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Parametric Performance Evaluation of Varying Slenderness Ratio of CFST Column by ANSYS

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Abstract: The present study is an Endeavour to understand the behavior of concrete filled steel tube column under axial load. Construction of concrete filled steel tube (CFST) column is done by filling a steel tube with concrete. Local Buckling is prolonged in concrete filled steel tube (CFST) columns as steel tube acts as formwork for concrete. The use of concrete filled steel tubes (CFST) columns is increasing day by day as it gives excellent static and earthquake-resistant properties. In the proposed research, models of CFST columns are investigated and prediction is made on the effect of some main influencing factors on which the compressive behavior of CFST columns depends. The parameters of interest are mainly the grade of concrete, thickness of steel tube and length to dimension ratio (L/D). A non-linear finite element (FE) numerical model using the finite element software ANSYS is developed. The modeling includes 240 models with varying in thickness of steel tubes (2mm, 3mm, 4mm, 5mm), Grades of Concrete (M20, M25, M30,M35,M40), L/D(from 10 to 120) and a constant load of 1000N. The main motive of this research is to provide values for Equivalent Stress, Buckling Load and Deformation for a particular L/D ratio with variation in thickness of steel tube and grade of concrete.
Keywords: CFST, non-linear finite element, excellent static, earthquake-resistant, ANSYS, Equivalent Stress, Buckling Load and Deformation.

I. INTRODUCTION

Steel Concrete Composite Columns were used for over a century. Concrete filled steel tubes (CFST) Columns have increased in popularity as the significant number of advantages they offer in both design and construction. Due to Composite Effects of Concrete Filled Steel Filled Columns they are used in tall buildings, bridges and other types of structures. CFST provides efficient structural system. CFST acts as an advantageous system for carrying large axial load benefitting from the interaction between the concrete and the steel section. Concrete Filled Steel Tube (CFST) columns are advantageous for structures which are subjected to high strain rate from traffic and railways decks like earthquake resistant structures, columns in high rise buildings, bridge piers etc. Concrete filled steel tube provides high compressive and torsional resistance about all axes as compared to concrete encased steel composite sections. Concrete filled steel tubes (CFST) are composite structures consisting of a steel tube infilled with concrete. In present international practice, CFST columns are used in the primary lateral resistance systems of both braced and unbraced building structures. CFSTs may be operated for retrofitting purposes for strengthening concrete columns in earthquake prone areas. Concrete filled steel tubes are generally used in Beams, Columns, Piers and caissons for deep foundations. In recent time, implementation of concrete filled steel tubular columns has done in dwelling houses, tall buildings and many types of arch bridges and use of Steel hollow sections used as reinforcement is done to make this composite structure. CFST columns have established an appropriate loading capacity, ductility and energy absorption capacity. For casting concrete steel tube acts as formwork and there is no other longitudinal and lateral reinforcement for the concrete core. An evaluation of available modeling studies shows that the main parameters influencing the behaviour and strength of concrete filled steel tubular columns are the initial geometry of the column which includes thickness of steel tube, L/D ratio and grade of Concrete.

II.CLASSIFICATION OF CFST

Concrete filled steel tubes are designed on the basis of their application. It may be square, hexagonal and circular depends upon design and use of their application. Concrete filled steel tubes are divided into two types according to the form of the concrete core. These two types are solid and hollow concrete core CFSTs. Solid concrete core is made by placing the plain concrete in the steel tube and compaction is done by vibration. Hollow concrete filled steel tubes are made by spinning method. The method of insertion of the wet concrete in the rotational mould is known as spinning method where wet concrete is compacted by vibration using centrifugation due to rotation of the mould. There are several shapes for the concrete filled steel tubes based on the confining steel tube's shape, such as rectangular, elliptical, circular, square, L shaped etc. In which Circular and Square sections of CFSTs are the

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widely used in construction. The load carrying capacity of CFST column is extremely affected by the shape of its cross-section, length to dimension and dimension to thickness ratio of the steel tube. As soon as static load is applied, deformation of CFST columns takes place which experience elastic-perfectly-plastic or strain-hardening behavior after yielding.

III. ADVANTAGES OF CFST

Steel sections are considered economical because of their low strength to weight ratio. With the increase in slenderness of the steel column the load carrying capacity decreases because of the buckling failure domination. When concrete is compressively loaded as composite columns buckling is delayed this enhances the capacity of the elements. Also thinner steel section would be required in the presence of concrete thus the cost is reduced. The CFST columns as structural member have many distinctive advantages above equivalent steel, reinforced concrete and steel-reinforced concrete member. Hence the advantages are as follows:

A. As steel is at the outer perimeter of CFST it becomes more effective in tension and can also bending moment.
B. Steel is having higher modulus of elasticity than concrete and is located farthest from the centroid contributes large moment of inertia and stiffness of CFST is greatly improved.
C. The concrete forms an ideal core to bear the compressive loading in typical applications, and it suspend and often avoids local buckling of the steel, particularly in rectangular CFSTs.
D. Steel tube confines concrete core which increases the compressive strength of circular CFSTs and also increases ductility of rectangular CFSTs. Hence, it is most beneficial to use CFSTs for the columns subjected to the large compressive loading.
E. In reinforced concrete columns having transverse reinforcement, it minimizes the congestion of reinforcement and also minimizes the spalling of concrete, especially for seismic design.
F. When thin walled steel tubes are used with high strength concrete local buckling offered by thin steel tube is delayed because of the brittle nature of high strength concrete because concrete partly mitigates the confinement which is offered by steel tube.
G. The tube acts as formwork in construction of concrete filled steel tubes, which decreases labour and material costs.
H. The columns which are smaller in sizes may be used in high strength applications by which there is increase in the amount of space utilization as a result smaller and lighter framework places less of a load on the foundation and there is reduction in cost so it can be used in office buildings.
I. CFST has good fire resistance due to concrete present in it. So that fireproof material can be reduced or omitted.
J. CFST performs ecology purpose also as reusing of steel pipes and recycled aggregates with high quality concrete, environmental burden can be reduced by omitting the formwork.

IV. FINITE ELEMENT METHOD

Finite Element Analysis has been used to predict the behavior of CFST using available commercial finite element software. ANSYS, a nonlinear FE Model is created to simulate the axial capacity and failure mode of CFST samples in the proposed experiment. Two main types of materials are considered in the proposed FE modeling; a non linear compression and tension concrete infill and elasto-plastic confining steel tube. The concrete infill is models using solid elements whereas the tube is modeled using shell elements.

V. MATERIAL SPECIFICATION

Material	Young's Modulus(MPa)	Poisson's Ratio	Density(kg/m^3)
Steel Fe415	200000	0.3	7850
Concrete M20	22360.6	0.18	2400
Concrete M25	25000		
Concrete M30	27386.12		
Concrete M35	29580.39		
Concrete M40	31622.77		

VI. BRIEF DESCRIPTION OF SOFTWARE USED ANSYS

ANSYS Software is used to develop finite element models. Engineering Problems are stimulated by the use of this software. This software creates computer models of structures to simulate different parameters like strength, toughness, elasticity and other attributes. ANSYS is a commercial package of FEM software which is capable of solving different ranges of problem varying from the simple, nonlinear, statically analysis to complex transient dynamic, nonlinear analysis. ANSYS is used to solve different types of models like one-dimensional models, two-dimensional models, and three-dimensional models. This software is more efficient in modeling of both concrete and steel tube structure as it gives good meshing of composite tube.

VII. DIMENSIONS OF CFST AS PER L/D RATIO

Table.1

CFST Model	Length(mm)	Dimension(mm)	Thickness(mm)	L/D Ratio
Model 1	1500	150	2,3,4,5	10
Model 2	3400	170	2,3,4,5	20
Model 3	5700	190	2,3,4,5	30
Model 4	8400	210	2,3,4,5	40
Model 5	11500	230	2,3,4,5	50
Model 6	15000	250	2,3,4,5	60
Model 7	18900	270	2,3,4,5	70
Model 8	23200	290	2,3,4,5	80
Model 9	27900	310	2,3,4,5	90
Model 10	33000	330	2,3,4,5	100
Model 11	38500	350	2,3,4,5	110
Model 12	48000	400	2,3,4,5	120

Assumed Dimensions of Columns

VIII. RESULTS

Following are the tables showing Equivalent Stress, Buckling Load and Deformation for CFST of varying L/D Ratio

Table.2

Grade of Concrete	Thickness of Steel Tube	L/D Ratio											
		10	20	30	40	50	60	70	80	90	100	110	120
M20	2mm	0.424	0.26	0.226	0.188	0.16	0.137	0.123	0.11	0.091	0.091	0.067	0.052
	3mm	0.367	0.253	0.208	0.174	0.148	0.128	0.115	0.102	0.086	0.077	0.064	0.05
	4mm	0.323	0.235	0.195	0.164	0.14	0.12	0.109	0.096	0.081	0.07	0.062	0.048
	5mm	0.297	0.22	0.203	0.155	0.132	0.114	0.104	0.087	0.077	0.068	0.06	0.047
M25	2mm	0.389	0.237	0.206	0.172	0.146	0.125	0.113	0.101	0.083	0.071	0.06	0.047
	3mm	0.339	0.233	0.191	0.16	0.136	0.117	0.106	0.094	0.078	0.069	0.058	0.045
	4mm	0.301	0.217	0.179	0.151	0.128	0.111	0.1	0.088	0.074	0.068	0.057	0.044
	5mm	0.277	0.204	0.189	0.143	0.122	0.105	0.096	0.08	0.071	0.062	0.549	0.043
M30	2mm	0.363	0.219	0.191	0.16	0.135	0.116	0.105	0.093	0.077	0.065	0.056	0.043
	3mm	0.317	0.216	0.178	0.149	0.127	0.109	0.098	0.087	0.072	0.064	0.054	0.042
	4mm	0.283	0.203	0.168	0.141	0.12	0.103	0.093	0.082	0.069	0.059	0.052	0.041
	5mm	0.262	0.192	0.179	0.134	0.114	0.098	0.089	0.075	0.066	0.057	0.052	0.04
M35	2mm	0.341	0.205	0.18	0.15	0.127	0.109	0.098	0.088	0.072	0.061	0.052	0.04
	3mm	0.3	0.204	0.168	0.14	0.119	0.102	0.092	0.082	0.068	0.06	0.05	0.039
	4mm	0.269	0.192	0.158	0.133	0.113	0.097	0.088	0.078	0.065	0.055	0.049	0.038
	5mm	0.249	0.182	0.17	0.127	0.108	0.093	0.084	0.071	0.063	0.053	0.048	0.037
M40	2mm	0.323	0.195	0.17	0.142	0.12	0.103	0.093	0.083	0.068	0.057	0.049	0.037
	3mm	0.286	0.194	0.159	0.133	0.113	0.097	0.087	0.077	0.064	0.056	0.047	0.037
	4mm	0.257	0.183	0.151	0.126	0.107	0.092	0.083	0.074	0.062	0.055	0.046	0.036
	5mm	0.238	0.173	0.162	0.121	0.103	0.088	0.08	0.067	0.059	0.051	0.045	0.035

Stress Values (MPa) of CFST for different Slenderness Ratio with increasing thickness of steel tubes for Different Grades of Concrete

Table.3

Grade of Concrete	Thickness of Steel Tube	L/D Ratio											
		10	20	30	40	50	60	70	80	90	100	110	120
M20	2mm	1466	455.9	252.7	179.3	149.8	141.4	334.5	173.1	82.8	59.81	55.09	59.07
	3mm	1674	517.1	280.8	194.1	155.9	140.4	279.2	153.2	83.77	64.47	59.3	63.41
	4mm	1879	575.7	309.2	210.3	165.1	144.2	251	145.6	86.87	69.46	63.36	67.22
	5mm	2078	633.1	334.6	227	175.4	150	235.9	99.21	90.98	74.07	67.56	71.24
M25	2mm	1581	493.4	273.9	194	161.2	151.3	347	182.4	89.47	65.22	60.48	65.34
	3mm	1787	553.7	301.4	208.3	167.1	149.9	290.2	161.9	90.53	70.26	64.6	69.28
	4mm	1988	611.5	329.3	224.3	176	153.3	261.3	153.1	93.22	75.03	68.67	73.06
	5mm	2185	668	354.3	240.7	186.1	158.9	245.5	106.1	96.89	79.69	72.69	77
M30	2mm	1686	527.2	292.7	207.2	171.7	160.2	359.4	190.6	95.03	70.72	65.28	70.69
	3mm	1889	586.7	319.9	221.1	177.1	158.3	299.7	169.4	96.34	75.42	69.29	74.54
	4mm	2088	643.8	347.4	236.9	185.8	161.6	270.1	160.4	99.07	80.09	73.38	78.35
	5mm	2282	699.5	372.1	253.1	195.8	167.1	253.7	112.2	102.6	84.64	73.38	82.2
M35	2mm	1782	558.4	310.3	219.3	181	168.1	370.6	198.3	100.7	75.5	69.71	75.62
	3mm	1983	617.3	336.9	233	186.4	166.1	308.3	176.5	101.5	80.11	73.82	79.46
	4mm	2179	673.4	364.1	248.5	194.8	169.2	278.2	165.8	104.4	84.98	77.76	83.16
	5mm	2371	728.7	388.4	264.4	204.5	174.5	261.1	117.6	107.6	89.36	81.79	87.03
M40	2mm	1872	587.3	326.4	230.5	189.9	175.8	379.9	203.9	106.1	79.79	79.98	80.15
	3mm	2070	645.4	352.8	244.1	195	173.3	316.1	181.3	106.2	84.57	77.93	83.89
	4mm	2264	701	379.7	259.2	203.2	176.3	285.6	171.7	109.2	89.18	81.71	87.71
	5mm	2454	755.7	403.6	275	212.8	181.4	268.1	122.9	112.5	93.56	85.81	91.39

Buckling Load (KN) of CFST for different Slenderness Ratio with increasing thickness of steel tubes for Different Grades of Concrete

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Table.4

Grade of Concrete	Thickness of Steel Tube	L/D Ratio											
		10	20	30	40	50	60	70	80	90	100	110	120
M20	2mm	0.002	0.004	0.006	0.007	0.009	0.01	0.01	0.011	0.012	0.012	0.013	0.012
	3mm	0.002	0.004	0.006	0.007	0.008	0.009	0.01	0.011	0.011	0.012	0.012	0.012
	4mm	0.002	0.004	0.005	0.007	0.008	0.009	0.009	0.01	0.011	0.011	0.012	0.012
	5mm	0.002	0.004	0.005	0.006	0.007	0.008	0.009	0.01	0.01	0.011	0.011	0.012
M25	2mm	0.002	0.004	0.006	0.007	0.008	0.009	0.009	0.01	0.011	0.011	0.012	0.011
	3mm	0.002	0.004	0.005	0.006	0.007	0.008	0.009	0.01	0.01	0.011	0.011	0.011
	4mm	0.002	0.004	0.005	0.006	0.007	0.008	0.009	0.009	0.01	0.01	0.011	0.011
	5mm	0.002	0.003	0.005	0.006	0.007	0.008	0.008	0.009	0.009	0.01	0.01	0.01
M30	2mm	0.002	0.004	0.005	0.006	0.007	0.008	0.009	0.009	0.01	0.01	0.011	0.01
	3mm	0.002	0.004	0.005	0.006	0.007	0.008	0.008	0.009	0.009	0.01	0.01	0.01
	4mm	0.002	0.033	0.005	0.006	0.007	0.007	0.008	0.009	0.009	0.01	0.01	0.01
	5mm	0.002	0.003	0.004	0.005	0.006	0.007	0.008	0.008	0.009	0.009	0.01	0.009
M35	2mm	0.002	0.004	0.005	0.006	0.006	0.007	0.008	0.009	0.009	0.01	0.01	0.01
	3mm	0.002	0.003	0.005	0.006	0.006	0.007	0.008	0.008	0.009	0.009	0.01	0.009
	4mm	0.002	0.003	0.004	0.005		0.007	0.007	0.008	0.009	0.009	0.009	0.009
	5mm	0.002	0.003	0.004	0.005	0.006	0.007	0.007	0.008	0.008	0.009	0.009	0.009
M40	2mm	0.002	0.003	0.004	0.006	0.006	0.007	0.008	0.008	0.009	0.009	0.009	0.009
	3mm	0.002	0.003	0.004	0.005	0.006	0.007	0.007	0.008	0.008	0.009	0.009	0.009
	4mm	0.002	0.003	0.004	0.005	0.006	0.006	0.007	0.008	0.008	0.008	0.009	0.009
	5mm	0.002	0.003	0.004	0.005	0.006	0.006	0.007	0.007	0.008	0.008	0.009	0.008

Deformation (mm) of CFST for different Slenderness Ratio with increasing thickness of steel tubes for Different Grades of Concrete

Following are the graphs showing Equivalent Stress, Buckling Load and Deformation for CFST of varying L/D Ratio

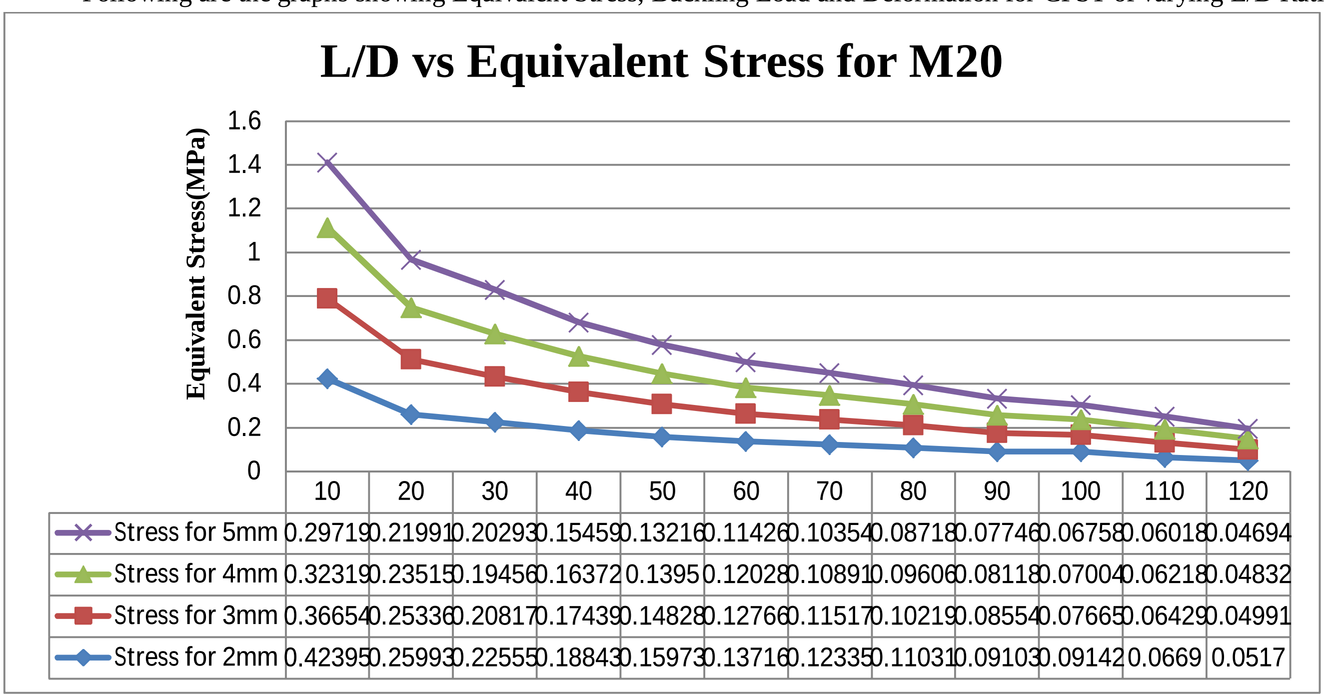
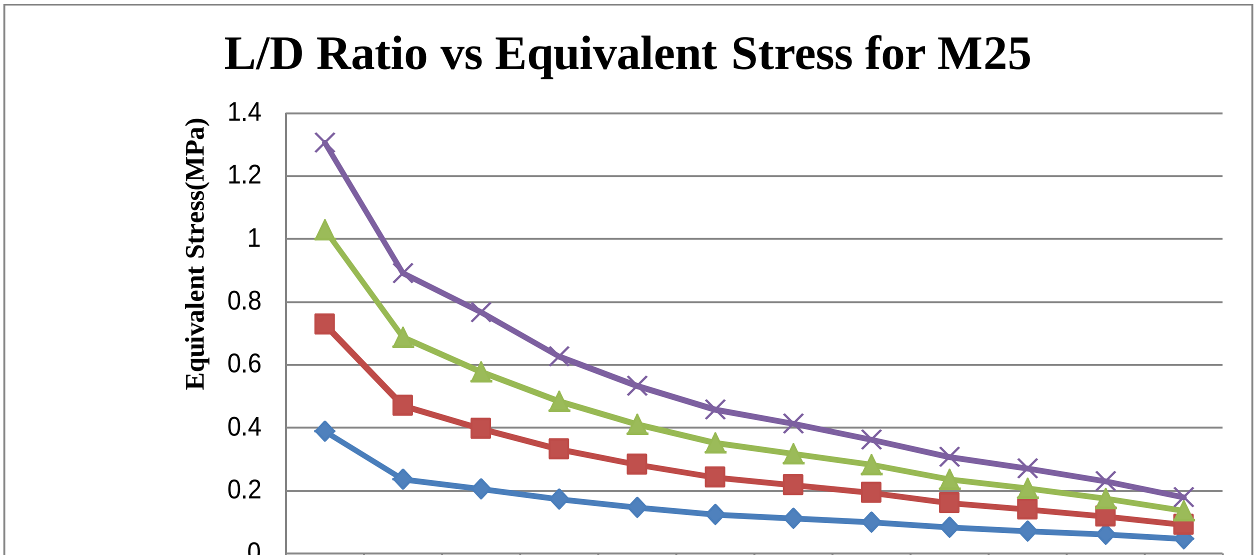


Fig.1

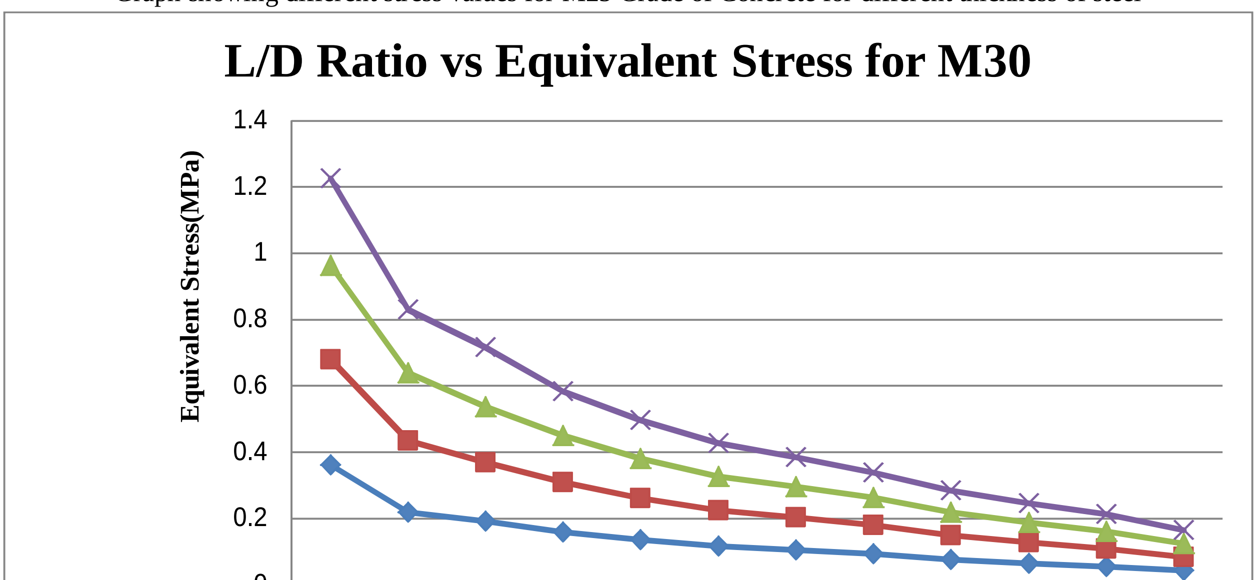
Graph showing different stress values for M20 Grade of Concrete for different thickness of steel



	10	20	30	40	50	60	70	80	90	100	110	120
Stress for 5mm	0.2774	0.2044	0.1895	0.143	0.1221	0.1054	0.0956	0.0803	0.0713	0.0616	0.0549	0.0427
Stress for 4mm	0.3008	0.2171	0.1795	0.1508	0.1283	0.1106	0.1002	0.0883	0.0744	0.0684	0.0565	0.0438
Stress for 3mm	0.339	0.2331	0.1912	0.1601	0.136	0.117	0.1055	0.0936	0.0781	0.0693	0.0583	0.0452
Stress for 2mm	0.3893	0.2368	0.2062	0.1721	0.1458	0.1251	0.1127	0.1007	0.0828	0.0706	0.0604	0.0466

Fig.2

Graph showing different stress values for M25 Grade of Concrete for different thickness of steel



	10	20	30	40	50	60	70	80	90	100	110	120
Stress for 5mm	0.2617	0.1923	0.1787	0.134	0.1142	0.0985	0.0894	0.075	0.0665	0.0571	0.0522	0.0395
Stress for 4mm	0.2832	0.2032	0.1678	0.1409	0.1198	0.1032	0.0934	0.0823	0.0692	0.059	0.0522	0.0405
Stress for 3mm	0.3175	0.2165	0.1782	0.1492	0.1266	0.1087	0.0981	0.087	0.0725	0.0639	0.0538	0.0416
Stress for 2mm	0.3626	0.2192	0.1914	0.1597	0.1351	0.1159	0.1046	0.0933	0.0766	0.0651	0.0556	0.0428

Fig.3

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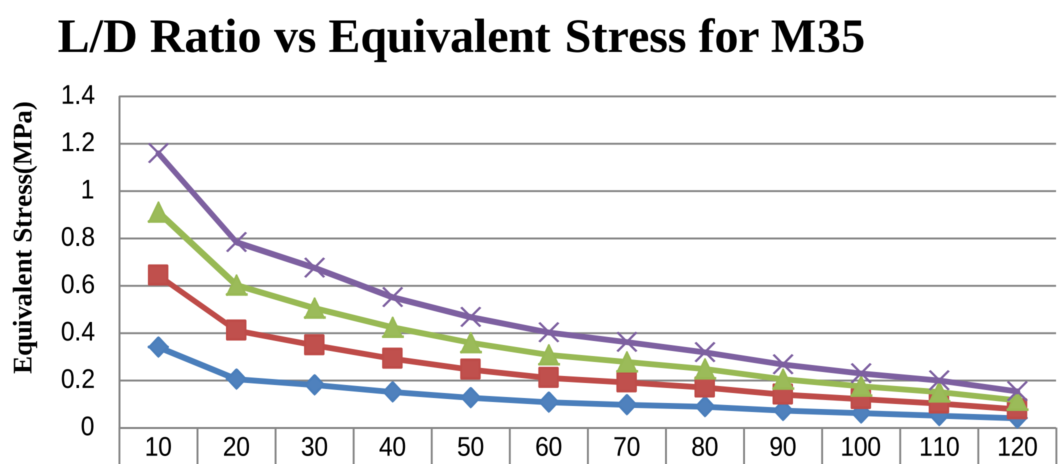
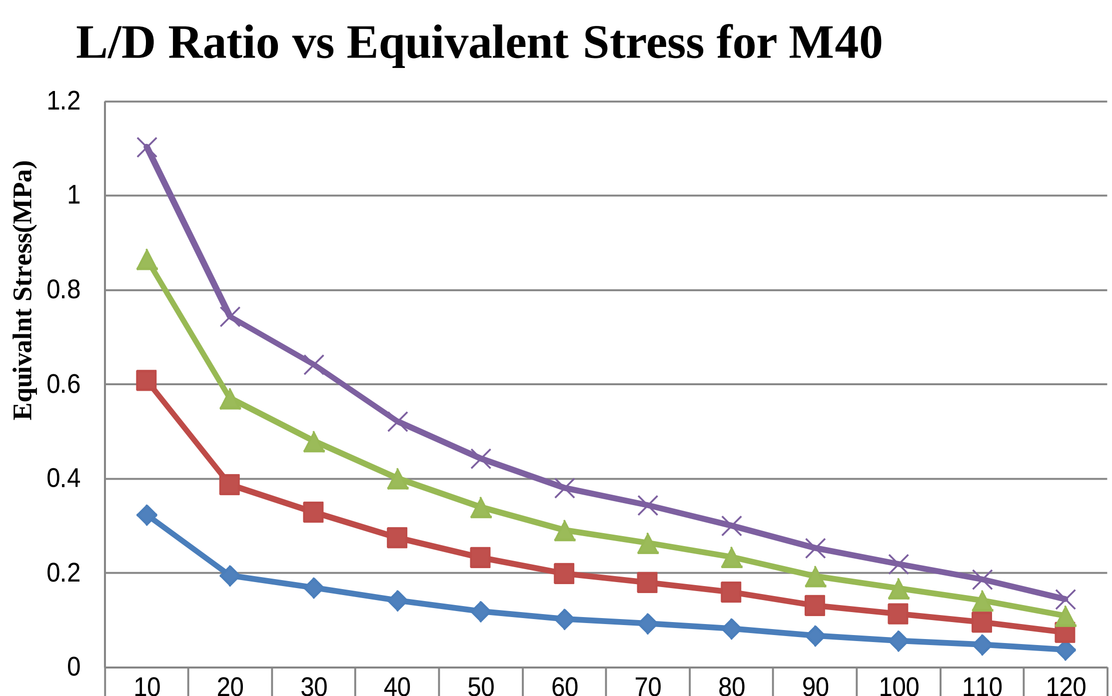
Graph showing different stress values for M30 Grade of Concrete for different thickness of steel



	10	20	30	40	50	60	70	80	90	100	110	120
Stress for 5mm	0.2488	0.182	0.1698	0.1267	0.1079	0.093	0.0844	0.0707	0.0626	0.0535	0.0476	0.0369
Stress for 4mm	0.2687	0.1921	0.1585	0.1329	0.113	0.0972	0.088	0.0776	0.0651	0.055	0.0488	0.0379
Stress for 3mm	0.3001	0.204	0.1678	0.1403	0.119	0.1022	0.0922	0.0818	0.068	0.0597	0.0502	0.0388
Stress for 2mm	0.3412	0.2052	0.1795	0.1497	0.1267	0.1086	0.0981	0.0875	0.0717	0.0608	0.0517	0.0399

Fig.4

Graph showing different stress values for M35 Grade of Concrete for different thickness of steel



	10	20	30	40	50	60	70	80	90	100	110	120
Stress for 5mm	0.23797	0.17347	0.16234	0.12066	0.10269	0.08843	0.08019	0.06712	0.05944	0.05058	0.04494	0.03487
Stress for 4mm	0.25663	0.18266	0.15067	0.12633	0.10729	0.09223	0.08349	0.07359	0.06164	0.05488	0.04603	0.03568
Stress for 3mm	0.28554	0.19355	0.15911	0.13304	0.11275	0.09677	0.08738	0.07746	0.06425	0.05628	0.04728	0.03654
Stress for 2mm	0.32348	0.19458	0.16981	0.14159	0.11977	0.10264	0.09285	0.0828	0.06764	0.05727	0.0486	0.03744

Fig.5

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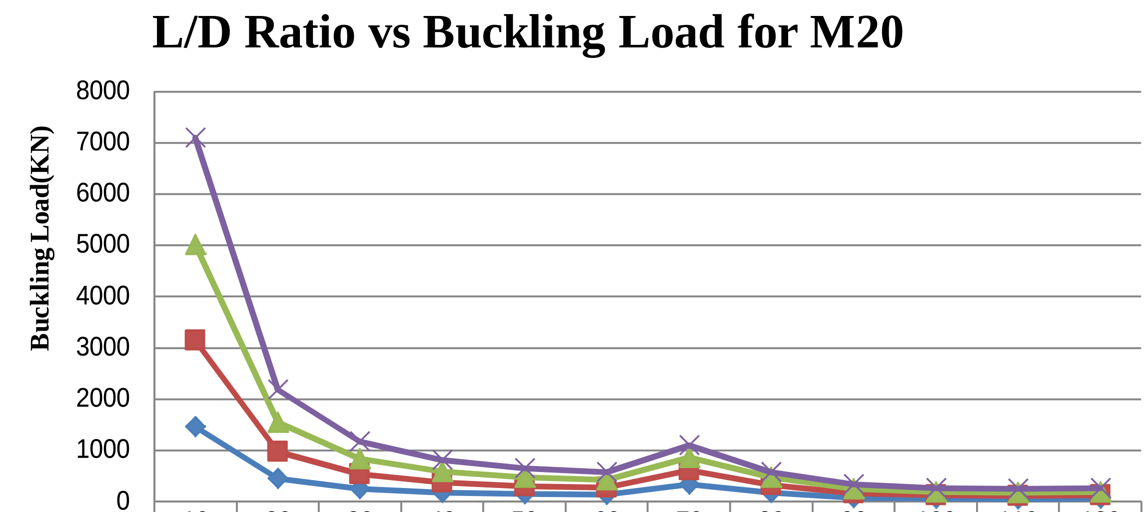
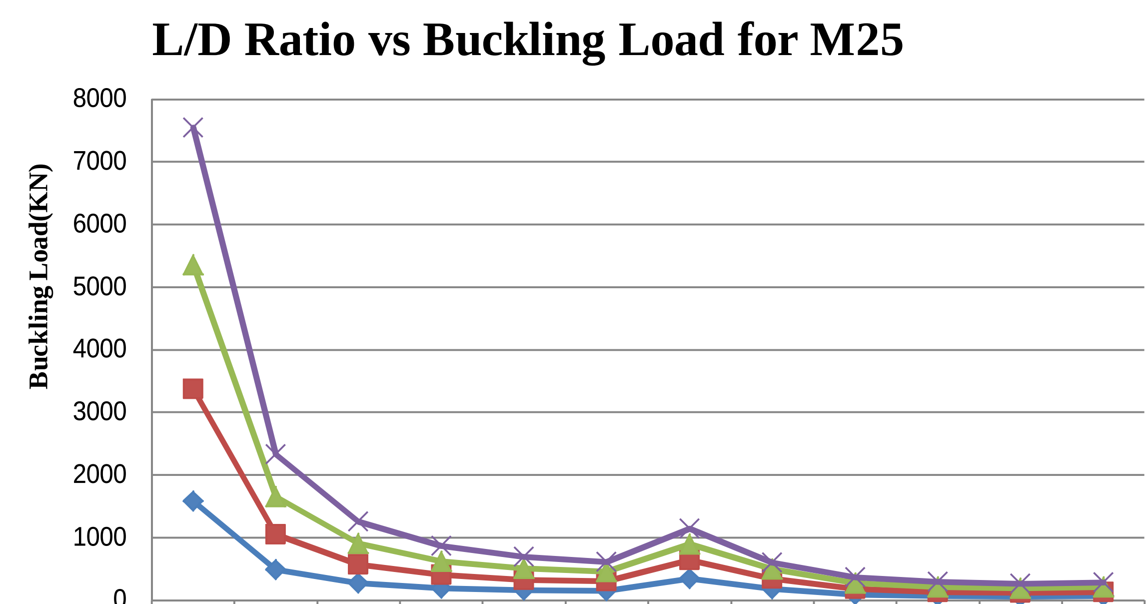
Graph showing different stress values for M40 Grade of Concrete for different thickness of steel



	10	20	30	40	50	60	70	80	90	100	110	120
Load for 5mm	2078.2	633.09	334.61	227.01	175.41	149.99	235.89	99.21	90.983	74.065	67.564	71.238
Load for 4mm	1878.5	575.67	309.24	210.28	165.09	144.22	251.01	145.62	86.866	69.462	63.364	67.221
Load for 3mm	1674.4	517.11	280.83	194.09	155.94	140.35	279.17	153.15	83.768	64.469	59.296	63.405
Load for 2mm	1465.6	455.92	252.68	179.32	149.81	141.38	334.52	173.11	82.795	59.813	55.087	59.067

Fig.6

Graph showing different Buckling Load values for M20 Grade of Concrete for different thickness of steel



	10	20	30	40	50	60	70	80	90	100	110	120
Load for 5mm	2185.3	668.04	354.31	240.65	186.13	158.92	245.48	106.11	96.888	79.688	72.69	76.998
Load for 4mm	1988.4	611.54	329.26	224.25	175.97	153.31	261.33	153.1	93.215	75.026	68.672	73.059
Load for 3mm	1787.1	553.7	301.35	208.25	167.11	149.85	290.2	161.91	90.525	70.261	64.602	69.281
Load for 2mm	1581.3	493.37	273.91	194.02	161.16	151.27	347	182.39	89.465	65.221	60.481	65.338

Fig.7

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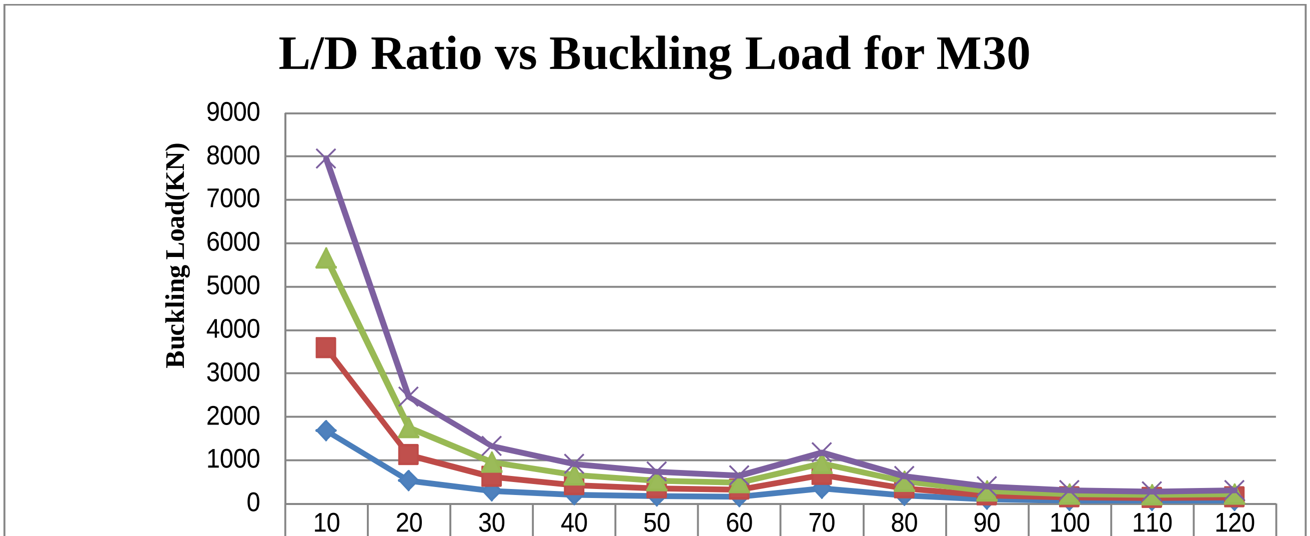
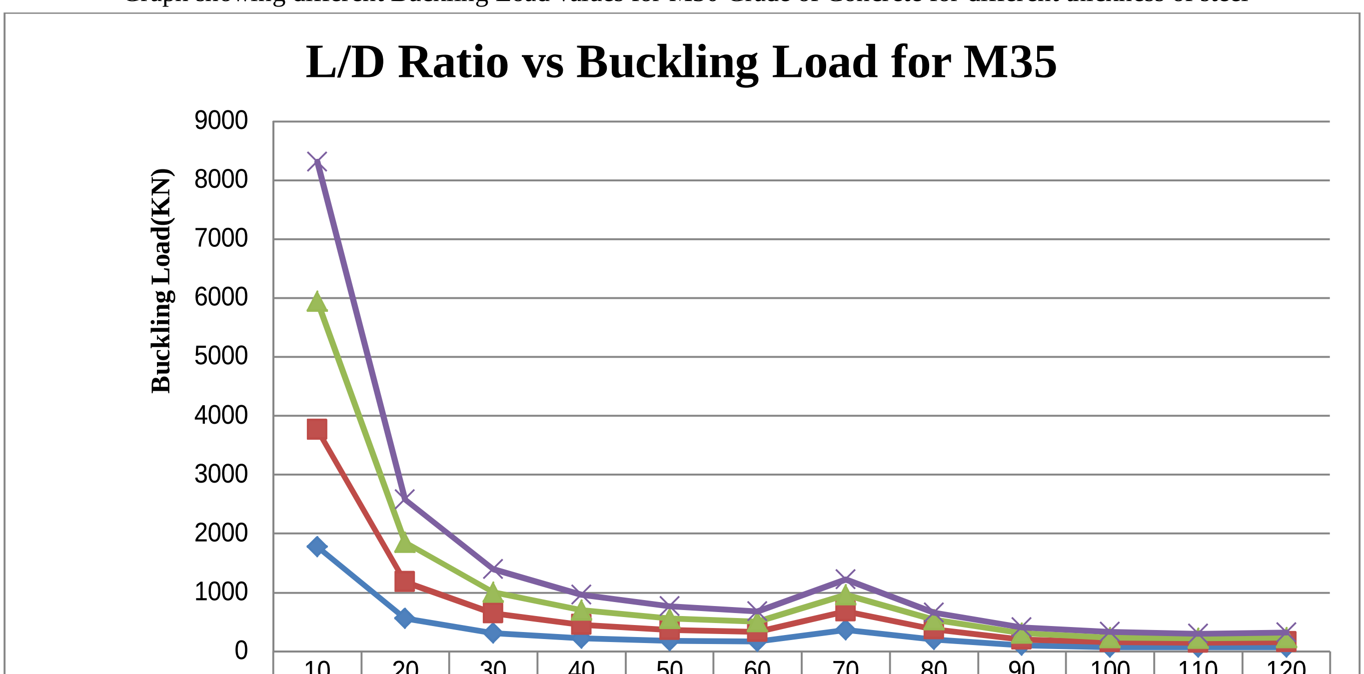
Graph showing different Buckling Load values for M25 Grade of Concrete for different thickness of steel



	10	20	30	40	50	60	70	80	90	100	110	120
Load for 5mm	2282.1	699.49	372.06	253.07	195.77	167.07	253.67	112.21	102.55	84.638	73.379	82.204
Load for 4mm	2087.8	643.84	347.38	236.86	185.76	161.59	270.09	160.35	99.068	80.085	73.378	78.354
Load for 3mm	1889.1	586.74	319.93	221.14	177.05	158.32	299.68	169.37	96.34	75.415	69.289	74.535
Load for 2mm	1685.9	527.22	292.73	207.19	171.66	160.17	359.35	190.62	95.03	70.719	65.279	70.694

Fig.8

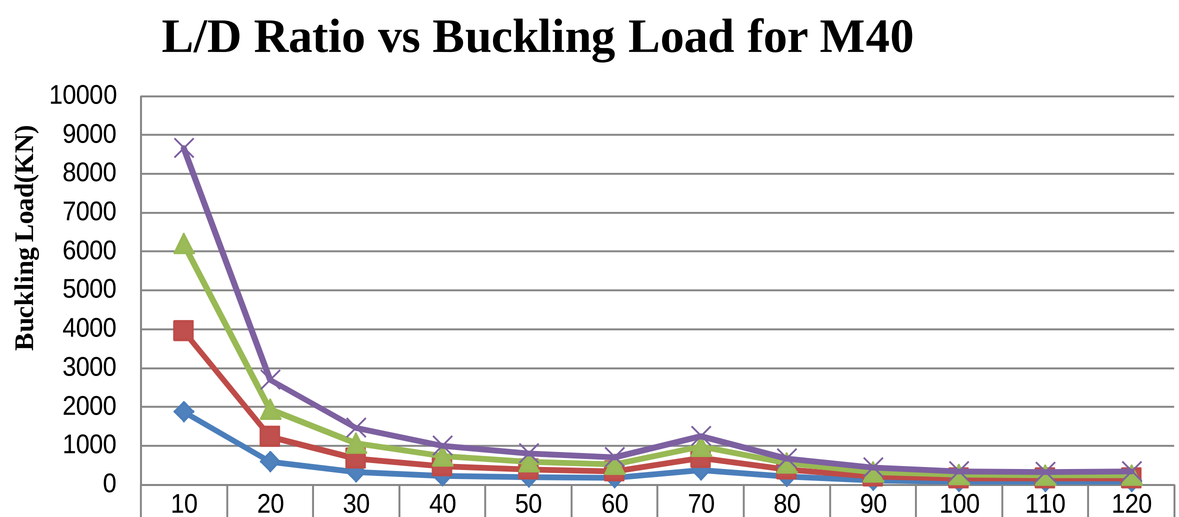
Graph showing different Buckling Load values for M30 Grade of Concrete for different thickness of steel



	10	20	30	40	50	60	70	80	90	100	110	120
Load for 5mm	2371	728.68	388.41	264.36	204.52	174.49	261.08	117.56	107.62	89.359	81.789	87.03
Load for 4mm	2179.2	673.41	364.1	248.47	194.79	169.22	278.21	165.8	104.36	84.975	77.76	83.164
Load for 3mm	1982.9	617.26	336.91	232.98	186.42	166.12	308.33	176.45	101.46	80.107	73.822	79.462
Load for 2mm	1782	558.35	310.28	219.26	180.99	168.14	370.58	198.25	100.65	75.499	69.713	75.616

Fig.9

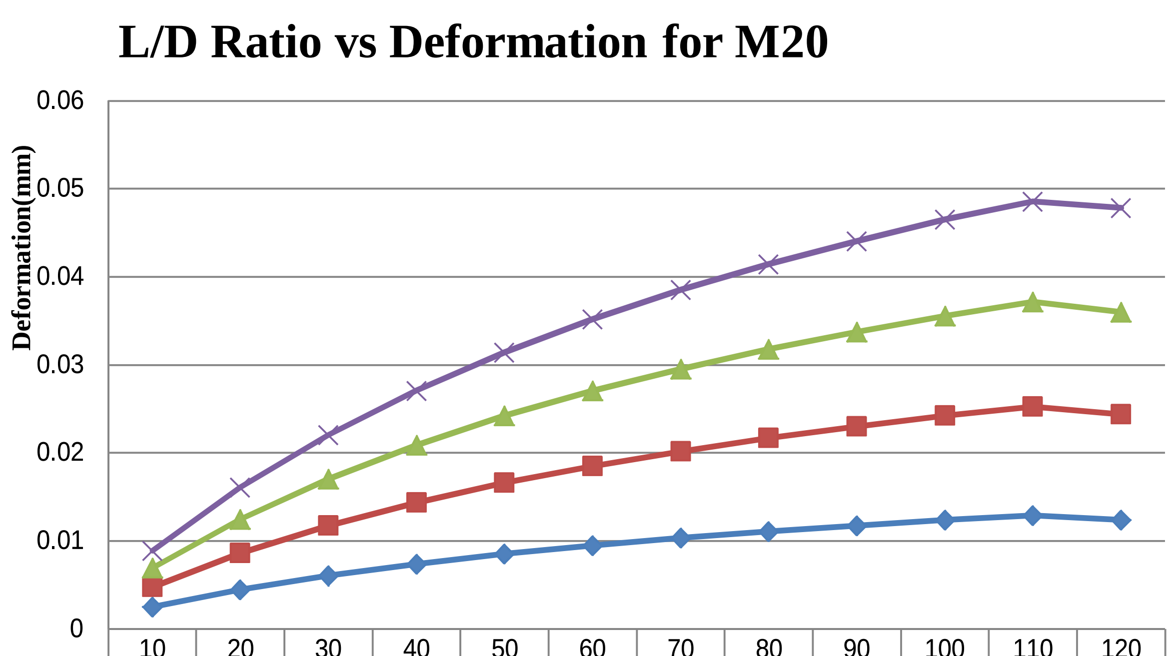
Graph showing different Buckling Load values for M35 Grade of Concrete for different thickness of steel



	10	20	30	40	50	60	70	80	90	100	110	120
Load for 5mm	2453.9	755.72	403.59	275.01	212.76	181.4	268.08	122.94	112.54	93.56	85.808	91.389
Load for 4mm	2264	701.04	379.65	259.2	203.23	176.29	285.61	171.69	109.23	89.18	81.707	87.706
Load for 3mm	2069.9	645.44	352.83	244.07	195.01	173.26	316.14	181.28	106.2	84.567	77.93	83.891
Load for 2mm	1871.7	587.31	326.43	230.49	189.86	175.75	379.86	203.86	106.1	79.793	79.976	80.147

Fig.10

Graph showing different Buckling Load values for M40 Grade of Concrete for different thickness of steel



	10	20	30	40	50	60	70	80	90	100	110	120
Deformation for 5mm	0.00201	0.00363	0.00502	0.0062	0.00724	0.00815	0.00895	0.00968	0.01033	0.01093	0.01145	0.01187
Deformation for 4mm	0.00214	0.00386	0.00531	0.00655	0.00762	0.00855	0.00937	0.01011	0.01076	0.01136	0.01189	0.01157
Deformation for 3mm	0.0023	0.00413	0.00565	0.00694	0.00805	0.009	0.00983	0.01058	0.01124	0.01186	0.01236	0.01198
Deformation for 2mm	0.00248	0.00445	0.00605	0.00739	0.00853	0.00951	0.01035	0.0111	0.01176	0.01237	0.01288	0.01242

Fig.11

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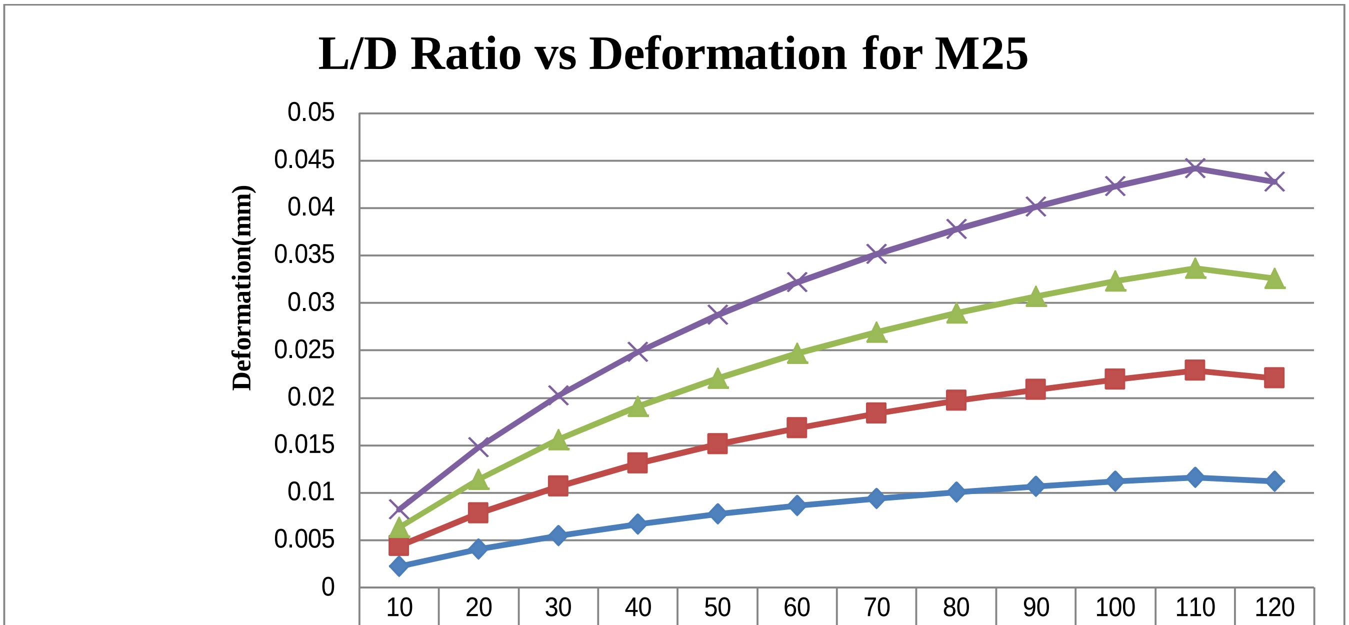
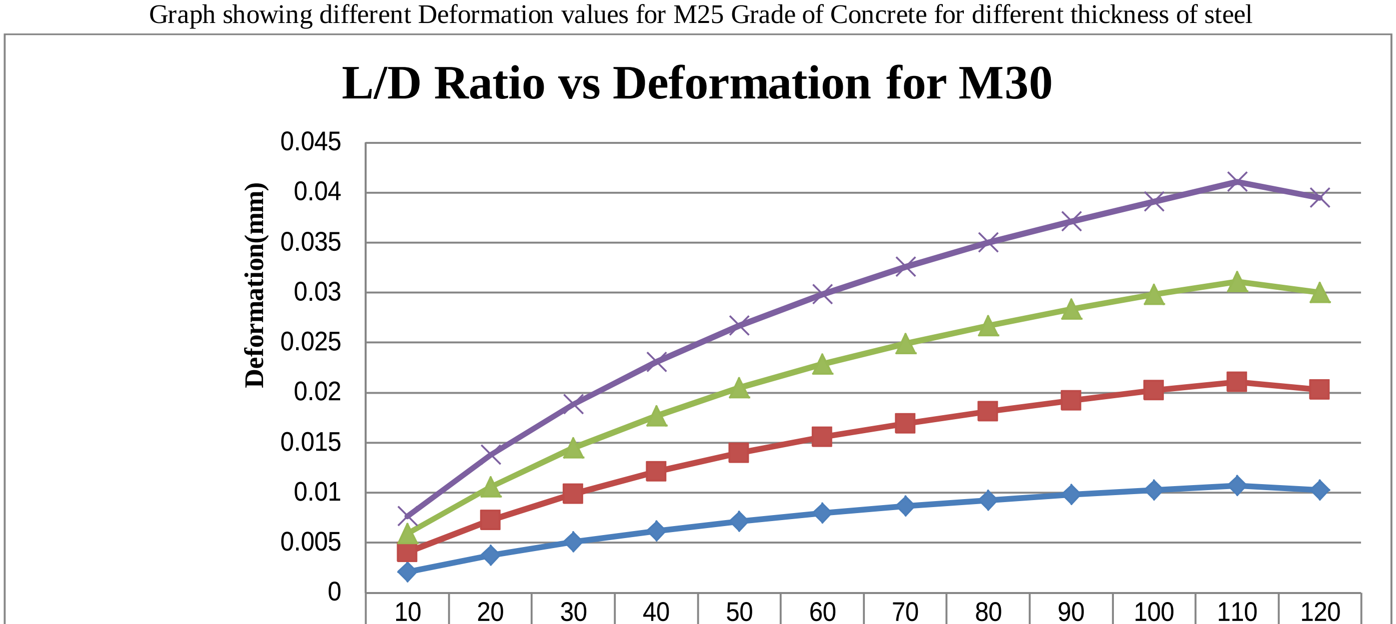
Graph showing different Deformation values for M20Grade of Concrete for different thickness of steel



	10	20	30	40	50	60	70	80	90	100	110	120
Deformation for 5mm	0.00187	0.00337	0.00464	0.00573	0.00667	0.0075	0.00823	0.00888	0.00947	0.01	0.01047	0.01021
Deformation for 4mm	0.00198	0.00356	0.00489	0.00602	0.00699	0.00784	0.00857	0.00924	0.00982	0.01038	0.01083	0.01052
Deformation for 3mm	0.00211	0.00379	0.00518	0.00635	0.00735	0.00821	0.00896	0.00962	0.01021	0.01076	0.01122	0.01085
Deformation for 2mm	0.00227	0.00405	0.0055	0.00672	0.00774	0.00862	0.00937	0.01005	0.01064	0.01117	0.01163	0.01121

Fig.12

Graph showing different Deformation values for M25 Grade of Concrete for different thickness of steel



	10	20	30	40	50	60	70	80	90	100	110	120
Deformation for 5mm	0.00175	0.00316	0.00435	0.00536	0.00623	0.007	0.00766	0.00827	0.0088	0.00929	0.01003	0.00946
Deformation for 4mm	0.00185	0.00333	0.00457	0.00561	0.00651	0.00729	0.00796	0.00857	0.00911	0.0096	0.01003	0.00972
Deformation for 3mm	0.00197	0.00353	0.00481	0.00589	0.00681	0.0076	0.00829	0.0089	0.00944	0.00993	0.01035	0.01
Deformation for 2mm	0.0021	0.00375	0.00509	0.0062	0.00714	0.00795	0.00864	0.00925	0.00979	0.01028	0.0107	0.0103

Fig.13

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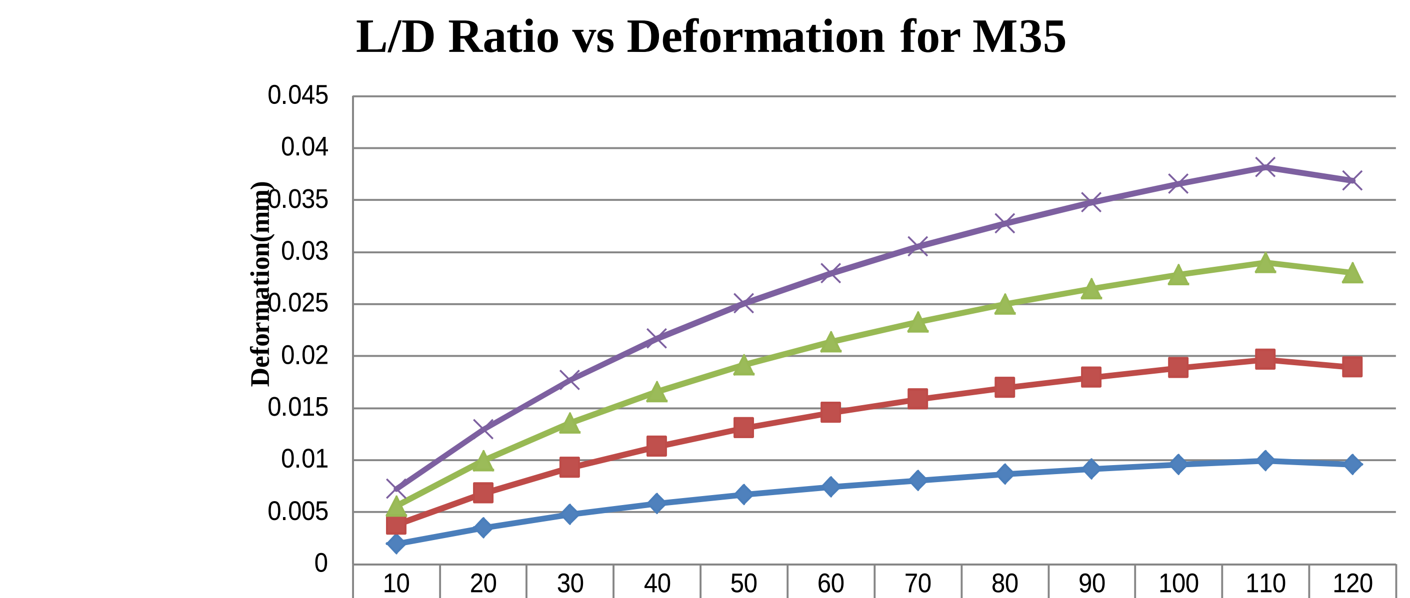
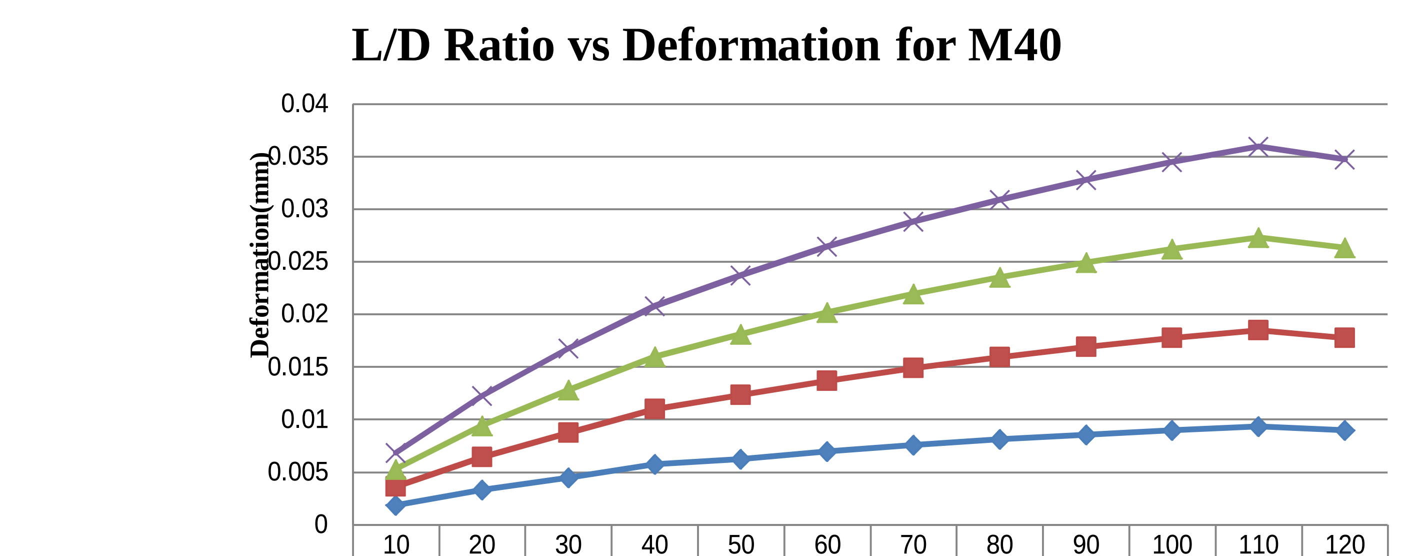
Graph showing different Deformation values for M30 Grade of Concrete for different thickness of steel



	10	20	30	40	50	60	70	80	90	100	110	120
Deformation for 5mm	0.00166	0.00299	0.00412	0.00506	0.00588	0.00659	0.00721	0.00777	0.00827	0.00872	0.00912	0.00886
Deformation for 4mm	0.00175	0.00315	0.0043	0.00528	0.00612	0.00684	0.00747	0.00804	0.00853	0.00899	0.00938	0.00909
Deformation for 3mm	0.00185	0.00332	0.00452	0.00553	0.00638	0.00712	0.00775	0.00832	0.00882	0.00928	0.00966	0.00933
Deformation for 2mm	0.00197	0.00351	0.00476	0.0058	0.00667	0.00742	0.00806	0.00863	0.00912	0.00957	0.00996	0.00958

Fig.14

Graph showing different Deformation values for M35 Grade of Concrete for different thickness of steel



	10	20	30	40	50	60	70	80	90	100	110	120
Deformation for 5mm	0.00156	0.00285	0.00392	0.00481	0.00558	0.00625	0.00684	0.00736	0.00783	0.00825	0.00862	0.00837
Deformation for 4mm	0.00167	0.00299	0.00409	0.00501	0.0058	0.00648	0.00707	0.0076	0.00806	0.00849	0.00885	0.00857
Deformation for 3mm	0.00176	0.00314	0.00428	0.00523	0.00603	0.00672	0.00732	0.00785	0.00831	0.00874	0.0091	0.00878
Defomation for 2mm	0.00186	0.00331	0.00449	0.00576	0.00628	0.00698	0.00758	0.00811	0.00858	0.009	0.00936	0.009

Fig.15 Graph showing different Deformation values for M40 Grade of Concrete for different thickness of steel

IX. CONCLUSION

Based on these extensive analytical investigations, important conclusions have been arrived at and they are as follows:

A. As the value of L/D ratio increases, the load carrying capacity of the CFST columns decreases.
B. As the value of D/t ratio increases, the load carrying capacity of the CFST column increases.
C. The local buckling of steel tube gets delayed due to the in-filled concrete.
D. It was observed from the analysis of different data, the failure mode of the CFST composite column depends on slenderness ratio.
E. On Lowering Slenderness ratio load carrying capacity of CFST columns increases as a result buckling failure is avoided.
F. When the slenderness ratio is very less, the column fails due to local buckling of steel nearer to the support and crushing of concrete under direct compression. When the slenderness ratio is large, the column fails by elastic buckling**.**
G. Equivalent Stress, Buckling Load, Deformation values for different L/D ratio with variation in grade of concrete and thickness of steel tube are calculated.
H. With the increase in L/D ratio Equivalent Stress decreases for all Grades of Concrete.
I. With the increase in L/D ratio from 10 to 60 load carrying capacity of columns decrease but when L/D ratio is 70, load carrying capacity suddenly increases then from 80 to 120 it again gradually decreases. So, it is concluded that CFST columns with L/D ratio as 70 is suitable for long columns for all Grades of Concrete.
J. With the increase in L/D ratio from 10 to 100 deformations of columns increases but when L/D ratio is 110, deformation is maximum and then gradually it starts decreasing

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