MODELING OF STEEL AND CONCRETE COMPOSITE COLUMNS

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Introduction

Composite steel construction has been recognized for a number of years as one of the most economical systems for construction and it has recently undergone increased usage throughout the world. Many researches have been presented in composite structures, here a list of some of these researches.
In May 2004 Mohanad Mursi, Brian Uy [1] presented a paper studying the Strength of slender concrete filled high strength steel box columns
In November 2006 L. Bouazaoui, G. Perrenot, Y. Delmas, A. Li [2] presented a paper which deals with the experimental analysis of the mechanical behavior of bonded steel–concrete composite structures. The steel girder and the concrete slab were assembled by adhesives. The effect of the main parameters, such as the adhesive nature and the irregular thickness of the adhesive joint, on mechanical performance and ultimate load was studied. Two adhesives were used in this work. The results showed that the connection between the steel girder and the concrete slab ensured by epoxy adhesive was perfect and without any slip in the steel–concrete interface. In January 2008 B. Uy [3] presented a research aimed to investigate the stability and ductility characteristics of concrete filled columns using high performance steels (HPS). HPS included both high strength steel and stainless steel which exhibit improved strength, as well as corrosion resistance, hardness etc. This paper provided both an experimental and a theoretical treatment of these issues and provided comparisons with existing design procedures, to illustrate the significant advantages which the juxtaposition of concrete provides to high performance steel sections. In August 2009 T. Aly. P. Thayalan, M. Elchalakani, I. Patnaikuni [4] presented an analytical study for modeling the behavior of concrete-filled steel tubular (CFST) columns subjected to Static Loading (SL) and Variable Repeated Loading (VRL). The variables considered in this study were concrete strength and load eccentricity. Simple mathematical models were developed and used in the analysis. The analytical results show that the incremental collapse (IC) occurs in high load ranges in CFST columns under VRL and instability failure occurs under SL. As mentioned above not many papers deal with building computer model to simulate the composite structures, so this paper focused on building a computer model to simulate a steel concrete composite column in order to use this model in predicting the failure load of any composite column, this was achieved by comparing the experimental the result of a research which was published by Mohanad Mursi and Brian Uy in 2004 [1] by the model built with the presented paper.

The experimental results [1]

This paper presents both an experimental and theoretical treatment of coupled local and global buckling of concrete filled high strength steel columns, the experimental study was performed on short and slender steel and composite columns the following two tables.(1,2) show the results for both short and slender column respectively

Column	Type	L mm	b mm	d mm	t mm	b/t	f_c N/mm^2	f_y N/mm^2	$N_{u.test}$ kN	$N_{u.test}$ / $N_{squash\ 1}$	$N_{u.test}$ / $N_{squash\ 2}$
SH-H110	Hollow	430	110	110	5	22	20.34	761	1324	0.77	0.85
SH-H160	Hollow	580	160	160	5	32	20.34	761	1524	0.62	0.97
SH-H210	Hollow	730	210	210	5	42	20.34	761	1572	0.49	1.0
SH-H260	Hollow	880	260	260	5	52	20.34	761	1570	0.39	0.99
SH-C110	Composite	430	110	110	5	22	20.34	761	1835	0.94	0.96
SH-C160	Composite	580	160	160	5	32	20.34	761	2831	0.95	0.97
SH-C210	Composite	730	210	210	5	42	20.34	761	3609	0.88	1.1
SH-C260	Composite	880	260	260	5	52	20.34	761	3950	0.74	1.08

Table.1. Short columns test results [1].

Column	Type	L mm	L_e mm	e mm	δ_0 mm	b mm	d mm	t mm	b/t	f_c N/mm^2	f_y N/mm^2	$N_{u.test}$ kN
SL-H110	Hollow	3020	2265	10	+2	110	110	5	22	20.34	761	1036
SL-H160	Hollow	3020	2416	15	−3	160	160	5	32	20.34	761	1505
SL-H210	Hollow	3020	2869	20	−2	210	210	5	42	20.34	761	1479
SL-H260	Hollow	3020	3020	25	0	260	260	5	52	20.34	761	1371
SL-C110	Composite	3020	2174	10	−2	110	110	5	2220.34	761	1481	
SL-C160	Composite	3020	2416	15	0	160	160	5	3220.34	761	2126	
SL-C210	Composite	3020	2416	20	−2	210	210	5	4220.34	761	2939	
SL-C260	Composite	3020	2817	25	−2	260	260	5	5220.34	761	3062	

Table.2. Slender columns test results [1].

The cross section of the short columns at the middle and at the ends is illustrated in fig.1

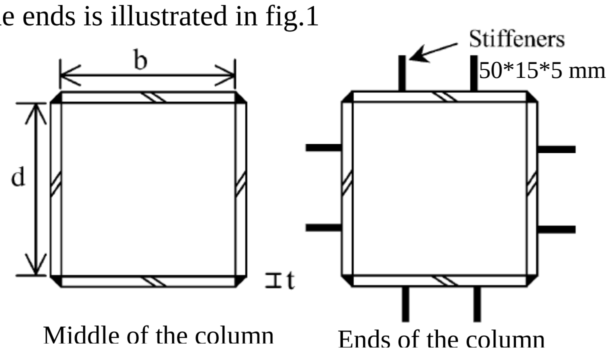

Fig.1. Short column cross section [1].

This paper compared the results of the computer model with the experimental result [1] of the marked columns in table.1.

The model used in this paper

This paper used ANSYS program in building the model, steel plates are modeled by using shell(63,143), Concrete fill are modeled using solid65, solid45 is used in modeling the top and the bottom steel plates that are used under the loading jack and beam4 is used in modeling the connectors between the steel plates and the concrete. The properties of all these elements can be found in the ANSYS library [5]. Fig.2 shows the model built in ANSYS.

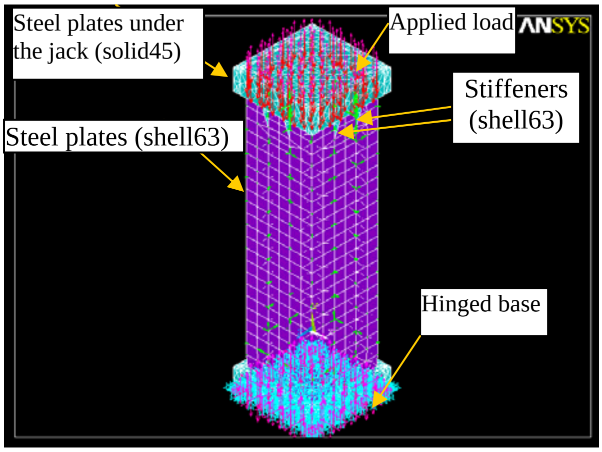

Fig.2. Model used in ANSYS program.

In the model material and geometric nonlinearity are taken under consideration. For materials, bilinear kinematic hardening is used in modeling the steel and concrete material. The maximum meshing size is 50mm with maximum aspect ratio of 2. Fig.3 shows the connection between the steel plate and the concrete.

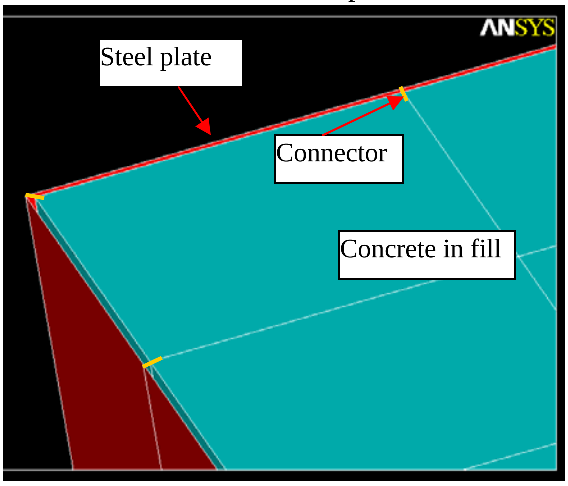

Fig.3. Connection between the steel plate and the infill concrete.

The normal stresses in steel plates and concrete fill according to the failure load of column (SH-C160) is illustrated in fig. (4, 5) respectively. Table.3 shows the ratio between the failure load due to experimental result and the computer model.

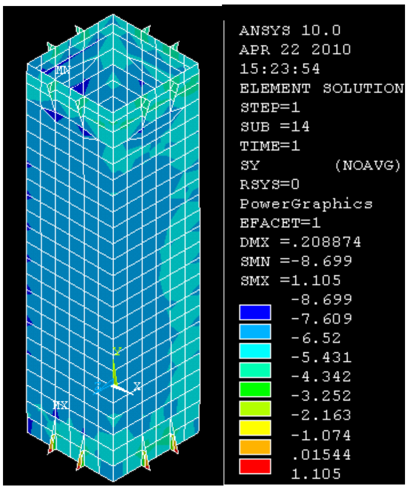

Fig.4. Normal stresses at failure load in steel plates.

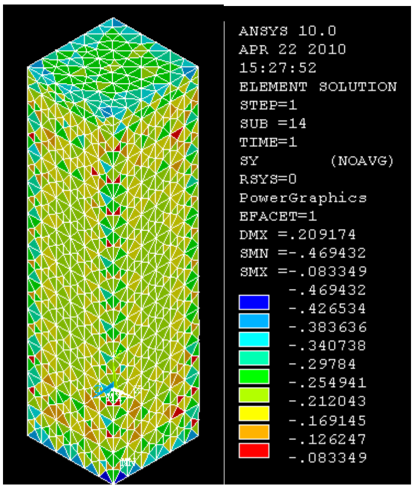

Fig.5. Normal stresses at failure load in steel plates.

Section	Failure load from experimental results (N_{us})(ton)	Failure load from computer model (N_{um})(ton)	N_{um}/ N_{us}
SH-C160	**283.1**	**268.65**	**0.949**
SH-C210	**360.9**	**365.7**	**1.01**
SH-C260	**395**	**457.95**	**1.16**

Table 3, the failure loads from experimental results and computer models.

Conclusions

The results in table 3 show that the difference between the failures loads from experimental results and the computer models are small. This indicate that the ANSYS model, the elements, meshing and boundary condition that are used in these models are accurate and can be used in determining the failure load of any composite columns.

References

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