Experimental study on tensile properties of steel casing welding

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Abstract: In order to study the tensile properties of steel casing welding, static tensile tests were carried out on 12 welded specimens. The load-displacement curve was obtained, and its bearing capacity, yield strength and tensile strength were studied. The test results show that this method is a feasible welding method. The tensile properties of the test piece are similar to those of the base metal, and the fracture is ductile fracture.

1. Introduction
Prefabricated structure has the characteristics of high efficiency, saving resources, green and environmental protection, and meets the development needs of "Green China". Prefabricated structure is of great significance to the modernization of construction industry in China. The joint connection of prefabricated structures is an important topic for scholars at home and abroad. At present, prefabricated structural joint connections are divided into two types: wet connection and dry connection.

As a kind of dry connection, welding connection has the advantages of low loss, fast operation and short time. Khaled A. Soudki et al. [1, 2] tested prefabricated concrete walls connected in five different ways including angle steel welded connections. Moustafa et al. [3] optimized reinforcement welding process by studying the influence of metallurgical factors on reinforcement. Rodrigues et al. [4] studied the influence of welding repair and transformation on the performance of reinforced concrete columns. At present, there are few researches on fabricated welded joints. Our research group proposes a new type of welded joint specimen. In this paper, the static tensile test of 12 welded joints was completed, and the bearing capacity and failure mode of the specimens were obtained.

2. Experimental research and analysis
2.1 Specimen design
The specimen consists of steel pipe, reinforcement and deposited metal after melting. Steel pipe selected 45 steel, and the length is 10 times of the diameter of the reinforcement. The steel pipe is divided into single-seam steel pipe and double-seam steel pipe, with the seam width of 8mm. As shown in picture 1. The diameter of reinforcement is 12mm and 16mm. Welding rod selection CHE857CrNi. The specimen was numbered in the form of d+A+B. d is the diameter of reinforcement; A is the form of open seam, including 1 (single seam) and 2 (double seam); B is the test specimen.
example, 12-1-1 represents the specimen with reinforcement of 12, single seam welding, and the number is 1. The processed test piece is shown in Figure 2.

![Steel pipe](image1.jpg)  ![Processed specimen](image2.jpg)

**Figure 1.** Steel pipe  
**Figure 2.** Processed specimen

### 2.2 Tensile test method

Unidirectional loading with universal testing machine, as shown in picture 3. The loading rate is 10mm/min, and the specific test loading is shown in Figure 4.

![Universal testing machine](image3.jpg)  ![Tensile strength loading test](image4.jpg)

**Figure 3.** Universal testing machine  
**Figure 4.** Tensile strength loading test

### 2.3 Tensile failure

The damage phenomenon is similar to that of steel reinforcement. It starts from the elastic stage; as the load increases, it enters the yield stage; then it enters the strengthening stage quickly; finally enters the necking stage and stops with the reinforcement fracture test. Figure 5 shows the specific failure mode.
3. The test results

The loads at the tensile limit of 12-1-1, 12-1-2, and 12-1-3 are 71.77kN, 73.18kN, and 72.66kN, respectively; The loads at the tensile limit of 12-2-1, 12-2-2, and 12-2-3 were 71.33kN, 66.07kN, 66.33kN, respectively; the load at the tensile limit of 16-1-1, 16-1-2, and 16-1-3 is 122.19kN, 128.14kN, and 115.16kN, respectively; The loads at the tensile limit of 16-2-1, 16-2-2, 16-2-3 were 132.05kN, 127.37kN, and 130.21kN, respectively. The average load of the C12 steel base material at the tensile limit is 68.78kN, and the average load of the C16 steel base material at the tensile limit is 127.7kN.

The load-displacement curves of the C12 and C16 specimens are shown in Figure 6 and Figure 7.
According to the test standard, the calculation formula of tensile strength of the specimen is as follows:

\[ R_m = \frac{F_m}{S_0} \]  

(1)

Where, \( R_m \) is tensile strength (Mpa); \( F_m \) is the maximum load (N); \( S_0 \) is the nominal area of reinforcement of the original sample (mm²).

By using the analysis to reduce the error, the average value of the calculated value was taken as the yield strength, tensile strength and fracture distance of the specimen (that is, the distance from the steel bar break to the weld). The performance data is shown in table 1.

**Table 1.** Tensile property of specimen

| Specimen | Base metal | C12 single seam | C12 double seam | C16 single metal | C16 double seam |
|----------|------------|-----------------|-----------------|-----------------|-----------------|
| yield strength/Mpa | 440.77 | 473.19 | 428.84 | 443.23 | 407.97 | 448.10 |
| tensile strength/Mpa | 608.14 | 641.37 | 600.46 | 635.13 | 605.94 | 645.95 |
| fracture distance of the specimen/cm | / | 5.43 | 4.93 | / | 5.33 | 5.00 |

It can be concluded from Table 1 that the yield strength error of the welded specimen is less than 8%, the tensile strength is within 5%, and the yield strength error is slightly larger because the performance of the base material is slightly different. The fracture of the specimen is at the reinforcement and away from the weld and the heat-affected zone. The fracture is a plastic deformation fracture, which can be considered as ductile failure.
4. Conclusion

1. Test yield strength and tensile strength of C12 and C16 welded specimens, the values are close to the base metal.
2. The load-displacement curve of the specimen tensile is similar to the load-displacement curve of the metal, and the fracture is ductile fracture.
3. Under the same test conditions, double seam welding is preferred to reduce the average weld shear strength.

References

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