled by using a special element developed particularly for Concrete by ANSYS, SOLID 65 element.

4.4 Discretization Of Structure

The process of modeling a structure using suitable number, shape and size of the elements is called Discretization. Modeling should be good enough to get results as close to actual behavior of the structure as possible.

4.5 Nodal Loads

While subdividing a structure, nodal locations are selected so as to coincide with external loads applied. This can be easily done in case of concentrated load.

4.6 Assembly And Solution Of Equations

In assembling the element stiffness equation, [K] {δ} = {F}, the first step is to derive the expression for element stiffness property and nodal force vector. The overall stiffness matrix and nodal load vectors are assembled from elements and then the set of simultaneous equations are solved to obtain the nodal displacements.

4.7 Finite Element Modeling & Analysis

Ansys software has been used for conducting the finite element analysis of the Concrete Beam Column Joint. Ansys has many features which help to carry out detailed study for such kind of complex problems.

4.8 Finite Element Modeling And Analysis Of Beam-Column Joints

The exterior and corner beam-column joint is considered to study joint behavior subjected to monotonic loading. Preparation of FE model is carried out based on results obtained from space frame analysis of a building located in zone-IV.

5.ANASYS REPORT

Units
Model (A4)

- Geometry
- Parts
- Coordinate Systems
- Connections
- Mesh

Static Structural (A5)

- Analysis Settings
- Loads
- Solution (A6)
- Solution Information

Results

- Material Data
- GFRP
- Structural Steel
- Concrete

5.1 UNITS

Table1,2,3,4 & 5 shows the ANASYS Report

Table 1 Units

Unit System	Metric (mm, kg, N, s, mV, mA) Degrees rad/s Celsius
Angle	Degrees
Rotational Velocity	rad/s
Temperature	Celsius

5.2 MODEL (A4)

GEOMETRY

Table 2 Model (a4) > geometry

Object Name	Geometry
State	Fully Defined
Definition	
Source	D:\Michael\Projects\Older\CIVIL BEAM AND COLUMN\New 13-12-16\BEAM\WITH GFRP\Assem1.SLDASM
Type	SolidWorks
Length Unit	Meters
Element Control	Program Controlled
Display Style	Body Color
Bounding Box	
Length X	575. mm
Length Y	150. mm
Length Z	1000. mm
Properties	
Volume	3.2443e+007 mm³
Mass	77.525 kg
Scale Factor Value	1.
Statistics	
Bodies	4
Active Bodies	4

Nodes	172215
Elements	101771
Mesh Metric	None
Basic Geometry Options	
Solid Bodies	Yes
Surface Bodies	Yes
Line Bodies	No
Parameters	Yes
Parameter Key	DS
Attributes	No
Named Selections	No
Material Properties	No
Advanced Geometry Options	
Use Associativity	Yes
Coordinate Systems	No
Reader Mode Saves Updated File	No
Use Instances	Yes
Smart CAD Update	No
Attach File Via Temp File	Yes
Temporary Directory	C:\Users\UIT\AppData\Local\Temp
Analysis Type	3-D
Mixed Import Resolution	None
Decompose Disjoint Faces	Yes
Enclosure and Symmetry Processing	Yes

COORDINATE SYSTEMS

Table 3 Model (a4) > geometry > parts

Object Name	Global Coordinate System
State	Fully Defined
Definition	
Type	Cartesian
Coordinate System ID	0.
Origin	
Origin X	0. mm
Origin Y	0. mm
Origin Z	0. mm
Directional Vectors	
X Axis Data	[1. 0. 0.]
Y Axis Data	[0. 1. 0.]
Z Axis Data	[0. 0. 1.]

CONNECTIONS

Table 4 Model (A4) > Connections > Contacts

Object Name	Contacts
State	Fully Defined
Definition	
Connection Type	Contact
Scope	
Scoping Method	Geometry Selection
Geometry	All Bodies
Auto Detection	
Tolerance Type	Slider
Tolerance Slider	0.
Tolerance Value	2.9081 mm
Use Range	No
Face/Face	Yes
Face/Edge	No
Edge/Edge	No

Priority	Include All
Group By	Bodies
Search Across	Bodies

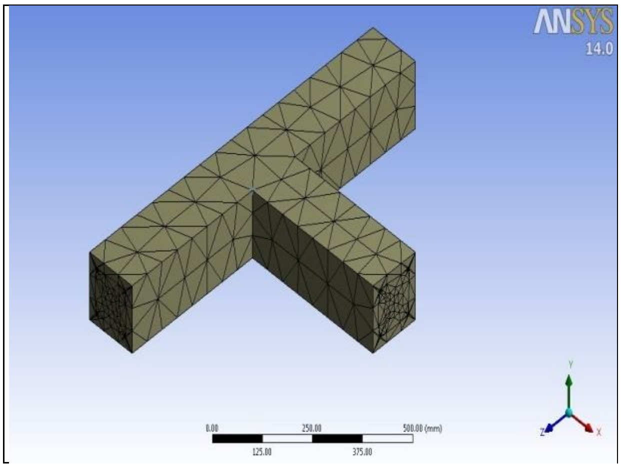

Figure 6 Meshed T-beam

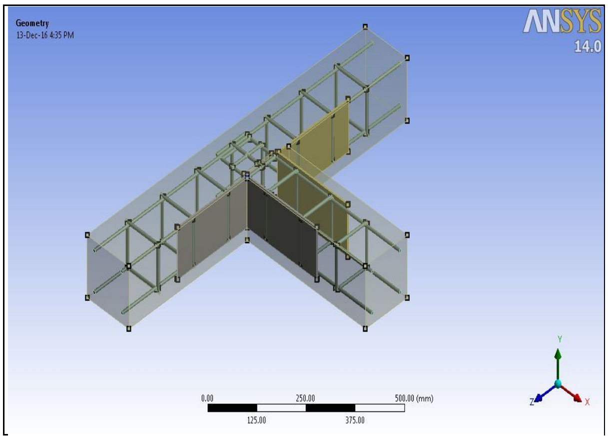

Figure 7 Imported T-beam

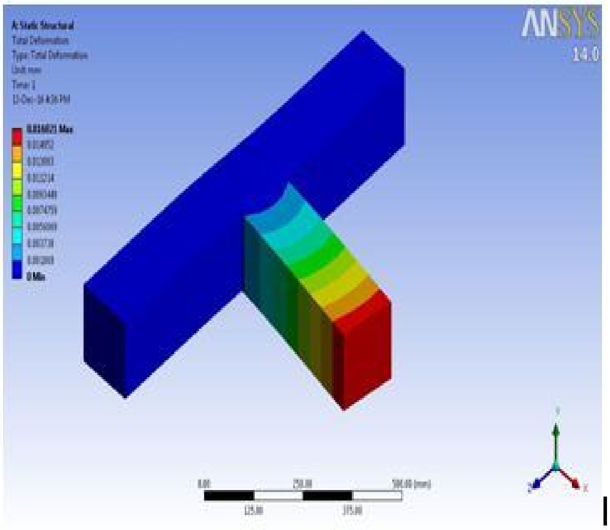

Figure 8 Deformation of T-beam

5.3 STATIC STRUCTURAL (A5)

Figure 6,7,8,9 & 10 shows the ANASYS Report

Table 5 Model (A4) > Analysis

Object Name	Static Structural (A5)
State	Solved
Definition	
Physics Type	Structural
Analysis Type	Static Structural
Solver Target	Mechanical APDL
Options	
Environment Temperature	22. °C
Generate Input Only	No

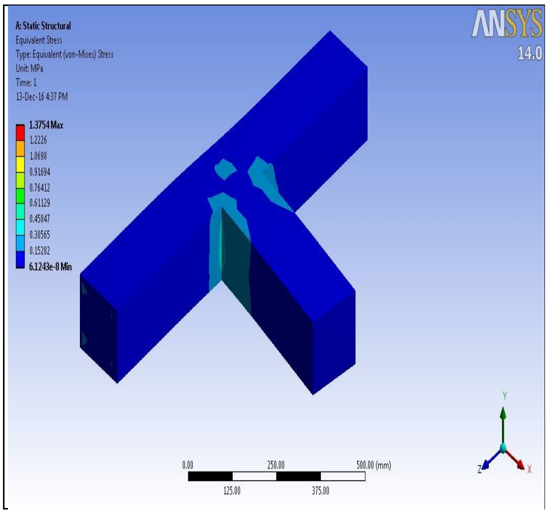

Figure 9 Stress diagram

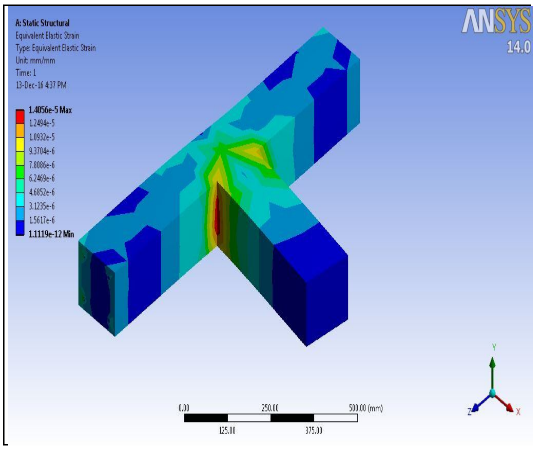

Figure 10 Strain diagram

6.CONCLUSION

Three series of dynamic experiments have been conducted to investigate mechanical anchor performance of longitudinal bars embedded within the T beam-column joints which are located at the side or on the top of a building. The structural behavior of interior RCC T beam column joint has been studied both experimentally and analytically by using ANSYS.

References

[1] T.Subramani., S.Krishnan. S.K.Ganesan., G.Nagarajan ”Investigation of Mechanical Properties in Polyester and Phenyl-ester Composites Reinforced With Chicken Feather Fiber” International Journal of Engineering Research and Applications Vol. 4, Issue 12(Version 4), pp.93-104, 2014.

[2] T.Subramani, J.Jayalakshmi , " Analytical Investigation Of Bonded Glass Fibre Reinforced Polymer Sheets With Reinforced Concrete Beam Using Ansys" , International Journal of Application or Innovation in Engineering & Management (IJAIEM) , Volume 4, Issue 5, pp. 105-112 , 2015

[3] T.Subramani, D.Latha , " Experimental Study On Recycled Industrial Waste Used In Concrete" , International Journal of Application or Innovation in Engineering & Management (IJAIEM) , Volume 4, Issue 5, pp. 113-122 , 2015

[4] T.Subramani, V.Angappan , " Experimental Investigation Of Papercrete Concrete" , International Journal of Application or Innovation in Engineering & Management (IJAIEM) , Volume 4, Issue 5, pp. 134-143 , 2015

[5] T.Subramani, V.K.Pugal , " Experimental Study On Plastic Waste As A Coarse Aggregate For Structural Concrete" , International Journal of Application or Innovation in Engineering & Management (IJAIEM) , Volume 4, Issue 5, pp.144-152 2015

[6] T.Subramani, B.Suresh , " Experimental Investigation Of Using Ceramic Waste As A Coarse Aggregate Making A Light Weight Concrete " , International Journal of Application or Innovation in Engineering & Management (IJAIEM) , Volume 4, Issue 5, pp. 153-162 , 2015

[7] T.Subramani, M.Prabhakaran , " Experimental Study On Bagasse Ash In Concrete" , International Journal of Application or Innovation in Engineering & Management (IJAIEM) , Volume 4, Issue 5, pp. 163-172 , 2015

[8] T.Subramani, A.Mumtaj , " Experimental Investigation Of Partial Replacement Of Sand With Glass Fibre" , International Journal of Application or Innovation in Engineering & Management (IJAIEM) , Volume 4, Issue 5, pp. 254-263 , 2015

[9] T.Subramani, S.B.Sankar Ram Experimental Study on Concrete Using Cement With Glass Powder, IOSR Journal of Engineering,Volume 5 , Issue 5, Version 3, pp43-53, 2015

[10] T.Subramani, S.Kumaran , " Experimental Investigation Of Using Concrete Waste And Brick Waste As A Coarse Aggregate " , International Journal of Application or Innovation in Engineering & Management (IJAIEM) , Volume 4, Issue 5, pp. 294-303 , 2015

[11] T.Subramani, G.Ravi, “Experimental Investigation Of Coarse Aggregate With Steel Slag In Concrete”, IOSR Journal of Engineering, Volume 5,Issue 5, Version 3, pp64-73, 2015

[12] T.Subramani, K.S.Ramesh , " Experimental Study On Partial Replacement Of Cement With Fly Ash And Complete Replacement Of Sand With M sand" , International Journal of Application or Innovation in Engineering & Management (IJAIEM) , Volume 4, Issue 5 , pp. 313-322 , 2015

[13] T.Subramani, G.Shanmugam , " Experimental Investigation Of Using Papercrete And Recycled Aggregate As A Coarse Aggregate " , International Journal of Application or Innovation in Engineering & Management (IJAIEM) , Volume 4, Issue 5, pp. 323-332 , May 2015

[14] T.Subramani, P.Sakthivel , " Experimental Investigation On Flyash Based Geopolymer Bricks" , International Journal of Application or Innovation in Engineering & Management (IJAIEM) , Volume 5, Issue 5, pp. 216-227 , 2016 .

[15] T.Subramani, R.Siva, “Experimental Study On Flexural And Impact Behavior Of Ferrocement Slabs” International Journal of Application or Innovation in Engineering & Management (IJAIEM), Volume 5, Issue 5, pp. 228-238 , 2016 .

[16] T.Subramani, A.Anbuchezian , " Experimental Study Of Palm Oil Fuel Ash As Cement Replacement Of Concrete " , International Journal of Application or Innovation in Engineering & Management (IJAIEM), Volume 6, Issue 3, March 2017 , pp. 001-005 , ISSN 2319 - 4847.

[17] T.Subramani, A.Anbuchezian , " Experimental Study Of Mineral Admixture Of Self Compacting Concrete " , International Journal of Application or Innovation in Engineering & Management (IJAIEM), Volume 6, Issue 3, March 2017 , pp. 006-010 , ISSN 2319 - 4847.

[18] T.Subramani, A.Anbuchezian , " Experimental Test On Bitumen With Addition Of 35% Of Plastic Fibre " , International Journal of Application or Innovation in Engineering & Management (IJAIEM), Volume 6, Issue 3, March 2017 , pp. 017-022 , ISSN 2319 - 4847.

[19] T.Subramani, A.Anbuchezian , " Stabilization Of M30 Concrete Pavement By Partially Replacing Cement By 20% Of Flyash And Sodium Silicate " , International Journal of Application or Innovation in Engineering & Management (IJAIEM), Volume 6, Issue 3, March 2017 , pp. 023-031 , ISSN 2319 - 4847.

[20] T.Subramani, A.Anbuchezian , " Experimental Investigation On Flexural Behavior Of Folded Ferro Cement Panels " , International Journal of Application or Innovation in Engineering & Management (IJAIEM), Volume 6, Issue 3, March 2017 , pp. 045-049 , ISSN 2319 - 4847.

[21] T.Subramani, A.Anbuchezian , " Experimental Study On Replacement Of Concrete Material By Water Treatment Plant Waste Sewage " , International

Journal of Application or Innovation in Engineering & Management (IJAIEM), Volume 6, Issue 3, March 2017 , pp. 050-057 , ISSN 2319 - 4847.

[22] T.Subramani, A. Fizoor Rahman , " An Experimental Study On The Properties Of Pet Fibre Reinforced Concrete " , International Journal of Application or Innovation in Engineering & Management (IJAIEM), Volume 6, Issue 3, March 2017 , pp. 058-066 , ISSN 2319 - 4847.

[23] T.Subramani. , S.Vishnupriya, "Finite Element Analysis of a Natural Fiber (Maize) Composite Beam", International Journal of Modern Engineering Research, Volume. 4, Issue. 6 (Version 1), pp 1 – 7, 2014,

[24] T.Subramani., R.Senthil Kumar, "Modelling and Analysis of Hybrid Composite Joint Using Fem in ANSYS", International Journal of Modern Engineering Research, Volume 4, Issue 6 (Version 1), pp 41- 46, 2014.

[25] T.Subramani, S.Sharmila, "Prediction of Deflection and Stresses of Laminated Composite Plate with Artificial Neural Network Aid", International Journal of Modern Engineering Research, Volume 4, Issue 6 (Version 1), pp 51 -58, 2014.

[26] T.Subramani., S.Sundar, M.Senthilkumar, "Investigation of the Behaviour for Reinforced Concrete Beam Using Non Linear Three Dimensional Finite Elements", International Journal of Modern Engineering Research, Volume. 4, Issue. 6 (Version 2), pp 13 -18, 2014,

[27] T.Subramani, A.Arul, "Design And Analysis Of Hybrid Composite Lap Joint Using Fem" International Journal of Engineering Research and Applications, Volume. 4, Issue. 6 (Version 5), pp 289- 295, 2014.

[28] T.Subramani., J.Jothi,, M.Kavitha "Earthquake Analysis Of Structure By Base Isolation Technique In SAP", International Journal of Engineering Research and Applications, Volume. 4, Issue. 6 (Version 5), pp 296 - 305, 2014.

[29] T.Subramani., R.Manivannan.R, M.Kavitha, "Crack Identification In Reinforced Concrete Beams Using Ansys Software" ,International Journal of Engineering Research and Applications, Volume. 4, Issue. 6 (Version 6), pp 133 - 141, 2014.

[30] T.Subramani., Reni Kuruvilla, J.Jayalakshmi., "Nonlinear Analysis Of Reinforced Concrete Column With Fiber Reinforced Polymer Bars" International Journal of Engineering Research and Applications Volume. 4, Issue. 6 (Version 5), pp 306- 316, 2014.

[31] T.Subramani, D.Sakthi Kumar, S.Badrinarayanan. "Fem Modelling And Analysis Of Reinforced Concrete Section With Light Weight Blocks Infill " International Journal of Engineering Research and Applications, Volume. 4, Issue. 6 (Version 6), pp 142 - 149, 2014.

[32] T.Subramani, B.Saravanan., J.Jayalakshmi., "Dynamic Analysis Of Flanged Shear Wall Using Staad Pro", International Journal of Engineering Research and Applications, Volume. 4, Issue. 6 (Version 6), pp 150 - 155, 2014.

[33] T.Subramani, M.Subramani., K.Prasath.,"Analysis Of Three Dimensional Horizontal Reinforced Concrete Curved Beam Using Ansys" International Journal of Engineering Research and Applications, Volume. 4, Issue. 6 (Version 6), pp 156 - 161, 2014.

[34] T.Subramani., K.Bharathi Devi., M.S.Saravanan. , Suboth , Analysis Of RC Structures Subject To Vibration By Using Ansys," International Journal of Engineering Research and Applications Vol. 4, Issue 12(Version 5), pp.45-54, 2014.

[35] T.Subramani., K.Bharathi Devi., M.S.Saravanan., Suboth Thomas, "Analysis Of Seismic Performance Of Rock Block Structures With STAAD Pro International Journal of Engineering Research and Applications Vol. 4, Issue 12(Version 5), pp.55- 68, 2014.

[36] T.Subramani., T.Krishnan., M.S.Saravanan.M , Suboth Thomas, "Finite Element Modeling On Behaviour Of Reinforced Concrete Beam Column Joints Retrofitted With CFRP Sheets Using Ansys" International Journal of Engineering Research and Applications Vol. 4, Issue 12(Version 5), pp.69 -76, 2014

[37] T.Subramani., S.Krishnan., M.S.Saravanan.M, Suboth Thomas "Analysis Of Retrofitting Non-Linear Finite Element Of RCC Beam And Column Using Ansys" International Journal of Engineering Research and Applications ,Vol. 4, Issue 12(Version 5), pp.77-87, 2014.

[38] T.Subramani, J.Jayalakshmi , " Analytical Investigation Of Bonded Glass Fibre Reinforced Polymer Sheets With Reinforced Concrete Beam Using Ansys" , International Journal of Application or Innovation in Engineering & Management (IJAIEM) , Volume 4, Issue 5, pp. 105-112 , 2015

[39] T.Subramani and M.Kavitha, "Analysis Of Reliability Of Steel Frame Systems With Semi-Rigid Connections Using Numerical Method And Finite Element Analysis", International Journal of Applied Engineering Research (IJAER), Volume 10, Number 38,Special Issues, pp.28240-28246, 2015.

[40] T.Subramani, M.S.Saravanan, "Analysis Of Non Linear Reinforced And Post Tensioned Concrete Beams Using ANSYS", International Journal of Applied Engineering Research (IJAER) International Journal of Applied Engineering Research (IJAER), Volume 10, Number 38 Special Issues, pp.28247-28252, 2015

[41] T.Subramani, K.Balamurugan , " Finite Element Anaylsis Of Composite Element For FRP Reinforced Concrete Slab By Using ANSYS" , International Journal of Application or Innovation in Engineering & Management (IJAIEM) , Volume 5, Issue 5, pp. 076-084 , 2016 .

[42] T.Subramani, V.Kanian Poonkundran , " Prefabricated Multistory Structure Exposure To Engineering Seismicity By Using SAP" , International Journal of Application or Innovation in Engineering & Management (IJAIEM) , Volume 5, Issue 5, pp. 123-131 , 2016 .

[43] T.Subramani, A.Kumaravel , " Analysis Of Polymer Fibre Reinforced Concrete Pavements By Using ANSYS" , International Journal of Application or Innovation in Engineering & Management (IJAIEM) , Volume 5, Issue 5, pp. 132-139 , 2016 .

[44] T.Subramani, R.Praburaj , " Pushover Anaylsis Of Retrofitted Reinforced Concrete Buildings By Using SAP" , International Journal of Application or Innovation in Engineering & Management (IJAIEM) , Volume 5, Issue 5, pp. 140-147 , 2016 .

[45] T.Subramani, M.Senthilkumar , " Finite Element Anaylsis Of RC Beams With Externally Bonded Simcon Laminates By Using ANSYS" , International Journal of Application or Innovation in Engineering & Management (IJAIEM) , Volume 5, Issue 5, pp. 148-155 , 2016

[46] T.Subramani, R.Vasanthi , " Earth Quake Resistant Building Using SAP" , International Journal of Application or Innovation in Engineering & Management (IJAIEM) , Volume 5, Issue 5, pp. 173-181 , 2016 .

[47] T.Subramani, A.Selvam , " Studies On Economical Configuration Of RCC And Prestressed Shell Roofs By Using ANSYS " , International Journal of Application or Innovation in Engineering & Management (IJAIEM) , Volume 5, Issue 5, pp. 182-191 , 2016 .

[48] T.Subramani, A.Anbuchezian , " Experimental Investigation On Flexural Behavior Of Folded Ferro Cement Panels " , International Journal of Application or Innovation in Engineering & Management (IJAIEM), Volume 6, Issue 3, March 2017 , pp. 045-049 , ISSN 2319 - 4847.

[49] T.Subramani, A. Fizoor Rahman , " An Experimental Study On The Properties Of Pet Fibre Reinforced Concrete " , International Journal of Application or Innovation in Engineering & Management (IJAIEM), Volume 6, Issue 3, March 2017 , pp. 058-066 , ISSN 2319 - 4847.

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