Experimental Study of Joint Tool Variations in Cold Rolled Steel Structure Connection Systems C75 – 0,65 mm

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ABSTRACT

C75 cold rolled steel is a material used in building construction with a lighter weight compared to conventional steel. One important aspect in the design of C75 light steel is the connection, where the connection must be designed safely so it is very important to maintain the structural integrity of the building and ensure the safety of building users. The aim of the research is to obtain the correct formulation for the C75 mild steel connection type in relation to the thickness of the C75 cold rolled steel. The method used is to create a connection system in the form of a variety of connections consisting of connections using screws only, combined screws and bolts, and connections using rivet nails. Overall, from the test results, it was found that the use of mild steel connections with a modified model between screws and bolts produced a greater value compared to using rivet connection tools alone or screws alone, this happened the same for every thickness of mild steel tested, both thickness 0, 65 mm, 0.75 mm or 1.00 mm. The greatest results were found in the connection of 4 screws and 1 bolt at a mild steel thickness of 1.00 to 100.00 N with a deflection of 2.58 mm. When compared with rivets, the increase reached 42.50%, while compared with screws, there was an increase of 20.00%. So rivet connections are brittle compared to screws and screw and bolt connections are a more ductile connection, so they can be recommended as connections in light steel. It's just that mild steel which has a greater thickness tends not to cause buckling compared to mild steel which is much thinner, where buckling is likely to occur in the mild steel material.

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1. INTRODUCTION

Current construction developments have had many impacts on construction industry technology, one of which is the existence of new materials used in construction. One of the materials currently widely used in construction is cold-rolled steel C75, which is called mild steel on the market. C75 cold rolled steel has advantages in terms of strength, corrosion resistance, efficiency in using materials, is relatively easy to work with, namely just using cutting gutters and a drilling machine, and has a more economical price. Therefore, C75 cold rolled steel is increasingly popular for use in building construction, both for commercial, industrial and residential buildings.

One of the important aspects in the design and construction of C75 cold rolled steel buildings is the joints, where the joints must be designed safely so it is very important to maintain the structural integrity of the building and ensure the safety of occupants and building users. Connections in C75 cold rolled steel construction use screws. Until now, the use of C75 cold-rolled steel connecting tools does not have a standard standard, where the connecting tools used to date only rely on three screws for each connection without considering the thickness of the C75 cold-rolled steel being connected and the diameter of the screws used.

On the other hand, theoretically the number of connecting devices is determined by the magnitude of the force acting on the elements being connected, and the magnitude of the force on the element determines the thickness or dimensions of the element. So the problem arises, is it appropriate for every C75 cold rolled steel connection to always use three screws and what is the effect if the screw connection is combined with bolts and whether the use of rivets in the connection tool will produce a stronger connection. So the researcher feels it is necessary to make research that can be used as a reference for a connection in C75 cold rolled steel construction, this is the novelty of this research.

2. METHODS

In each research there are several stages which are made in diagram form, with the aim that the research can be carried out systematically.

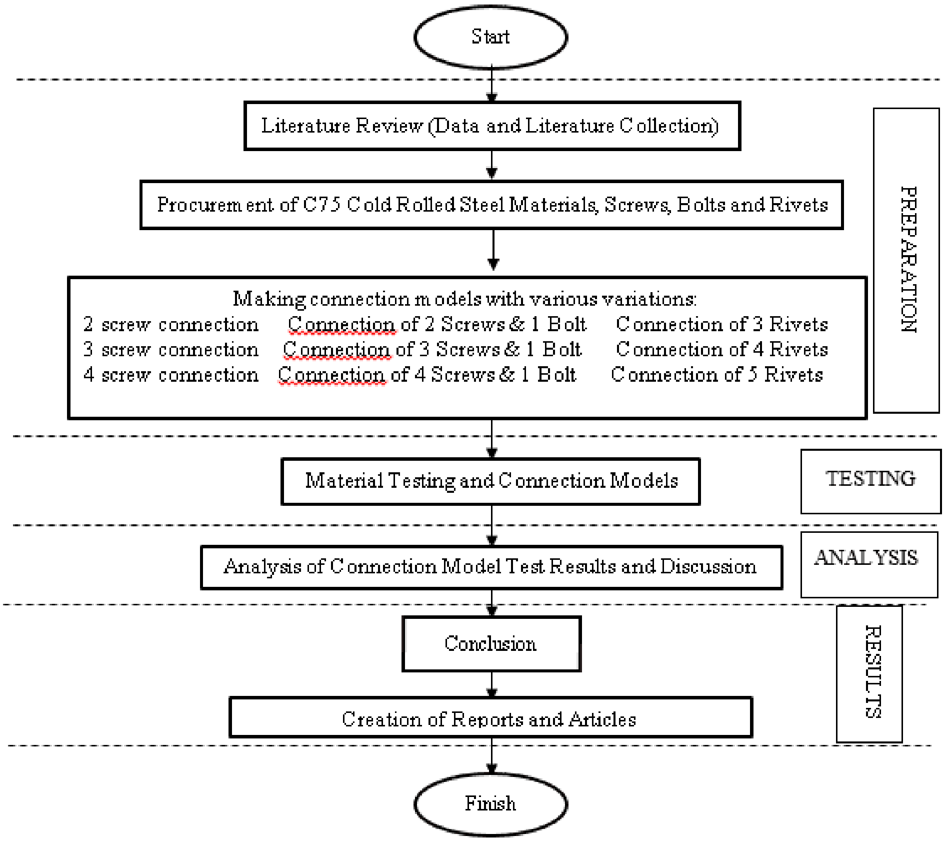

Figure 1. Research Flowchart

2.1 Observed/Measured Variables

The variable observed is the ability of the connection to withstand shear where the force applied is in the form of a tensile or compressive force at each end of the connected element, then the damage that occurs due to the application of this force occurs at the connection or element, from here the service of the connection type can be observed. at each thickness of the C75 cold rolled steel being joined.

2.1.1 Research Design Model Used

The following is a test of C75 cold rolled steel material in research to obtain the tensile strength of light steel profiles for each profile thickness.

Table 1. Material Test Cold rolled steel C75

Test Type	Profile Type	Number of Test objects	Total
Tensile Test of C75 cold rolled steel	C75-0,65	3	9

C75 – 0,65

Figure 2. Material Test Cold rolled steel C75

Meanwhile, the following is a sample connection plan design model in the research to get the right joint configuration for each type of C75 cold rolled steel profile thickness.

Table 2. Joint Model Plan C75 cold rolled steel

Test Type	Profile Type	Connection Configuration	Jumlah
Joint shear test	C 75 - 0,65	2 screw	3
		3 screw	3
		4 screw	3
		2 screw 1 bolt	3
		3 screw 1 bolt	3
		4 screw 1 bolt	3
		3 rivet nails	3
		4 rivet nails	3
		5 rivet nails	3

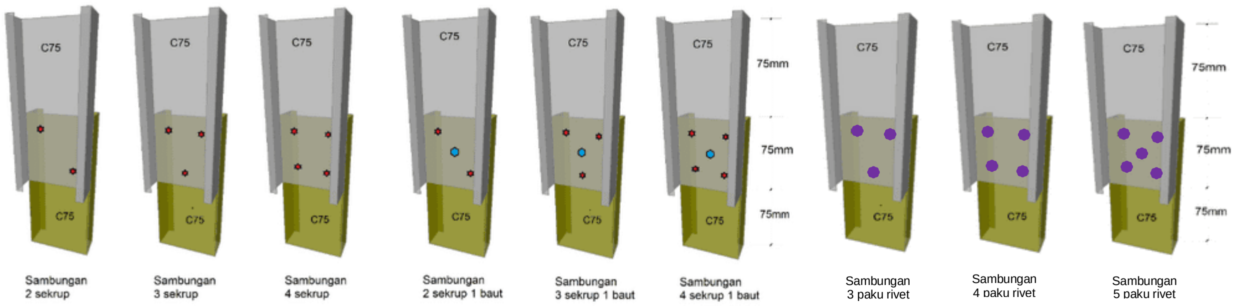

Figure 3. Variations in Connection Models

3. RESULTS AND DISCUSSION

Tensile testing of mild steel involves a series of standard procedures designed to evaluate the mechanical properties and strength of materials to withstand tensile forces. Tensile testing on mild steel materials is carried out using a simple test portal tool where the tensile test object is systemd in such a way as to be able to obtain tensile results on the test object. The following is the tensile testing system carried out in this research.

Figure 4. Tensile Strength Testing Set-Up

From the results of tensile strength tests that have been carried out on tensile test objects, it is obtained.

Table 3. Table of Recapitulation of Tensile Strength Test Results

No	Load (Kg)	Deformation Average (mm)	Stressing (kg/mm^2)	Stressing (MPa)
Mild Steel Thickness 0,65				
1	50	0,685	7,69	76,92
2	100	0,485	15,38	153,85
3	150	0,53	23,08	230,77
4	200	0,715	30,77	307,69
5	250	0,92	38,46	384,62
6	300	1,14	46,15	461,54
7	350	1,43	53,85	538,46
8	400	1,72	61,54	615,38
9	450	2,065	69,23	692,31
10	500	2,805	76,92	769,23
11	536	3,925	82,46	824,62

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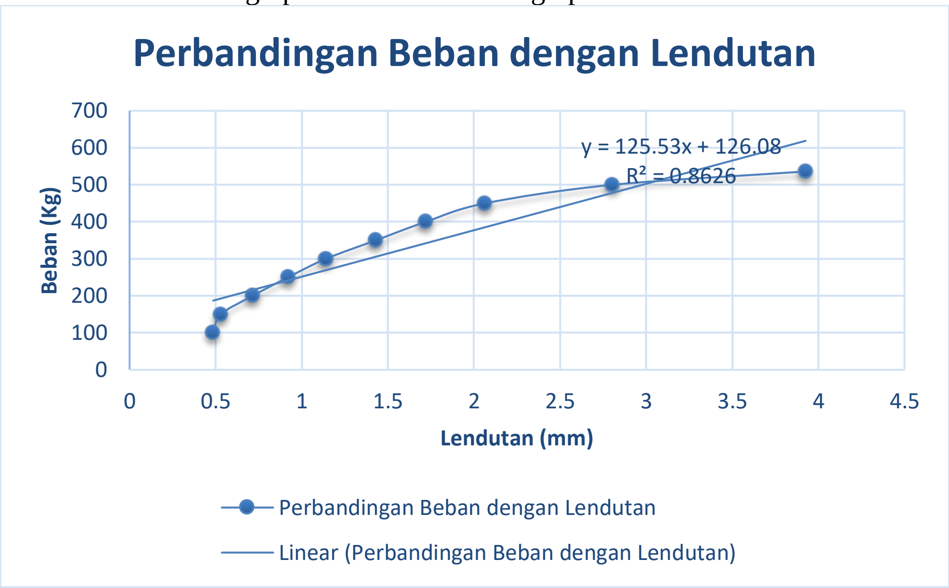

Figure 5. Graph of Recapitulation of Tensile Strength Test Results

From the results of tensile testing of mild steel material, it was found that the maximum tensile resistance possessed by mild steel with a thickness of 0.65 mm, 0.75 mm. And 1.00 mm respectively 824.62 MPa, 933.33 MPa, and 975.00 MPa. It can be concluded that the thicker a mild steel material of the same type will get a higher tensile resistance value where the increase in tensile resistance between thicknesses of 0.65 mm, 0.75 mm and 1.00 mm is around ± 4.27% up to 11.65%. So in other words, what can be recommended for the use of light steel for construction is to compare thicknesses of 0.65 mm, 0.75 mm and 1.00 mm, namely with a thickness of 1.00 mm, because it has a high tensile strength, namely around 975 MPa. Based on research by Duppa, 2018, thin mild steel has a tensile strength of between 500 – 550 MPa, exceeding conventional steel at around 300 MPa. For the roof frame, the light steel quality standard used is G550, meaning it has a tensile strength value of at least 550 MPa. So this is in accordance with the test results in this study.

Testing of shear connections in mild steel is usually carried out using a shear tensile testing method called a "shear test" or "lap shear test." This method makes it possible to measure the strength of shear connections and identify the behavior of the connection when subjected to shear loads. In this research, the method used is a static test using a compression testing portal tool but a shear test system is prioritized. So the results of the compression test have a shear effect or impact on the connection. The following is documentation for setting up the tool for joint shear testing.

Figure 6. Setting-Up Shear Test of Light Steel Joints

The test results show that the method of using the type of connection has a significant influence on the strength and deformation of light steel connections. Light steel connections with various dimensions, namely 0.65 mm, 0.75 mm and 1.00 mm and the use of connecting tools such as screws, combinations of screws with bolts and rivet nails show different maximum strengths. Apart from that, the maximum deformation that occurs also varies between each sample, the following are the results of testing the light steel connection..

Table 4. Table of Recapitulation of Shear Joint Test Results

Profile Type	Connection Configuration	Maximum Load Average (N)	Average Maximum Deformation (mm)
C 75 - 0,65	2 screw	24,17	1,75
	3 screw	47,50	3,35
	4 screw	25,00	2,56
	2 screw 1 bolt	45,00	2,92
	3 screw 1 bolt	25,00	0,55
	4 screw 1 bolt	42,50	2,33
	3 rivet nails	25,00	1,17
	4 rivet nails	35,00	1,53
	5 rivet nails	25,00	0,54

The table above is outlined in graphical form as in the graphic below:

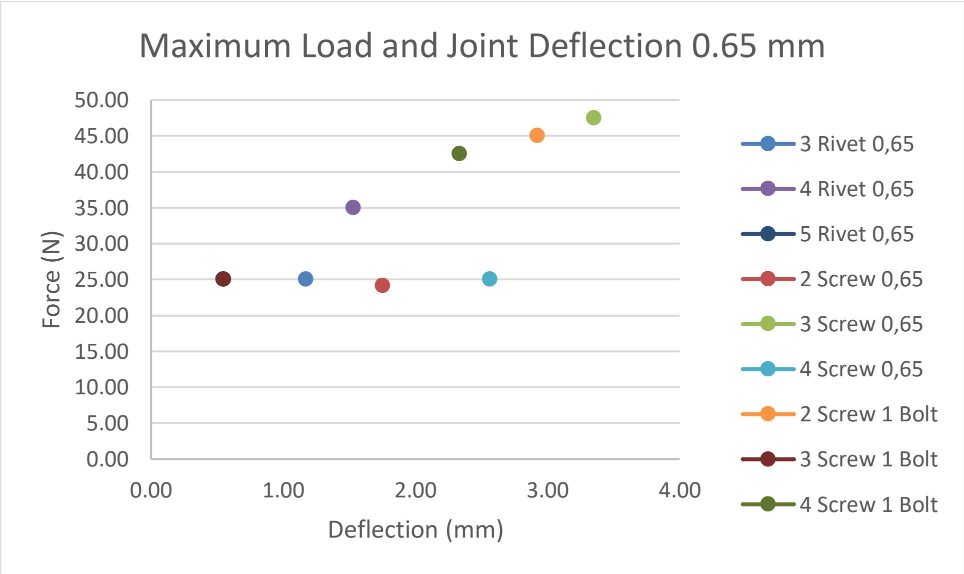

Figure 7. Graph of Recapitulation of Shear Rivet Joint Test Results

From the test results, it was found that the use of light steel connections with a modified model of screws and bolts produced greater values than light steel connections using only rivets or screws alone, this happened the same for every thickness of light steel tested, both 0.65 mm, 0.75 mm or 1.00 mm thick. The greatest results were found in the connection of 4 screws and 1 bolt at a mild steel thickness of 1.00, namely up to 100.00 N with a deflection of 2.58 mm.

4. CONCLUSION

Overall, from the test results it is known that the use of light steel connections with a screw model produces greater values than light steel connections that only use rivets or modified rivet screws with a steel thickness of 0.65 mm. This happens the same for every thickness of mild steel tested at a thickness of 0.65 m. The greatest results were obtained when connecting 3 screws, namely up to 47.5 N with a deflection of 3.35 mm. So it can be concluded that rivet nail connections are brittle compared to screws and screw and bolt connections are more ductile connections.

What makes the difference in durability is only the thickness of the mild steel itself, this will influence the failure that occurs in the mild steel material. Mild steel which has a greater thickness tends not to cause buckling in the mild steel material, in contrast to mild steel which is much thinner, where buckling is more likely to occur in the mild steel material.

This research can be continued by identifying the layout and effective distance between connecting devices.

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