Advances in Nano Research, *Vol. 8, No. 4 (2020) 323-333*
DOI: https://doi.org/10.12989/anr.2020.8.4.323

Performance assessment of buckling restrained brace with tubular profile

Yan Cao [1], Sadaf Mahmoudi Azar [2], S.N.R. Shah [3], Ahmed Fathi Mohamed Salih [4,5],
Tiana Thiagi [6], Kittisak Jermsittiparsert [*7,8] and Lanh Si Ho [9]

[1] *School of Mechatronic Engineering, Xi'an Technological University, Xi'an, 710021, China*
[2] *Department of Civil Engineering, Faculty of Engineering, University of Malaya, Malaysia*
[3] *Department of Civil Engineering, Mehran University of Engineering and Technology, SZAB Campus, Pakistan*
[4] *Civil Engineering Department, College of Engineering, University of Bisha, Bisha 67714, Saudi Arabia*
[5] *Civil Engineering Department, College of Engineering, University of Bahri, Khartoum, Sudan*
[6] *Sunway Group Education Malaysia, Malaysia*
[7] *Department for Management of Science and Technology Development, Ton Duc Thang University, Ho Chi Minh City, Vietnam*
[8] *Faculty of Social Sciences and Humanities, Ton Duc Thang University, Ho Chi Minh City, Vietnam*
[9] *Institute of Research and Development, Duy Tan University, Da Nang 550000, Vietnam*

(*Received November 19, 2019, Revised February 18, 2020, Accepted May 18, 2020*)

Abstract. In recent years, there has been an upsurge for the usage of buckling restrained braces (BRB) rather than ordinary braces, as they have evidently performed better. If the overall brace buckling is ignored, BRBs are proven to have higher energy absorption capacity and flexibility. This article aims to deliberate an economically efficient yet adequate type of all-steel BRB, comprised of the main components as in traditional ones, such as : (1) a steel core that holds all axial forces and (2) a steel restrainer tube that hinders buckling to occurr in the core; there is a more practical detailing in the BRB system due to the elimination of a filling mortar. An investigation has been conducted for the proposed rectangular-tube core BRB and it is hysteric behavioral results have been compared to previous researches conducted on a structure containing a similar plate core profile that has the same cross-sectional area in its core. A loss of strength is known to occur in the BRB when the limiting condition of local buckling is not satisfied, thus causing instability. This typically occurs when the thickness of the restrainer tube's wall is smaller than the cross-sectional area of the core plate or its width. In this study, a parametric investigation for BRBs with different formations has been performed to verify the effect of the design parameters such as different core section profiles, restraining member width to thickness ratio and relative cross-sectional area of the core to restrainer, on buckling load evaluation. The proposed BRB investigation results have also been presented and compared to past BRB researches with a plate profile as the core section, and the advantages and disadvantages of this configuration have been discussed, and it is concluded that BRBs with tubular core section exhibit a better seismic performance than the ones with a plate core profile.

Keywords: buckling restrained braces; hysteretic response; tubular profile; seismic performance

1. Introduction

A major asset of Buckling Restrained Braced Frames (BRBFs) is how it is able to yield under compression and tension despite the absence of global buckling, which drives the brace behavior to the asymmetric and balanced hysteretic response. There has been an increase in the usage of BRBs that contain a core encased by a restrainer mechanism. All steel BRBs with the objective to eradicate filling material have been reviewed and conferred in order to produce the most beneficial outcome. Remarkably, the most prevalent configuration used is a mortar filled tube, by which its negative points include heaviness and concrete placing difficulties. BRBs with different types of restrainers and core profiles have been tested and numerically analyzed (Safa *et al*. 2016, Shafaei *et al*. 2017, Shafieifar *et al*. 2017, Sedghi *et al*. 2018, Sajedi and Shariati 2019b). In 2008, some authors proposed a composite restrainer, sandwiching the core by high-strength bolts (Chen *et al*. 2001, Toghroli *et al*. 2020), "By this detailing not only a better opportunity of inspection or replacing the core is provided, but also unbonded material is simply substituted by an air gap. The optimum Pe/Py ratio and the clearance between a rectangular steel tube restrainer and core plate are discussed by Watanabe *et al*. in 1988 (Watanabe *et al*. 1988). Takeuchi *et al*. in 2005 discussed a BRB configuration including a tube core restrained by another outer tube (Takeuchi *et al*. 2010, Zhong and Wille 2016, Zandi *et al*. 2018), The configuration, double-tube members, which is the major of the following article, was introduced in (Kuwahara *et al*. 1993, Yu *et al*. 2015, Toghroli *et al*. 2018c, Wei *et al*. 2018, Yilmaz and Fidan 2018, Zandi *et al*. 2018b, Ziaei-Nia *et al*. 2018, Chen *et al*. 2019, Davoodnabi *et al*. 2019, Katebi *et al*. 2019, Li *et al*. 2019, Luo *et al*. 2019, Mansouri *et al*. 2019, Xie *et al*. 2019). Takeuchi *et al*. (2010) also conducted experiments on the effect of mortar thickness on BRBs behaviour and showed its negligible effect, which can be omitted in numerical, analyses (Takeuchi *et al*. 2005). They hysteric

∗Corresponding author, Ph.D.,
E-mail: kittisak.jermsittiparsert@tdtu.edu.vn

http://www.techno-press.org/?journal=journal=anr&subpage=5
ISSN: 2287-237X (Print), 2287-2388 (Online)

response of BRBs was also investigated the effect of restrainer width to thickness ratio when its core profile is a steel plate (Toghroli *et al*. 2018a, Truong-Thi *et al*. 2018, Vo-Duy *et al*. 2018, Cao *et al*. 2020, Shariati *et al*. 2020a, b, c, d, e, f). The following research examines and compares plate profiles cores by the effects of an inner or outer steel tube profile that constrains a rectangular steel tube core (Khorami *et al*. 2017b, Khorramian *et al*. 2017, Shariati *et al*. 2017, Toghroli *et al*. 2017, Heydari and Shariati 2018, Hosseinpour *et al*. 2018, Ismail *et al*. 2018, Nasrollahi *et al*. 2018, Nosrati *et al*. 2018, Paknahad *et al*. 2018, Sadeghipour Chahnasir *et al*. 2018, Sedghi *et al*. 2018, Shariat *et al*. 2018, Shariati *et al*. 2018, Toghroli *et al*. 2018b). The behavior of local buckling failure in the core tube and the deformation in the restrainer, as an aftereffect was reviewed. Moreover, only models that have numerous restrainer thickness ratuis are subject to cyclic loading (Jalali *et al*. 2012, Shariati *et al*. 2012a, b, c, 2013, 2014a, b, 2015, 2016, Sinaei *et al*. 2012, Mohammadhassani *et al*. 2013a, b, 2014a, b, Toghroli *et al*. 2014, Khorramian *et al*. 2015, Shah *et al*. 2015, 2016a, b, c, Khanouki *et al*. 2016, Shahabi *et al*. 2016a, b, Tahmasbi *et al*. 2016, Khorami *et al*. 2017a). The model performance of those with identical restrainer thickness ratios, but with varying positions of the restrainers are studied. The arrangements of the restrainers towards the inner or outer core tube are compared. Hence, a discussion for the effects of the varying distance between cores and restrainers are made (Arabnejad Khanouki *et al*. 2010, 2011, Daie *et al*. 2011, Shariati *et al*. 2011a, b, c, Sinaei *et al*. 2011, Armaghani *et al*. 2020, Naghipour *et al*. 2020, Razavian *et al*. 2020, Safa *et al*. 2020).

2. Verification

Takeuchi *et al*. (2010) conducted multiple experimental and theoretical analysis on the behaviour of BRBs with multiple restrainer thicknesses to width ratios (Takeuchi *et al*. 2010, Shariati *et al*. 2020e, f). In this article, firstly one of the same specimens is modelled and the results are verified. Subsequently, this experiment consists of varying core profiles and restrainer size and equal core section area as some new specimens.

3. Finite element analysis

The core plates buckling about the stronger axis is verified by Takeuchi *et al*. The effect of mortar thickness between the edge of the core plate and the restrainer wall in a finite element model is negligible. Therefore, the BRB may be modelled as a plate restrained by two other plates from bottom and top without modelling the mortar fill (Fig. 1) (Takeuchi *et al*. 2010). They also showed that to simplify the modelling process it would be acceptable to not simulate the connections and in return, take an additional length of 0.5Lp from each side of core plate with a rigidly fixed boundary condition (Fig. 1) (Sinaei *et al*. 2011, Tahmasbi *et al*. 2016). To verify this method of modelling, the model in Fig. 1 is firstly simulated and the response is compared to that of experimental and numerical analysis done by Takeuchi *et al*. and finally it is checked to verify if eliminating the concrete fill and replacing it with some boundary conditions gives correct answers or not (Suhatril *et al*. 2019, Trung *et al*. 2019a, b, Xie *et al*. 2019, Alabduljabbar *et al*. 2020, Alaskar *et al*. 2020a, b, Zhu *et al*. 2020).

3.1 Properties of specimens and required assumptions

The verification model is constructed by "ABAQUS" software. Taking the planar aspect ratio of 1 into consideration and utilising the shell element "S4R", the core plate and restrainer tube are meshed. It is important to note that the hardening rule is presumed to be fully kinematic. The connection between restrainer walls and the core plate edge must be logged in as the node to the frictionless contact surface. Initially, before conducting the experiment, an out of plane deformation of 0.5S (0.5 mm) is provided to the software as well (Milovancevic *et al*. 2019, Safa *et al*. 2019, Sajedi and Shariati 2019a, Shariati *et al*. 2019a, b, c, d, e, f). Table 1 shows the properties of the selected verification model equal to the boundary conditions and the properties of models mentioned in Takeuchi's article. The properties, dimensions and boundary conditions for this finite element modeling are presented in Fig. 2(a). Fig. 2(b) shows the BRB with a restrainer of a concrete-filled tube which is compared with Fig. 2(a) which is the simplfied model. The loading pattern begins from

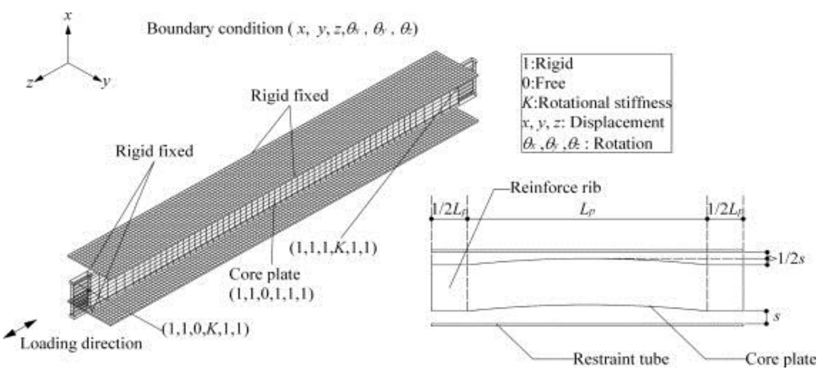
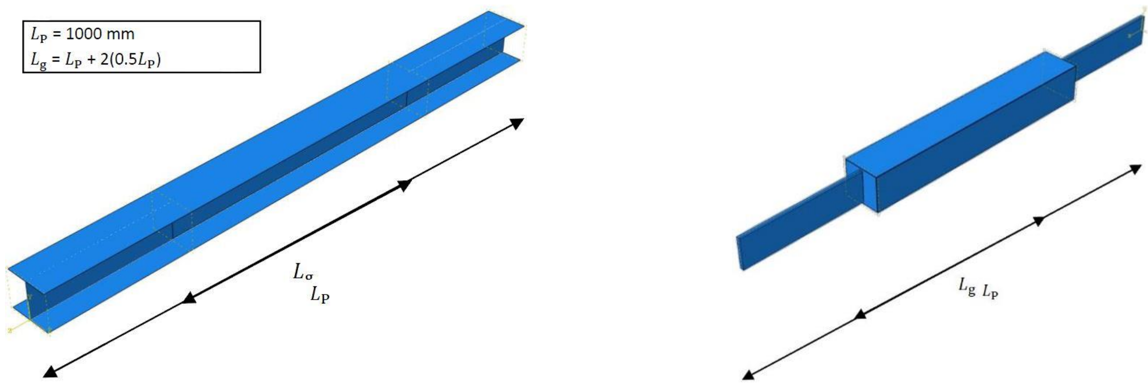


Fig. 1 Simplified modelling of BRB (Takeuchi *et al*. 2010)

Table 1 Verification model properties

Specimen	L_p $[mm]$	B_r $[mm]$	t_r $[mm]$	σ_{ry} $[n/mm^2]$	E_{tr} $[n/mm^2]$	B_c $[mm]$	t_c $[mm]$	σ_{cy} $[n/mm^2]$	E_{tc} $[mm^2]$	S $[mm]$
RY65	1000	150	2.3	351	2.05×10^5	130	16	261	2.05×10^5	1



(a) (b)

Fig. 2 Verification models with general configuration

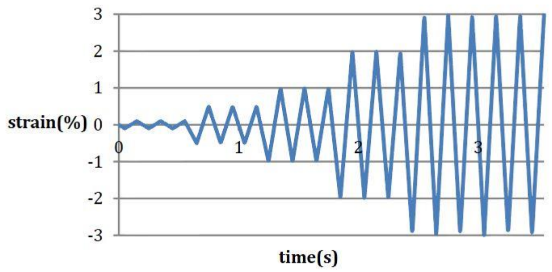


Fig. 3 Applied load pattern

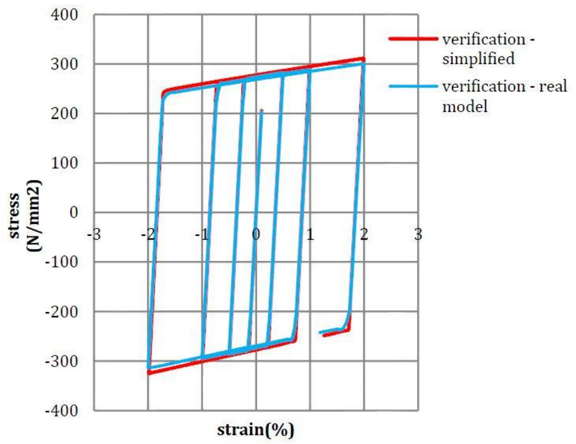


Fig. 4 Hysteretic response comparison core

0.1% strain up to the 2% strain with three trials for every step. The loading resumes until the brace failure at 3% strain. This loading pattern is shown in Fig. 3.

4. Results of analysis

The verification is successful and results are matched with hysteretic results obtained from the mentioned article until 2% strain of the core plate. This verification also indicates that the method of excluding infill concrete can be relied upon. Table 2 shows a contrast amongst the ductility capacities of the models.

To compare the effect of a restrainer tube on limiting the core global buckling, the same core plate is subjected to the introduced load pattern, and the resulted hysteretic loops are illustrated in Fig. 5. The methods verified in this section are used for modelling the computer models in this study.

4.1 Introducing analytical models

Three types of models are designed separately; each considers a certain parameter as varying-parameter so that the effect of each parameter can be studied in BRB's hysteretic behavior.

Table 2 Comparison of cumulative ductility capacity

	RY65	Verification
Loading cycle	Cumulative ductility capacity	Cumulative ductility capacity
0.5% strain	33.94	31.38
1% strain	80.71	77.59
2% strain	170.39	166.43
∑	285.04	275.4

– Geometric characteristics of the models
- Group A Models

Group A consists of the effect of friction between the concrete fill and the core plate. A representation of the cross-section of this group models is shown in Fig. 6. Here in the first series of models, the concrete fill is not yet eliminated. Table 3 shows the detailed cross-section

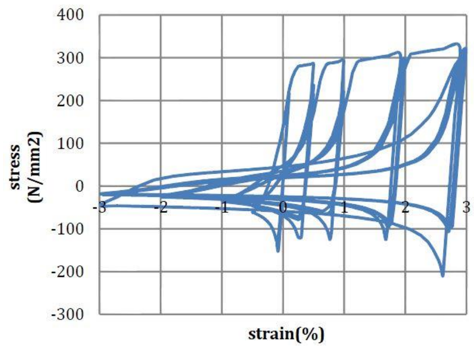


Fig. 5 Hysteretic response of the core

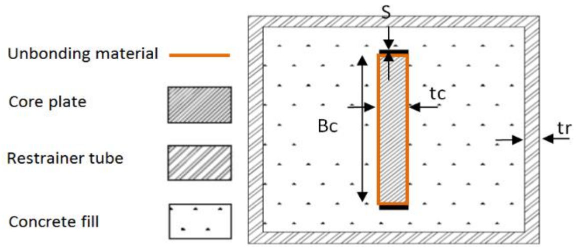


Fig. 6 Group A : Cross section

dimensions of the model illustrated in Fig. 6. all models of this group have the same structure. The friction ratio between the concrete and core plate is the only difference between the models. Therefore, friction ratios of 0, 0.1, 0.2 and 0.3 are assigned to models A1 to A4 respectively. Fig. 7 also shows an overall schematic of how the BRBs of this group are modeled.

- Group B Models

This study aims to show how short the concrete cover may get, in order to prevent the core plate to buckle about its weak axis. Group B is designed to study the behavior of the optimum cover length for BRBs. Meaning that reduction of the concrete cover length is the variable parameter. An important note should be how the core section's properties have not been altered even though the concrete cover length is shortened. Thus, the core plastic length must be considered constant. As presented in Fig. 8, models B1 to B5 indicate models with cover length ratio of 0.5 to 1.0 respectively.

- Group C Models

Group C models concentrate on studying if concrete fills

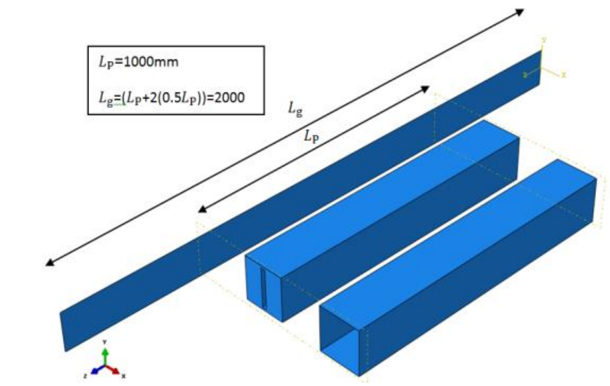


Fig. 7 Overall schematic of group A

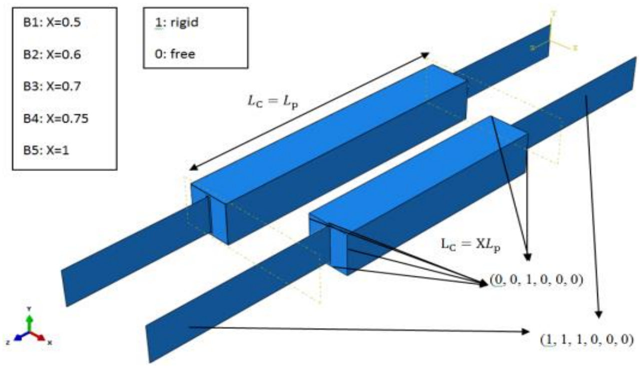


Fig. 8 Overall schematic of group B

Table 3 Details of cross-section dimensions of the model

Model No.	Br [mm]	tr [mm]	Bc [mm]	tc [mm]	S [mm]
A1-A2-A3-A4	152	2.3	130	16	1

can be eliminated by integrating a different core profile. In order to be able to eliminate the concrete fill, the design of the core profile must be altered. Hence, a rectangular profile is designed to be the core profile. This box profile is repressed by the outer or inner restrainer tube. The first two models are designed to be restrained using an outer restrainer tube. The varying factor between the two models are the restrainer's thickness which are shown in model C1 and C2. Fig. 9 shows models including an inner restrainer which are also represented in models C3 to C10. The behaviour of each model is analysed and discussed based on

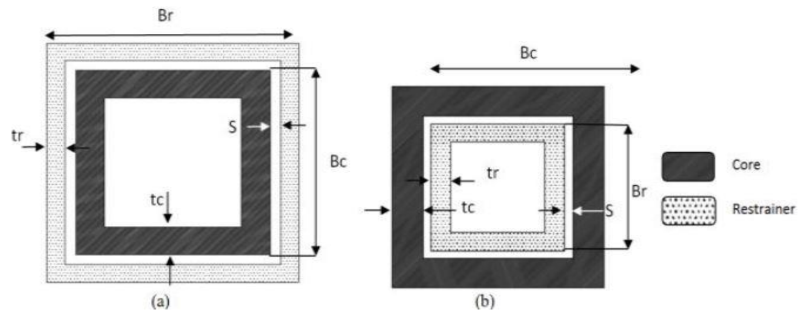


Fig. 9 Group C : Cross section

Table 4 Details of dimensions shown in Fig. 9

Model No	Br [mm]	tr [mm]	Bc [mm]	tc [mm]	S [mm]	$\frac{P_e}{P_y}$
D1	77.6	1.3	73	8	1	1.337
D2	79	2	73	8	1	2.11
D3	55	1.3	73	8	1	0.466
D4	55	2	73	8	1	0.689
D5	55.6	1.3	73	8	0.7	0.481
D6	56	1.3	73	8	0.5	0.492
D7	57	1.3	73	8	0	0.520
D8	56	2.3	73	8	0.7	0.824
D9	55	1.4	73	8	1	0.499
D10	56	1.4	73	8	0.5	0.527

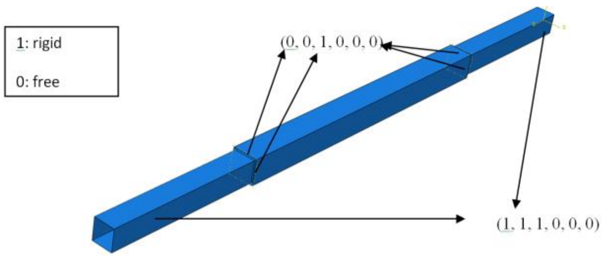


Fig. 10 Group C Models : Overall schematic

Table 5 The steel properties

	Plastic behaviour			Elastic behaviour	
	F_y [Mpa]	F_u [Mpa]	ε_u	E [Gpa]	ν
Core	280	480	10	205	0.3
Restrainer	351	510	15	205	0.3

their restrainer thickness as well as the gap between core and restrainer. Table 4 provides dimensions of the models in Fig. 9. It is noted that the core tube has constant dimensions in all models of the group. Fig. 10 provides the overall structure and boundary conditions of the proposed BRB.

4.2 Material properties

The introduced models are made up of steel (Table 5) for restrainer and core profile, concrete for restrainer infill and the debonding material which is not modelled as an independent material; this is introduced as a contact element which will be described in following section.

4.3 Finite element analysis (Results)

A dynamic explicit method was used and it applied concrete damaged plasticity property for the concrete. Thus, provided a more thorough analysis on Group A and Group B models respectively. The hysteric results of BRB's overall stability of models from Group A are shown in Fig. 11, meaning that overall buckling does not occur when the friction is increased up to 0.3. However, additional strength is evident in the compressive region for models with a higher friction ratio. In order to avoid an asymmetric hysteretiic curve, the AISC has set a limit for additional compressive strength. Equation 4.1 describes the ratio of maximum compressive stength to maximum tensile strength in every individual cycle, the β ratio. This is an upper limit for the increase of compressive strength. The previsions of this ratio are not permitted to exceed 1.3 in any of the cycles (AISC 2005). Table 6 provides β for the BRBs of group A during cyclic loading.

$$\beta = \frac{P_{compression}}{P_{tension}} \tag{1}$$

Table 6 β values

Model	A1	A2	A3	A4
β	1.071	1.107	1.150	1.194

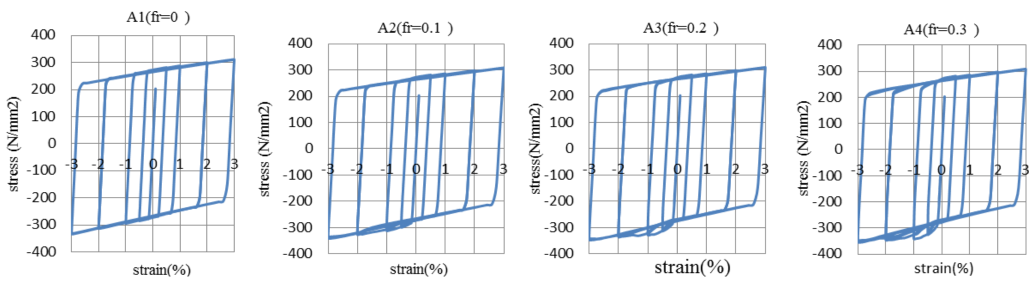


Fig. 11 Group A models : Hysteretic response

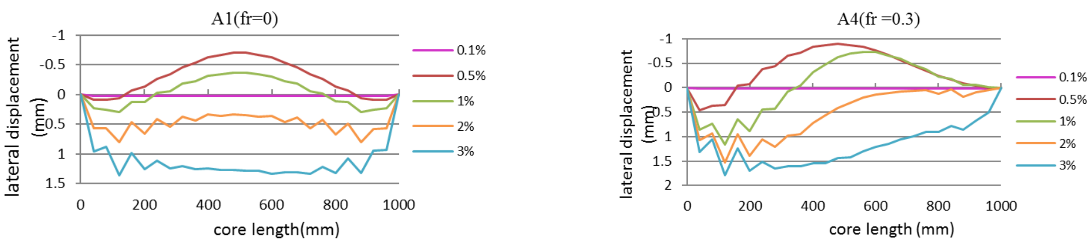


Fig. 12 Lateral displacement of core plate

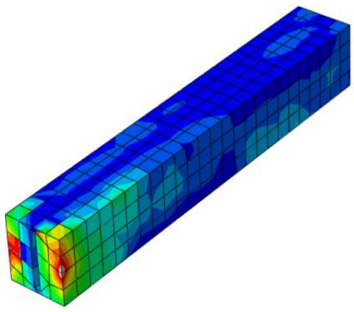


Fig. 13 Excessive pressure in concrete fill

In addition to hysteretic curves, another notable curve about the models of this group is the lateral displacement of the core plate, illustrated in Fig. 12. In model A1 the lateral displacement of core plate has a symmetric shape during the core length while by increasing the friction ratio in models A2 to A4 the curves are pulled to the fixed support side which leads to excessive pressure in concrete fill near the support (Fig. 13), and this is not a desirable matter and should be considered.

The optimum cover length is discussed in Models of Group B. Meanwhile, the hysteretic response of Models of Group B are represented in Fig. 14.

Notably, the depreciation in concrete cover length has no effect on the BRBs hysteretic response down to the cover length of 0.7 times of core length, but in shorter cover lengths in models B1 and B2 buckling about weak axis of core plate happens (Fig. 15) and causes instability in hysteretic response. Fig. 16 provides a comparison between compressive and tensile maximum load in each cycle of these models, which shows a considerable decrease in compressive load of model B1 from 4th cycle, and B2 from 10th cycle.

Models of group C are analysed by a static general method. Firstly, the ultimate strength is determined by a uniform compressive load that has been practiced on all the models. Fig. 17 illustrates the maximum compressive strength in front of the $\frac{P_e}{P_y}$ Ratio. It shows that the maximum tolerable load does not directly depend on the $\frac{P_e}{P_y}$ Ratio. The distance between the core and the restrainer tube is another affecting factor. The hysteretic curve improves when the "S" gap is reduced, within a restrainer that is used as an inner tube.

Models with $\frac{P_e}{P_y}$ ratios of less than 0.52, have experienced overall buckling, in accordance to the results in Fig. 18 for models with an inner restrainer.

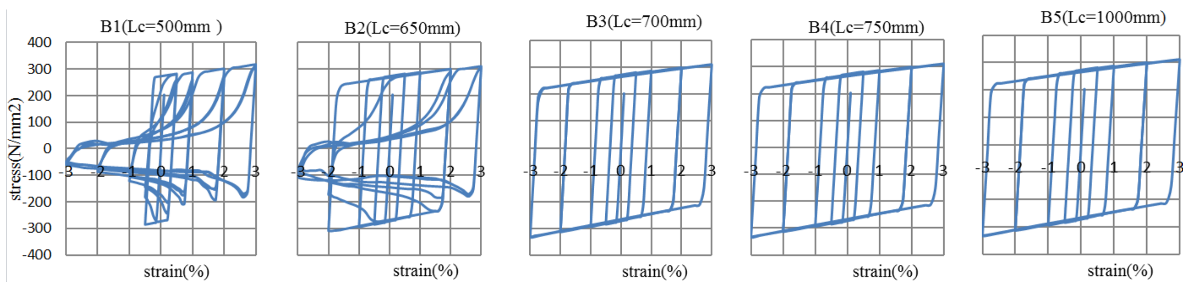


Fig. 14 Group B models : Hysteretic responses

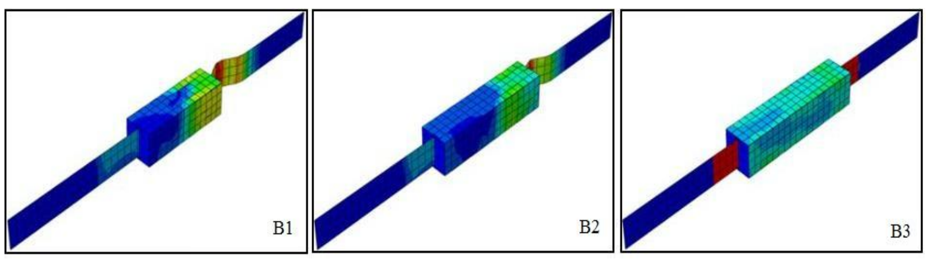


Fig. 15 Core buckling in models of group B

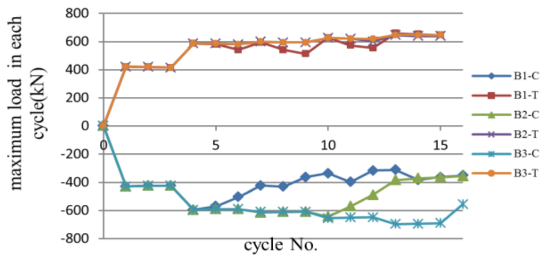


Fig. 16 Maximum load in each cycle

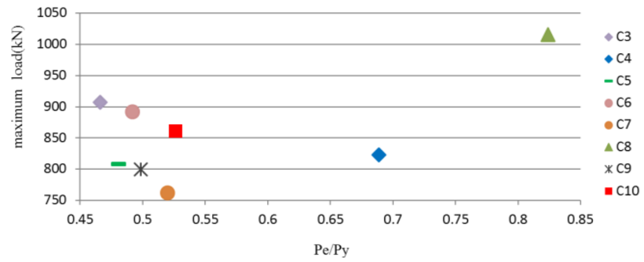


Fig.17 Maximum compressive strength of group C

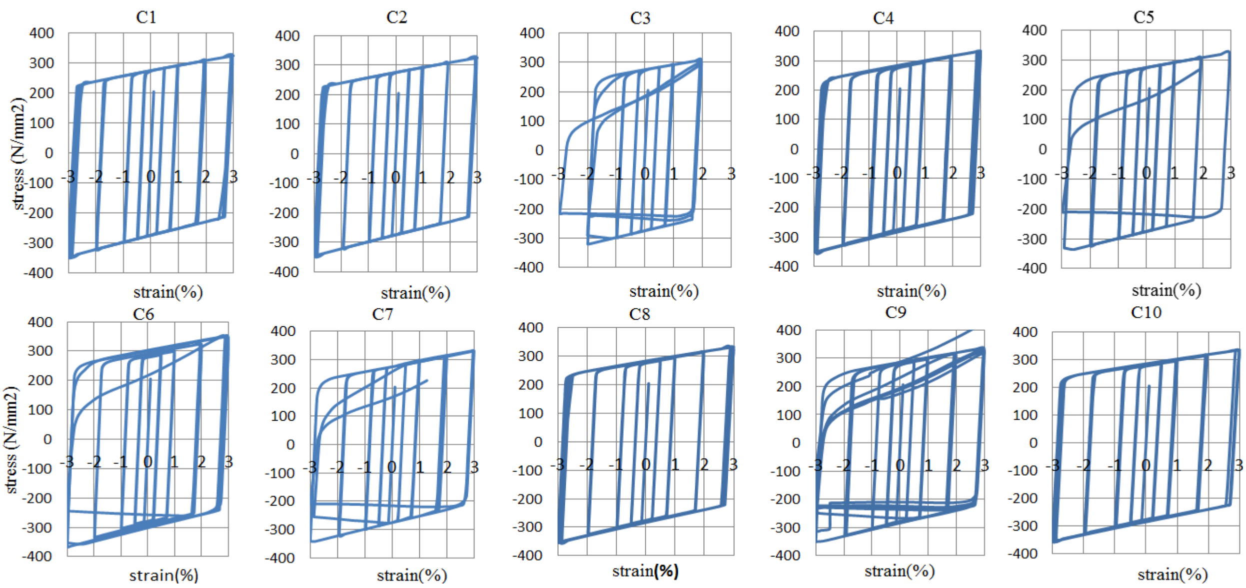


Fig. 18 Models of Group C : Hysteretic responses

5. Conclusions

The obtained results are classified for each group of models as follow:

- Group A

In models of this group, if the friction ratio is increased up to 0.3 it causes the β ratio to grow to 1.2 which is in a permissible range according to AISC provisions. Even the model with highest friction ratio did not experience global buckling but in such cases, the lateral displacement of core plate should be considered because of the overpressure applied to concrete fill due to asymmetric lateral displacement.

- Group B

The restrainer length of a BRB can be shortened without any change in core plastic length. The estimated optimum length in models of this group is 0.7 times as long as core plastic length that means in shorter lengths, the objections in two sides of restrainer will experience global buckling.

- Group C

Applying profiles with the equal moment of inertia in both directions, eliminating the concrete fill will be possible due to eliminating the need for lateral support in one direction. This may transfer the buckling process from elastic to plastic range which means to benefit from the maximum load resisting capacity of core profile.

Using the inner tube as the restrainer results in a stable hysteretic response in $\frac{P_e}{P_y}$ ratios of 0.52 and higher, which is much less, than figure 1.5 specified by AISC provisions. About models with inner restrainer, reducing the gap size down to zero results in better hysteretic responses which are different from what happens about models with outer restrainer. When the restrainer element is the inner tube, core tube can freely expand outside the restrainer, and the need to gap element is eliminated in this group of models.

Acknowledgments

This paper is supported by Shaanxi Innovation Capability Support Plan (Grant: 2018TD-036), Shaanxi Natural Science Basic Research Project (Grant: S2019-JC-YB-2897), and Research Project of Graduate Education and Teaching Reform of Xi'an Technological University in 2017.

References

Alabduljabbar, H., Haido, J.H., Alyousef, R., Yousif, S.T., McConnell, J., Wakil, K. and Jermsittiparsert, K. (2020),

Prediction of the Flexural Behavior of Corroded Concrete Beams using Combined Method, Structures, Elsevier.
Alaskar, A., Alyousef, R., Alabduljabbar, H., Alrshoudi, F., Mohamed, A.M., Jermsittiparsert, K. and Ho, L.S. (2020a), “Elevated temperature resistance of concrete columns with axial loading”, *Adv. Concrete Constr., Int. J.*, **9**(4), 355-365. https://doi.org/10.12989/acc.2020.9.4.355
Alaskar, A., Wakil, K., Alyousef, R., Jermsittiparsert, K., Ho, L. S., Alabduljabbar, H., Alrshoudi, F. and Mohamed, A.M. (2020b), “Computational analysis of three dimensional steel frame structures through different stiffening members”, *Steel Compos. Struct., Int. J.*, **35**(2), 187-197. https://doi.org/10.12989/scs.2020.35.2.187
Arabnejad Khanouki, M., Ramli Sulong, N. and Shariati, M. (2010), “Investigation of seismic behaviour of composite structures with concrete filled square steel tubular (CFSST) column by push-over and time-history analyses”, *Proceedings of the 4th International Conference on Steel & Composite Structures*.
Arabnejad Khanouki, M.M., Ramli Sulong, N.H. and Shariati, M. (2011), “Behavior of through beam connections composed of CFSST columns and steel beams by finite element studying”, *Adv. Mater. Res.*, **168**, 2329-2333. https://doi.org/10.4028/www.scientific.net/AMR.168-170.2329
Armaghani, D.J., Mirzaei, F., Shariati, M., Trung, N.T., Shariati, M. and Trnavac, D. (2020), “Hybrid ANN-based techniques in predicting cohesion of sandy-soil combined with fiber”, *Geomech. Eng., Int. J.*, **20**(3), 191-205. https://doi.org/10.12989/gae.2020.20.3.191
Cao, Y., Wakil, K., Alyousef, R., Jermsittiparsert, K., Ho, L.S., Alabduljabbar, H., Alaskar, A., Alrshoudi, F. and Mohamed, A. M. (2020), *Application of Extreme Learning Machine in Behavior of Beam to Column Connections*, Structures, Elsevier.
Chen, C.-C., Chen, S.-Y. and Liaw, J.-J. (2001), “Application of low yield strength steel on controlled plastification ductile concentrically braced frames”, *Can. J. Civil Eng.*, **28**(5), 823-836. https://doi.org/10.1139/l01-044
Chen, C., Shi, L., Shariati, M., Toghroli, A., Mohamad, E.T., Bui, D.T. and Khorami, M. (2019), “Behavior of steel storage pallet racking connection-A review”, *Steel Compos. Struct., Int. J.*, **30**(5), 457-469. https://doi.org/10.12989/scs.2019.30.5.457
Daie, M., Jalali, A., Suhatril, M., Shariati, M., Khanouki, M.A., Shariati, A. and Kazemi-Arbat, P. (2011), “A new finite element investigation on pre-bent steel strips as damper for vibration control”, *Int. J. Phys. Scie.*, **6**(36), 8044-8050. https://doi.org/10.5897/IJPS11.1585
Davoodnabi, S.M., Mirhosseini, S.M. and Shariati, M. (2019), “Behavior of steel-concrete composite beam using angle shear connectors at fire condition”, *Steel Compos. Struct., Int. J.*, **30**(2), 141-147. http://doi.org/10.12989/scs.2019.30.2.141
Heydari, A. and Shariati, M. (2018), “Buckling analysis of tapered BDFGM nano-beam under variable axial compression resting on elastic medium”, *Struct. Eng. Mech., Int. J.*, **66**(6), 737-748. https://doi.org/10.12989/sem.2018.66.6.737
Hosseinpour, E., Baharom, S., Badaruzzaman, W.H.W., Shariati, M. and Jalali, A. (2018), “Direct shear behavior of concrete filled hollow steel tube shear connector for slim-floor steel beams”, *Steel Compos. Struct., Int. J.*, **26**(4), 485-499. https://doi.org/10.12989/scs.2018.26.4.485
Ismail, M., Shariati, M., Abdul Awal, A.S.M., Chiong, C.E., Sadeghipour Chahnasir, E., Porbar, A., Heydari, A. and Khorami, M. (2018), “Strengthening of bolted shear joints in industrialized ferrocement construction”, *Steel Compos. Struct., Int. J.*, **28**(6), 681-690. https://doi.org/10.12989/scs.2018.28.6.681
Jalali, A., Daie, M., Nazhadan, S.V.M., Kazemi-Arbat, P. and Shariati, M. (2012), “Seismic performance of structures with pre-bent strips as a damper”, *Int. J. Phys. Sci.*, **7**(26), 4061-4072. https://doi.org/10.5897/IJPS11.1324
Katebi, J., Shoaei-parchin, M., Shariati, M., Trung, N.T. and Khorami, M. (2019), “Developed comparative analysis of metaheuristic optimization algorithms for optimal active control of structures”, *Eng. Comput.*, 1-20. https://doi.org/10.1007/s00366-019-00780-7
Khanouki, M.M.A., Ramli Sulong, N.H., Shariati, M. and Tahir, M.M. (2016), “Investigation of through beam connection to concrete filled circular steel tube (CFCST) column”, *J. Constr. Steel Res.*, **121**, 144-162. https://doi.org/10.1016/j.jcsr.2016.01.002
Khorami, M., Alvansazyazdi, M., Shariati, M., Zandi, Y., Jalali, A. and Tahir, M. (2017a), “Seismic performance evaluation of buckling restrained braced frames (BRBF) using incremental nonlinear dynamic analysis method (IDA)”, *Earthq. Struct., Int. J.*, **13**(6), 531-538. https://doi.org/10.12989/eas.2017.13.6.531
Khorami, M., Khorami, M., Motahar, H., Alvansazyazdi, M., Shariati, M., Jalali, A. and Tahir, M. (2017b), “Evaluation of the seismic performance of special moment frames using incremental nonlinear dynamic analysis”, *Struct. Eng. Mech., Int. J.*, **63**(2), 259-268. https://doi.org/10.12989/sem.2017.63.2.259
Khorramian, K., Maleki, S., Shariati, M. and Sulong, N.R. (2015), “Behavior of tilted angle shear connectors”, *PLoS one*, **10**(12), e0144288. https://doi.org/10.1371/journal.pone.0148945
Khorramian, K., Maleki, S., Shariati, M., Jalali, A. and Tahir, M. (2017), “Numerical analysis of tilted angle shear connectors in steel-concrete composite systems”, *Steel Compos. Struct., Int. J.*, **23**(1), 67-85. https://doi.org/10.12989/scs.2017.23.1.067
Kuwahara, S., Tada, M., Yoneyama, T. and Imai, K. (1993), “A study on stiffening capacity of double-tube members”, *J. Struct. Constr. Eng.*, **445**(3), 151-158. https://doi.org/10.3130/aijsx.445.0_151
Li, D., Toghroli, A., Shariati, M., Sajedi, F., Bui, D.T., Kianmehr, P., Mohamad, E.T. and Khorami, M. (2019), “Application of polymer, silica-fume and crushed rubber in the production of Pervious concrete”, *Smart Struct. Syst., Int. J.*, **23**(2), 207-214. https://doi.org/10.12989/sss.2019.23.2.207
Luo, Z., Sinaei, H., Ibrahim, Z., Shariati, M., Jumaat, Z., Wakil, K., Pham, B.T., Mohamad, E.T. and Khorami, M. (2019), “Computational and experimental analysis of beam to column joints reinforced with CFRP plates”, *Steel Compos. Struct., Int. J.*, **30**(3), 271-280. https://doi.org/10.12989/scs.2019.30.3.271
Mansouri, I., Shariati, M., Safa, M., Ibrahim, Z., Tahir, M. and Petković, D. (2019), “Analysis of influential factors for predicting the shear strength of a V-shaped angle shear connector in composite beams using an adaptive neuro-fuzzy technique”, *J. Intel. Manuf.*, **30**(3), 1247-1257. https://doi.org/10.1007/s10845-017-1306-6
Milovancevic, M., Marinović, J.S., Nikolić, J., Kitić, A., Shariati, M., Trung, N.T., Wakil, K. and Khorami, M. (2019), “UML diagrams for dynamical monitoring of rail vehicles”, *Phys. A: Statist. Mech. Applicat.*, 121169. https://doi.org/10.1016/j.physa.2019.121169
Mohammadhassani, M., Nezamabadi-Pour, H., Suhatril, M. and Shariati, M. (2013a), “Identification of a suitable ANN architecture in predicting strain in tie section of concrete deep beams”, *Struct. Eng. Mech., Int. J.*, **46**(6), 853-868. https://doi.org/10.12989/sem.2013.46.6.853
Mohammadhassani, M., Suhatril, M., Shariati, M. and Ghanbari, F. (2013b), “Ductility and strength assessment of HSC beams with varying of tensile reinforcement ratios”, *Struct. Eng. Mech., Int. J.*, **48**(6), 833-848. https://doi.org/10.12989/sem.2013.48.6.833
Mohammadhassani, M., Akib, S., Shariati, M., Suhatril, M. and Arabnejad Khanouki, M.M. (2014a), “An experimental study on the failure modes of high strength concrete beams with particular references to variation of the tensile reinforcement ratio”, *Eng. Fail. Anal.*, **41**, 73-80.

https://doi.org/10.1016/j.engfailanal.2013.08.014

Mohammadhassani, M., Nezamabadi-Pour, H., Suhatril, M. and Shariati, M. (2014b), "An evolutionary fuzzy modelling approach and comparison of different methods for shear strength prediction of high-strength concrete beams without stirrups", *Smart Struct. Syst., Int. J.*, **14**(5), 785-809. https://doi.org/10.12989/sss.2014.14.5.785

Naghipour, M., Yousofizinsaz, G. and Shariati, M. (2020), "Experimental study on axial compressive behavior of welded built-up CFT stub columns made by cold-formed sections with different welding lines", *Steel Compos. Struct., Int. J.*, **34**(3), 347-359. https://doi.org/10.12989/scs.2020.34.3.347

Nasrollahi, S., Maleki, S., Shariati, M., Marto, A. and Khorami, M. (2018), "Investigation of pipe shear connectors using push out test", *Steel Compos. Struct., Int. J.*, **27**(5), 537-543. https://doi.org/10.12989/scs.2018.27.5.537

Nosrati, A., Zandi, Y., Shariati, M., Khademi, K., Aliabad, M.D., Marto, A., Mu'azu, M., Ghanbari, E., Mahdizadeh, M. and Shariati, A. (2018), "Portland cement structure and its major oxides and fineness", *Smart Struct. Syst., Int. J.*, **22**(4), 425-432. https://doi.org/10.12989/sss.2018.22.4.425

Paknahad, M., Shariati, M., Sedghi, Y., Bazzaz, M. and Khorami, M. (2018), "Shear capacity equation for channel shear connectors in steel-concrete composite beams", *Steel Compos. Struct., Int. J.*, **28**(4), 483-494. https://doi.org/10.12989/scs.2018.28.4.483

Razavian, L., Naghipour, M., Shariati, M. and Safa, M. (2020), "Experimental study of the behavior of composite timber columns confined with hollow rectangular steel sections under compression", *Struct. Eng. Mech., Int. J.*, **74**(1), 145-156. https://doi.org/10.12989/sem.2020.74.1.145

Sadeghipour Chahnasir, E., Zandi, Y., Shariati, M., Dehghani, E., Toghroli, A., Mohamad, E.T., Shariati, A., Safa, M., Wakil, K. and Khorami, M. (2018), "Application of support vector machine with firefly algorithm for investigation of the factors affecting the shear strength of angle shear connectors", *Smart Struct. Syst., Int. J.*, **22**(4), 413-424. https://doi.org/10.12989/sss.2018.22.4.413

Safa, M., Shariati, M., Ibrahim, Z., Toghroli, A., Baharom, S.B., Nor, N.M. and Petkovic, D. (2016), "Potential of adaptive neuro fuzzy inference system for evaluating the factors affecting steel-concrete composite beam's shear strength", *Steel Compos. Struct., Int. J.*, **21**(3), 679-688. http://dx.doi.org/10.12989/scs.2016.21.3.679

Safa, M., Maleka, A., Arjomand, M.-A., Khorami, M. and Shariati, M. (2019), "Strain rate effects on soil-geosynthetic interaction in fine-grained soil", *Geomech. Eng., Int. J.*, **19**(6), 533-542. https://doi.org/10.12989/gae.2019.19.6.533

Safa, M., Sari, P.A., Shariati, M., Suhatril, M., Trung, N.T., Wakil, K. and Khorami, M. (2020), "Development of neuro-fuzzy and neuro-bee predictive models for prediction of the safety factor of eco-protection slopes", *Physica A: Statist. Mech. Applicat.*, 124046. https://doi.org/10.1016/j.physa.2019.124046

Sajedi, F. and Shariati, M. (2019a), "Behavior study of NC and HSC RCCs confined by GRP casing and CFRP wrapping", *Steel Compos. Struct., Int. J.*, **30**(5), 417-432. https://doi.org/10.12989/scs.2019.30.5.417

Sajedi, F. and Shariati, M. (2019b), "Behavior study of NC and HSC RCCs confined by GRP casing and CFRP wrapping", *Steel Compos. Struct., Int. J.*, **30**(5), 417-432. https://doi.org/10.12989/scs.2019.30.5.417

Sedghi, Y., Zandi, Y., Shariati, M., Ahmadi, E., Moghimi Azar, V., Toghroli, A., Safa, M., Tonnizam Mohamad, E., Khorami, M. and Wakil, K. (2018), "Application of ANFIS technique on performance of C and L shaped angle shear connectors", *Smart Struct. Syst., Int. J.*, **22**(3), 335-340. http://dx.doi.org/10.12989/sss.2018.22.3.335

Shafaei, S., Farahbod, F. and Ayazi, A. (2017), "Concrete stiffened steel plate shear walls with an unstiffened opening", *Structures*, **12**, 40-53. https://doi.org/10.1016/j.istruc.2017.07.004

Shafieifar, M., Farzad, M. and Azizinamini, A. (2017), "Experimental and numerical study on mechanical properties of Ultra High Performance Concrete (UHPC)", *Constr. Build. Mater.*, **156**, 402-411. https://doi.org/10.1016/j.conbuildmat.2017.08.170

Shah, S., Sulong, N.R., Shariati, M. and Jumaat, M. (2015), "Steel rack connections: identification of most influential factors and a comparison of stiffness design methods", *PloS one*, **10**(10), e0139422. https://doi.org/10.1371/journal.pone.0139422

Shah, S., Sulong, N.R., Jumaat, M. and Shariati, M. (2016a), "State-of-the-art review on the design and performance of steel pallet rack connections", *Eng. Fail. Anal.*, **66**, 240-258. https://doi.org/10.1016/j.engfailanal.2016.04.017

Shah, S., Sulong, N.R., Khan, R., Jumaat, M. and Shariati, M. (2016b), "Behavior of industrial steel rack connections", *Mech. Syst. Signal Process.*, **70**, 725-740. https://doi.org/10.1016/j.ymssp.2015.08.026

Shah, S., Sulong, N.R., Shariati, M., Khan, R. and Jumaat, M. (2016c), "Behavior of steel pallet rack beam-to-column connections at elevated temperatures", *Thin-Wall. Struct.*, **106**, 471-483. https://doi.org/10.1016/j.tws.2016.05.021

Shahabi, S., Sulong, N., Shariati, M., Mohammadhassani, M. and Shah, S. (2016a), "Numerical analysis of channel connectors under fire and a comparison of performance with different types of shear connectors subjected to fire", *Steel Compos. Struct., Int. J.*, **20**(3), 651-669. https://doi.org/10.12989/scs.2016.20.3.651

Shahabi, S., Sulong, N., Shariati, M. and Shah, S. (2016b), "Performance of shear connectors at elevated temperatures-A review", *Steel Compos. Struct., Int. J.*, **20**(1), 185-203. https://doi.org/10.12989/scs.2016.20.1.185

Shariat, M., Shariati, M., Madadi, A. and Wakil, K. (2018), "Computational Lagrangian Multiplier Method by using for optimization and sensitivity analysis of rectangular reinforced concrete beams", *Steel Compos. Struct., Int. J.*, **29**(2), 243-256. https://doi.org/10.12989/scs.2018.29.2.243

Shariati, M., Ramli Sulong, N.H., Arabnejad Khanouki, M.M. and Mahoutian, M. (2011a), "Shear resistance of channel shear connectors in plain, reinforced and lightweight concrete", *Sci. Res. Essays*, **6**(4), 977-983. https://doi.org/10.5897/SRE10.1120

Shariati, M., Ramli Sulong, N.H., Arabnejad Khanouki, M.M., Shafigh, P. and Sinaei, H. (2011b), "Assessing the strength of reinforced concrete structures through Ultrasonic Pulse Velocity and Schmidt Rebound Hammer tests", *Sci. Res. Essays*, **6**(1), 213-220. https://doi.org/10.5897/SRE10.879

Shariati, M., Ramli Sulong, N.H., Sinaei, H., Khanouki, A., Mehdi, M. and Shafigh, P. (2011c), "Behavior of channel shear connectors in normal and light weight aggregate concrete (experimental and analytical study)", *Adv. Mater. Res.*, **168**, 2303-2307. https://doi.org/10.4028/www.scientific.net/AMR.168-170.2303

Shariati, A., Ramli Sulong, N.H., Suhatril, M. and Shariati, M. (2012a), "Investigation of channel shear connectors for composite concrete and steel T-beam", *Int. J. Phys. Sci.*, **7**(11), 1828-1831. https://doi.org/10.5897/IJPS11.1604

Shariati, M., Ramli Sulong, N.H., Sinaei, H., Arabnejad Khanouki, M.M. and Shafigh, P. (2012b), "Behaviour of C-shaped angle shear connectors under monotonic and fully reversed cyclic loading: An experimental study", *Mater. Des.*, **41**, 67-73. https://doi.org/10.1016/j.matdes.2012.04.039

Shariati, M., Sulong, N.R. and Khanouki, M.A. (2012c), "Experimental assessment of channel shear connectors under monotonic and fully reversed cyclic loading in high strength concrete", *Mater. Des.*, **34**, 325-331.

https://doi.org/10.1016/j.matdes.2011.08.008

Shariati, M., Ramli Sulong, N.H., Suhatril, M., Shariati, A., Arabnejad Khanouki, M.M. and Sinaei, H. (2013), "Comparison of behaviour between channel and angle shear connectors under monotonic and fully reversed cyclic loading", *Constr. Build. Mater.*, **38**, 582-593. https://doi.org/10.1016/j.conbuildmat.2012.07.050

Shariati, A., Shariati, M., Sulong, N.R., Suhatril, M., Khanouki, M.A. and Mahoutian, M. (2014a), "Experimental assessment of angle shear connectors under monotonic and fully reversed cyclic loading in high strength concrete", *Constr. Build. Mater.*, **52**, 276-283. https://doi.org/10.1016/j.conbuildmat.2013.11.036

Shariati, M., Shariati, A., Sulong, N.R., Suhatril, M. and Khanouki, M.A. (2014b), "Fatigue energy dissipation and failure analysis of angle shear connectors embedded in high strength concrete", *Eng. Fail. Anal.*, **41**, 124-134. https://doi.org/10.1016/j.engfailanal.2014.02.017

Shariati, M., Ramli Sulong, N.H., Shariati, A. and Khanouki, M.A. (2015), "Behavior of V-shaped angle shear connectors: experimental and parametric study", *Mater. Struct.*, **49**(9), 3909-3926. https://doi.org/10.1617/s11527-015-0762-8

Shariati, M., Ramli Sulong, N.H., Shariati, A. and Kueh, A.B.H. (2016), "Comparative performance of channel and angle shear connectors in high strength concrete composites: An experimental study", *Constr. Build. Mater.*, **120**, 382-392. https://doi.org/10.1016/j.conbuildmat.2016.05.102

Shariati, M., Toghroli, A., Jalali, A. and Ibrahim, Z. (2017), "Assessment of stiffened angle shear connector under monotonic and fully reversed cyclic loading", *Proceedings of the 5th International Conference on Advances in Civil, Structural and Mechanical Engineering - CSM 2017*, Zurich, Switzerland.

Shariati, M., Tahir, M., Wee, T.C., Shah, S., Jalali, A., Abdullahi, M.a.M. and Khorami, M. (2018), "Experimental investigations on monotonic and cyclic behavior of steel pallet rack connections", *Eng. Fail. Anal.*, **85**, 149-166. https://doi.org/10.1016/j.engfailanal.2017.08.014

Shariati, M., Faegh, S.S., Mehrabi, P., Bahavarnia, S., Zandi, Y., Masoom, D.R., Toghroli, A., Trung, N.-T. and Salih, M.N. (2019a), "Numerical study on the structural performance of corrugated low yield point steel plate shear walls with circular openings", *Steel Compos. Struct., Int. J.*, **33**(4), 569-581. https://doi.org/10.12989/scs.2019.33.4.569

Shariati, M., Heyrati, A., Zandi, Y., Laka, H., Toghroli, A., Kianmehr, P., Safa, M., Salih, M.N. and Poi-Ngian, S. (2019b), "Application of waste tire rubber aggregate in porous concrete", *Smart Struct. Syst., Int. J.*, **24**(4), 553-566. https://doi.org/10.12989/sss.2019.24.4.553

Shariati, M., Mafipour, M.S., Mehrabi, P., Zandi, Y., Dehghani, D., bahadori, A., Shariati, A., Trung, N.T., Salih, M.N. and Poi-Ngian, S. (2019c), "Application of Extreme Learning Machine (ELM) and Genetic Programming (GP) to design steel-concrete composite floor systems at elevated temperatures", *Steel Compos. Structu., Int. J.*, **33**(3), 319-332. https://doi.org/10.12989/scs.2019.33.3.319

Shariati, M., Mahmoudi Azar, S., Arjomand, M.-A., Tehrani, H.S., Daei, M. and Safa, M. (2019d), "Comparison of dynamic behavior of shallow foundations based on pile and geosynthetic materials in fine-grained clayey soils", *Geomech. Eng., Int. J.*, **19**(6), 473-484. https://doi.org/10.12989/gae.2020.19.6.473

Shariati, M., Rafiei, S., Zandi, Y., Fooladvand, R., Gharehaghaj, B., Shariat, A., Trung, N.T., Salih, M.N., Mehrabi, P. and Poi-Ngian, S. (2019e), "Experimental investigation on the effect of cementitious materials on fresh and mechanical properties of self-consolidating concrete", *Adv. Concrete Constr., Int. J.*, **8**(3), 225-237. https://doi.org/10.12989/acc.2019.8.3.225

Shariati, M., Trung, N.T., Wakil, K., Mehrabi, P., Safa, M. and Khorami, M. (2019f), "Moment-rotation estimation of steel rack connection using extreme learning machine", *Steel Compos. Struct., Int. J.*, **31**(5), 427-435. https://doi.org/10.12989/scs.2019.31.5.427

Shariati, M., Ghorbani, M., Naghipour, M., Alinejad, N. and Toghroli, A. (2020a), "The effect of RBS connection on energy absorption in tall buildings with braced tube frame system", *Steel Compos. Struct., Int. J.*, **34**(3), 393-407. https://doi.org/10.12989/scs.2020.34.3.393

Shariati, M., Mafipour, M.S., Haido, J.H., Yousif, S.T., Toghroli, A., Trung, N.T. and Shariati, A. (2020b), "Identification of the most influencing parameters on the properties of corroded concrete beams using an Adaptive Neuro-Fuzzy Inference System (ANFIS)", *Steel Compos. Struct., Int. J.*, **34**(1), 155-170. https://doi.org/10.12989/scs.2020.34.1.155

Shariati, M., Mafipour, M.S., Mehrabi, P., Ahmadi, M., Wakil, K., Trung, N.T. and Toghroli, A. (2020c), "Prediction of concrete strength in presence of furnace slag and fly ash using Hybrid ANN-GA (Artificial Neural Network-Genetic Algorithm)", *Smart Struct. Syst., Int. J.*, **25**(2), 183-195. https://doi.org/10.12989/sss.2020.25.2.183

Shariati, M., Mafipour, M.S., Mehrabi, P., Shariati, A., Toghroli, A., Trung, N.T. and Salih, M.N. (2020d), "A novel approach to predict shear strength of tilted angle connectors using artificial intelligence techniques", *Eng. Comput.*, 1-21. https://doi.org/10.1007/s00366-019-00930-x

Shariati, M., Mahmoudi Azar, S., Arjomand, M.-A., Tehrani, H.S., Daei, M. and Safa, M. (2020e), "Evaluating the impacts of using piles and geosynthetics in reducing the settlement of fine-grained soils under static load", *Geomech. Eng., Int. J.*, **20**(2), 87-101. https://doi.org/10.12989/gae.2020.20.2.087

Shariati, M., Naghipour, M., Yousofizinsaz, G., Toghroli, A. and Tabarestani, N.P. (2020f), "Numerical study on the axial compressive behavior of built-up CFT columns considering different welding lines", *Steel Compos. Struct., Int. J.*, **34**(3), 377-391. https://doi.org/10.12989/sem.2019.70.4.499

Sinaei, H., Jumaat, M.Z. and Shariati, M. (2011), "Numerical investigation on exterior reinforced concrete Beam-Column joint strengthened by composite fiber reinforced polymer (CFRP)", *Int. J. Phys. Sci.*, **6**(28), 6572-6579. https://doi.org/10.5897/IJPS11.1225

Sinaei, H., Shariati, M., Abna, A., Aghaei, M. and Shariati, A. (2012), "Evaluation of reinforced concrete beam behaviour using finite element analysis by ABAQUS", *Sci. Res. Essays*, **7**(21), 2002-2009. https://doi.org/10.5897/SRE11.1393

Suhatril, M., Osman, N., Sari, P.A., Shariati, M. and Marto, A. (2019), "Significance of Surface Eco-Protection Techniques for Cohesive Soils Slope in Selangor, Malaysia", *Geotech. Geol. Eng.*, **37**(3), 2007-2014. https://doi.org/10.1007/s10706-018-0740-3

Tahmasbi, F., Maleki, S., Shariati, M., Sulong, N.R. and Tahir, M. (2016), "Shear capacity of C-shaped and L-shaped angle shear connectors", *PloS one*, **11**(8), e0156989. https://doi.org/10.1371/journal.pone.0156989

Takeuchi, T., Suzuki, K., Marukawa, T., Kimura, Y., Ogawa, T., Sugiyama, T. and Kato, S. (2005), "Performance of compressive tube members with buckling restrained composed of mortar in-filled steel tube", *J. Struct. Constr. Eng.*, **590**, 71-78. https://doi.org/10.3130/aijs.70.71_2

Takeuchi, T., Hajjar, J., Matsui, R., Nishimoto, K. and Aiken, I.D. (2010), "Local buckling restraint condition for core plates in buckling restrained braces", *J. Constr. Steel Res.*, **66**(2), 139-149. https://doi.org/10.1016/j.jcsr.2009.09.002

Toghroli, A., Mohammadhassani, M., Suhatril, M., Shariati, M. and Ibrahim, Z. (2014), "Prediction of shear capacity of channel shear connectors using the ANFIS model", *Steel Compos. Struct., Int. J.*, **17**(5), 623-639.

http://dx.doi.org/10.12989/scs.2014.17.5.623

Toghroli, A., Shariati, M., Karim, M.R. and Ibrahim, Z. (2017), "Investigation on composite polymer and silica fume–rubber aggregate pervious concrete", *Proceedings of the 5th International Conference on Advances in Civil, Structural and Mechanical Engineering - CSM 2017*, Zurich, Switzerland.

Toghroli, A., Darvishmoghaddam, E., Zandi, Y., Parvan, M., Safa, M., Abdullahi, M., Heydari, A., Wakil, K., Gebreel, S.A. and Khorami, M. (2018a), "Evaluation of the parameters affecting the Schmidt rebound hammer reading using ANFIS method", *Comput. Concrete, Int. J.*, **21**(5), 525-530. http://dx.doi.org/10.12989/cac.2018.21.5.525

Toghroli, A., Shariati, M., Sajedi, F., Ibrahim, Z., Koting, S., Tonnizam Mohamad, E. and Khorami, M. (2018b), "A review on pavement porous concrete using recycled waste materials", *Smart Struct. Syst., Int. J.*, **22**(4), 433-440. https://doi.org/10.12989/sss.2018.22.4.433

Toghroli, A., Suhatril, M., Ibrahim, Z., Safa, M., Shariati, M. and Shamshirband, S. (2018c), "Potential of soft computing approach for evaluating the factors affecting the capacity of steel–concrete composite beam", *J. Intel. Manuf.*, **29**, 1793-1801. https://doi.org/10.1007/s10845-016-1217-y

Toghroli, A., Mehrabi, P., Shariati, M., Trung, N.T., Jahandari, S. and Rasekh, H. (2020), "Evaluating the use of recycled concrete aggregate and pozzolanic additives in fiber-reinforced pervious concrete with industrial and recycled fibers", *Constr. Build. Mater.*, **252**, 118997. https://doi.org/10.1016/j.conbuildmat.2020.118997

Trung, N.T., Alemi, N., Haido, J.H., Shariati, M., Baradaran, S. and Yousif, S.T. (2019a), "Reduction of cement consumption by producing smart green concretes with natural zeolites", *Smart Struct. Syst., Int. J.*, **24**(3), 415-425. https://doi.org/10.12989/sss.2019.24.3.415

Trung, N.T., Shahgoli, A.F., Zandi, Y., Shariati, M., Wakil, K., Safa, M. and Khorami, M. (2019b), "Moment-rotation prediction of precast beam-to-column connections using extreme learning machine", *Struct. Eng. Mech., Int. J.*, **70**(5), 639-647. https://doi.org/10.12989/sem.2019.70.5.639

Truong-Thi, T., Vo-Duy, T., Ho-Huu, V. and Nguyen-Thoi, T. (2018), "Static and Free Vibration Analyses of Functionally Graded Carbon Nanotube Reinforced Composite Plates using CS-DSG3", *Int. J. Computat. Methods*. https://doi.org/10.1142/s0219876218501335

Vo-Duy, T., Ho-Huu, V. and Nguyen-Thoi, T. (2018), "Free vibration analysis of laminated FG-CNT reinforced composite beams using finite element method", *Frontiers Struct. Civil Eng.*, **13**(2), 324-336. https://doi.org/10.1007/s11709-018-0466-6

Watanabe, A., Hitomi, Y., Saeki, E., Wada, A. and Fujimoto, M. (1988), "Properties of brace encased in buckling-restraining concrete and steel tube", *Proceedings of 9th World Conference on Earthquake Engineering*.

Wei, X., Shariati, M., Zandi, Y., Pei, S., Jin, Z., Gharachurlu, S., Abdullahi, M., Tahir, M. and Khorami, M. (2018), "Distribution of shear force in perforated shear connectors", *Steel Compos. Struct., Int. J.*, **27**(3), 389-399. http://dx.doi.org/10.12989/scs.2018.27.3.389

Xie, Q., Sinaei, H., Shariati, M., Khorami, M., Mohamad, E.T. and Bui, D.T. (2019), "An experimental study on the effect of CFRP on behavior of reinforce concrete beam column connections", *Steel Compos. Struct., Int. J.*, **30**(5), 433-441. http://dx.doi.org/10.12989/scs.2019.30.5.433

Yilmaz, F. and Fidan, D. (2018), "Influence of freeze-thaw on strength of clayey soil stabilized with lime and perlite", *Geomech. Eng., Int. J.*, **14**(3), 301-306. https://doi.org/10.12989/gae.2018.14.3.301

Yu, L., Zhou, S. and Deng, W. (2015), "Properties and pozzolanic reaction degree of tuff in cement-based composite", *Adv. Concrete Constr., Int. J.*, **3**(1), 71-90. http://dx.doi.org/10.12989/acc.2015.3.1.071

Zandi, Y., Shariati, M., Marto, A., Wei, X., Karaca, Z., Dao, D., Toghroli, A., Hashemi, M.H., Sedghi, Y. and Wakil, K. (2018), "Computational investigation of the comparative analysis of cylindrical barns subjected to earthquake", *Steel Compos. Struct., Int. J.*, **28**(4), 439-447. http://dx.doi.org/10.12989/scs.2018.28.4.439

Zhong, R. and Wille, K. (2016), "Linking pore system characteristics to the compressive behavior of pervious concrete", *Cement Concrete Compos.*, **70**, 130-138. https://doi.org/10.1016/j.cemconcomp.2016.03.016

Zhu, E., Najem, R. M., Dinh-Cong, D., Shao, Z., Wakil, K., Ho, L. S., Alyousef, R., Alabduljabbar, H., Alaskar, A. and Alrshoudi, F. (2020), "Optimizing reinforced concrete beams under different load cases and material mechanical properties using genetic algorithms", *Steel Compos. Struct., Int. J.*, **34**(4), 467-485. https://doi.org/10.12989/scs.2020.34.4.467

Ziaei-Nia, A., Shariati, M. and Salehabadi, E. (2018), "Dynamic mix design optimization of high-performance concrete", *Steel Compos. Struct., Int. J.*, **29**(1), 67-75. https://doi.org/10.12989/scs.2018.29.1.067

CC