Discussion on Influence of High Strength Bolt's Parameters on the Weld Reinforced Combined Connection with Bolts and Welds

Jiansuo Ma,[1] Yuanqing Wang,[2] Mingfeng Li,[1] Runshan Bai[1] and Huiyong Ban[2]

[1]Hebei University of Architecture, Civil engineering college. zhangjiakou, Hebei, China.

[2]Key Laboratory of Civil Engineering Safety and Durability of China Education Ministry, Department of Civil Engineering, Tsinghua University. Beijing, China.

hbjdmjs@126.com

Abstracts: In the process of existing steel structure operation, in order to prevent the bolted joints from being damaged by insufficient carrying capacity, welds can be used for reinforcement. Weld reinforced combined connection with bolts and weld consists with high strength bolts and side fillet weld composition. The parameters and properties of high strength bolts and fillet welds have a direct effect on the connection. Based on the test results,We explore the influence that welding seam reinforcement and the performance of the connection between the number of high strength bolts and specifications changes in this paper. It will provide a theoretical reference for the design of connection nodes of steel structure reinforcement project.

1. Introduction

The construction sequence of weld reinforced combined connection with bolts and welds is welding after bolts connecting. Details as follows: give the high strength bolt specimen a load and keep the load unchanged , then put a certain size of side weld reinforcement; after waiting for weld cooling continues, give the connection load continuously until the specimen damaged [1]-[6] .In this paper, the high strength bolt specifications are M20, M22 and M24 respectively. The number of high-strength bolts is 2,4 and 6 respectively. After the test piece of the pure high-strength bolt is subjected to 0.5Ps, the load remains unchanged. The reinforced weld consists with four side fillet weld (hf×lw=6mm*80mm).Through the tests we explore the impact of the number of high-strength bolts and specifications on the performance of the connection.

2. Experiment overview

2.1. Specimen design

For this trial, we used nine sets of connections. The splicing form is a double - cover plate. The steel is Q345B, the thickness of the core plate is 18mm and the thickness of the cover plate is 14mm.Bolts are M20 (8.8), M22 (8.8) and M24 (8.8) high strength hexagonal head bolts. The screw hole diameter is 22mm, 24mm and 26mm respectively. Connection board grit blasting, the friction coefficient is 0.45. Use E43-type welding rod. In order to ensure non-destructive destruction of non-end damage, the test

will be carried out in the end of the three sides welding fillet weld connection, welding foot size of 10mm. See figure1, 2, 3 for the specimen form and size.

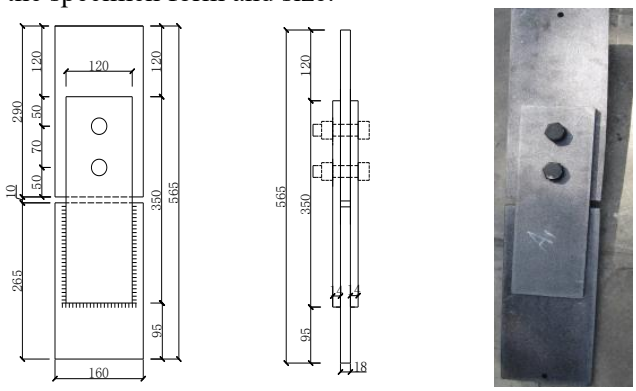


Figure1.Two bolts specimen design and physical drawings

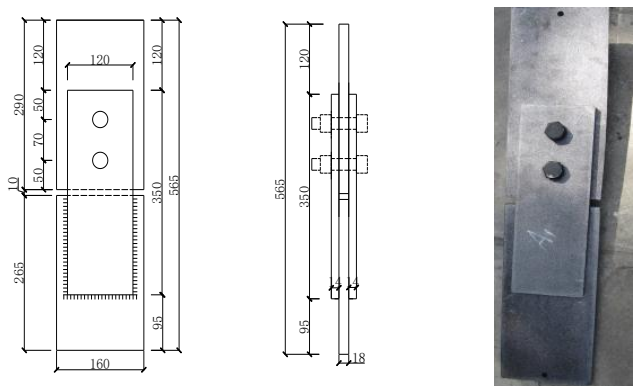


Figure 2. Four bolts specimen design and physical drawings

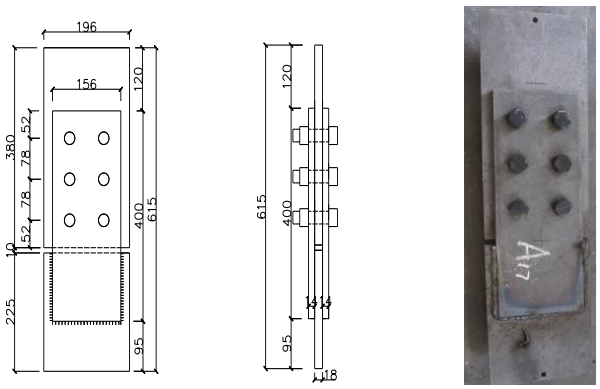


Figure 3. Six bolts specimen design and physical drawings

The strength of the test pieces and the size and form of the weld are different according to the test pieces of each group, as shown in table 1.

Table 1. Specimen reinforcement and number

Test piece number	Bolt specifications	Weld size （mm）	Bolt stress before reinforcing
1#	2M20	CW6×80	0.5Ps
2#	4M20	CW6×80	0.5Ps
3#	6M20	CW6×80	0.5Ps
4#	2M22	CW6×80	0.5Ps
5#	4M22	CW6×80	0.5Ps
6#	6M22	CW6×80	0.5Ps
7#	2M24	CW6×80	0.5Ps
8#	4M24	CW6×80	0.5Ps
9#	6M24	CW6×80	0.5Ps

Note：Ps—The maximum tension of the bolt specimen theory.

2.2. Test equipment

This test uses 500t hydraulic jack, the displacement of the test end is measured by the YHD-20 guide rod extensor. The physical graph is shown in figure 4.

Figure 4. Guide rod extensometer arrangement figure

3. Test results and analysis of results

3.1. Ultimate carrying capacity

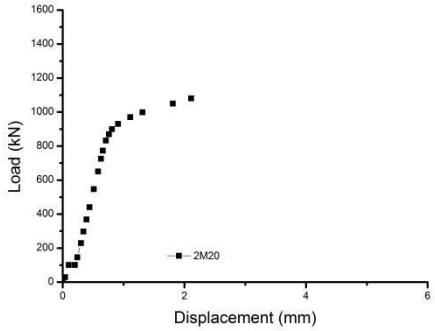
The ultimate carrying capacity of each specimen is shown in table 2.

Table 2. Test piece connection form and carrying capacity

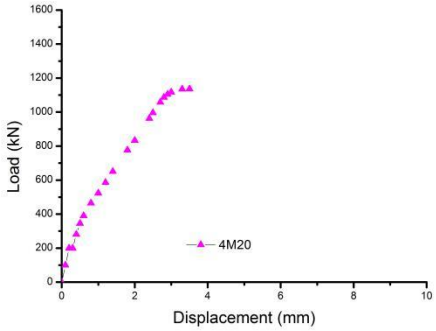
Test piece number	Bolt specification	Weld size （mm）	Bolt stress before reinforcing	Ultimate load capacity / kN
1#	2M20	CW6×80	0.5Ps	1080
2#	4M20	CW6×80	0.5Ps	1179
3#	6M20	CW6×80	0.5Ps	1304
4#	2M22	CW6×80	0.5Ps	1158
5#	4M22	CW6×80	0.5Ps	1245
6#	6M22	CW6×80	0.5Ps	1378
7#	2M24	CW6×80	0.5Ps	1221
8#	4M24	CW6×80	0.5Ps	1310
9#	6M24	CW6×80	0.5Ps	1445

3.2. Test load - displacement curve

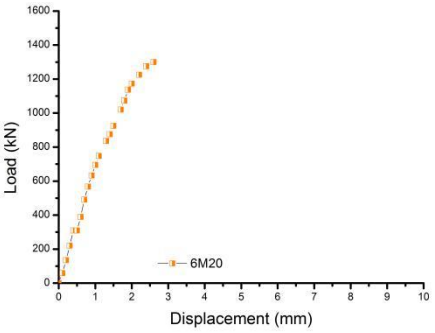
The load-displacement curve of the tests are shown in Figure 5(a)-(i).



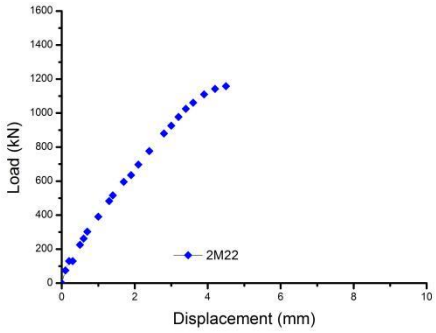
(a) .1#-2M20-CW6-80-0.5Ps Specimen load - displacement curve



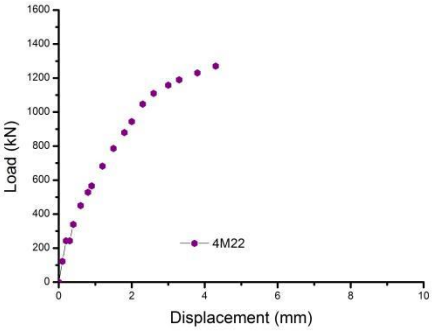
(b).2#-4M20-CW6-80-0.5Ps Specimen load - displacement curve



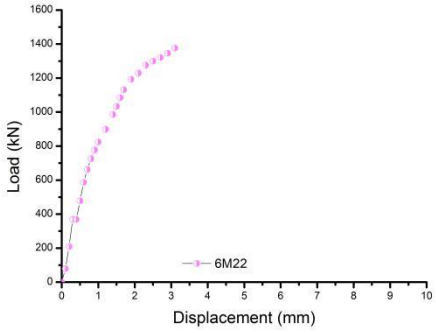
(c).3#-6M20-CW6-80-0.5Ps Specimen load - displacement curve



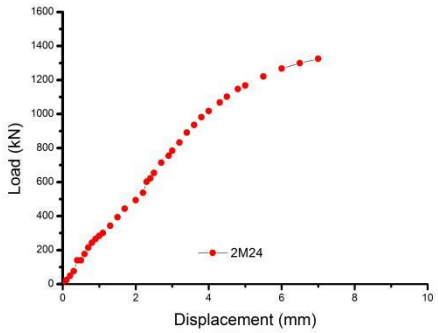
(d).4#-2M22-CW6-80-0.5Ps Specimen load - displacement curve



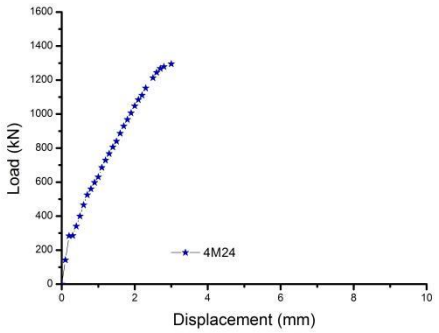
(e).5#-4M22-CW6-80-0.5Ps Specimen load - displacement curve



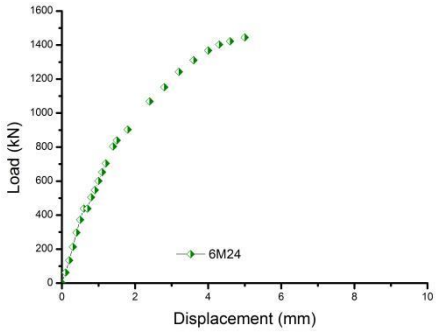
(f).6#-6M22- CW 6-80-0.5Ps Specimen load - displacement curve



(g).7#-2M24-CW6-80-0.5Ps
Specimen load - displacement curve



(h).8#-4M24-CW6-80-0.5Ps
Specimen load - displacement curve



(i).9#-6M24-CW6-80-0.5PsSpecimen load - displacement curve

Figure 5. Specimen load - displacement curve

3.3. The influence of high strength bolt specification on connectins

The tensile load displacement curve is shown in figure6,7 and 8.

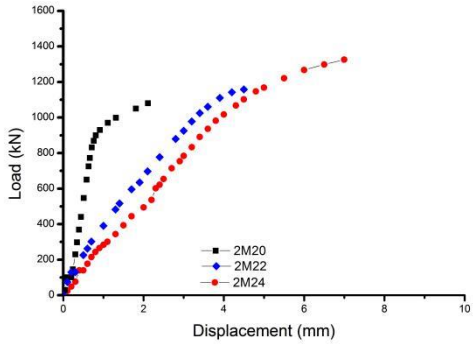


Figure6.The load-displacement curve comparison chart of specimen contains two high-strength bolts

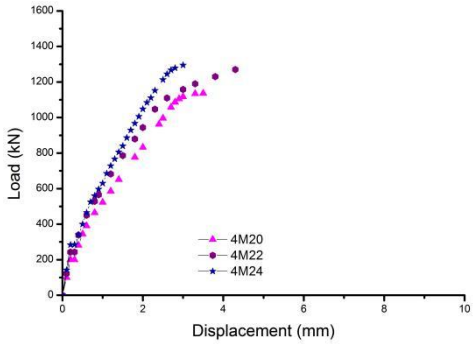


Figure 7. The load - displacement curve comparison chart of specimen contains four high strength bolts

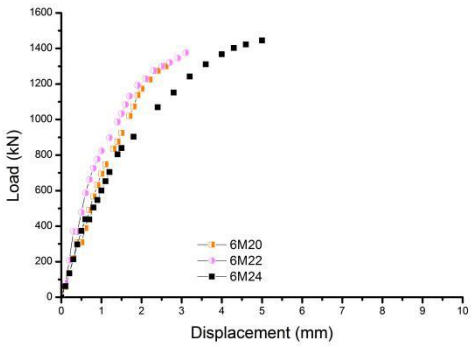
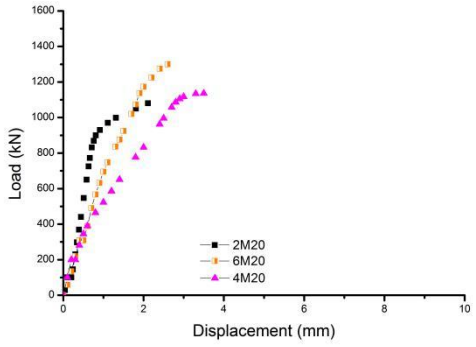


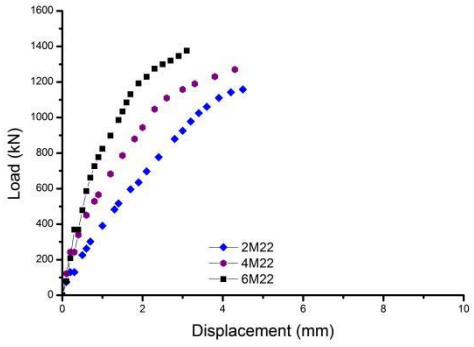
Figure 8. The load-displacement curve
comparison chart of specimen contains six high-strength bolts

From Figure 6, 7 and 8, the general rule is shown as follows: the pure bolt specimen is reinforced with the same weld after undergoing same damage. As the bolt size changes from M20 to M24, the ultimate carrying capacity and deformation compatibility of the specimen improves. For the specimens containing two high strength bolts, the change of bolt specification has obvious effect on the test results. For four and six high strength bolts of the specimen, bolt specification change will affect the result of the test is relatively slow, mainly because of the strength of the weld and two high strength bolt specimens more matches.

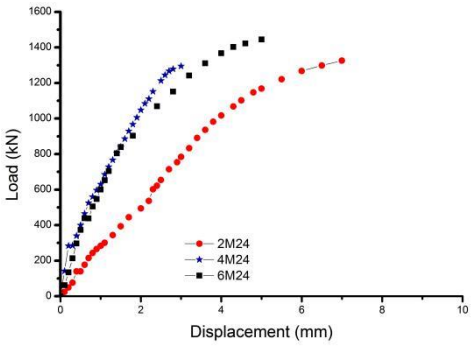
3.4. The influence of the number of high strength bolts on bolting and connecting
The tensile load displacement curve is shown in figure9(a)-(c).



(a). Specimens with different number of M20



(b). Specimens with different number of M22



(c). Specimens with different number of M24

Figure 9. Load - displacement curve comparison chart

It can be seen from figure 9, the change of bolt number has obvious influence on the test results for the different number of high strength bolts. As the number of bolts increases, the ultimate carrying capacity of the specimen is improved.

4. Conclusion

(1) In this paper, through the tests of the combined connections with bolts and welds, the load-displacement curves are obtained .

(2) By comparing the sample load-displacement curves of different bolt specifications, the following results are obtained: the change of bolt specification has obvious effect on test results with two high strength bolts. For specimens with four and six high-strength bolts, changes in bolt specifications have a more modest effect on the test results, primarily because the strength of the reinforcement weld is more compatible with the two high-strength bolts.

(3) By comparing the sample load-displacement curves of different bolt number, the results show that the change of bolt number has obvious influence on the test results for different high strength bolts. As the number of bolts increases, the ultimate carrying capacity of the specimen is improved.

Acknowledgement

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