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18 Februari 2021

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Embossment effect analysis on compression of mild steel using finite element methods

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# Embossment effect analysis on compression of mild steel using finite element methods

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**Abstract.** In the world of construction the use of mild steel is increasing due to the relatively light material and has great strength. This makes the producers start to innovate with the addition of reinforcement to get greater strength. Mild steel is formed from the grinding process on steel plate sheets. Because its thin thickness makes mild steel susceptible to buckling. The use of mild steel as a structural component requires great strength with the addition reinforcement. This research will discuss the effect of embossment width and dimensions on the compressive strength values of mild steel by the finite element method. This thesis uses MIDAS FEA finite element method program. The channel profile used is 75 mm x 34 mm x 5 mm x 0,65 mm with length 2000 mm. Model used is with and without stiffener and embossment distance variation from 15 - 150 mm. Boundary condition used hinge-roller, loading use axial load. The results of the analysis found that the greater the embossment distance, the greater the compressive strength produced. failure that occurs in a stiffener model that has embossment is lateral buckling

## 1. Introduction

This study aims to determine the effect of embossment on compressive strength values. In this modern era the use of mild steel in indonesia growing rapidly. The development of the use of mild steel is widely used as a component of the framework of roof structures or building partitions such as walls The use of mild steel also replaces the role of wood that has been difficult to obtain and the price is relatively expensive compared to mild steel. The easy application and able to resist a considerable force that became the selection of mild steel in the construction world. Mild steel is formed through the cold forming process of carbon steel or low alloy material in the form of sheets, and plates with maximum thickness of 25 mm. Mild steel is cold rolled steel that is reprocessed with a pressure on sheet steel plates such as press brake operation and bending brake operation with the desired shape which makes the mild steel more flexible [1]. The use of conventional thin steel sheets has several problems such as increased deflection due to the low strength and stiffness of the steel. With the aim of overcoming it is proposed by strengthening the steel sheet in a simpler way that is inflating or emphasizing mild steel. In this process it will increase the strength and stiffness due to uneven shape of the steel plate which increases the modulus of the part and the effect of hardening applied to the steel sheet [2]. The use of mild steel continues to grow among consumers, making mild steel producers begin to innovate various forms of mild steel or with the addition of stiffeners on the body or wings in order to get effective strength and minimize the bending tendencies of the mild steel. The manufacturers modify mild steel with the addition of embossment which aims to add strength from the mild steel. This development is carried out in order to produce steel products that have greater strength compared to ordinary mild steel. This research was conducted to find out more about the influence of distance embossment on compressive



strength value of mild steel and observed failure on the mild steel. In this study, used finite element method based programs MIDAS FEA, is able to solve structural problems by dividing into smaller elements.

## 2. Method and materials

### 2.1. Modelling with Midas Fea

Mild steel modelling is carried out with a shell element where the forces acting on the surface are stress and strain where the direction of the stress corresponds to the coordinate axis of the object and the relationship between the stress and strain of the material used in the form of elastic modulus [3].

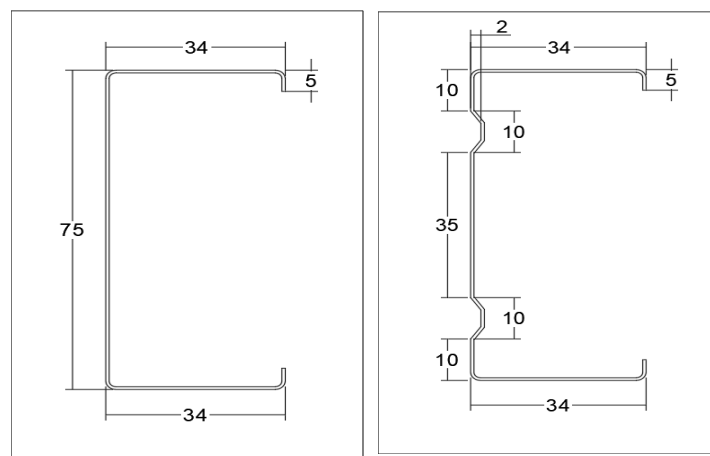
### 2.2. Mild steel model with and without stiffener

The model that used for analysis is profile lip channel with dimensions 75 mm x 34 mm x 5 mm x 0,65 mm. The profile length used is 2000 mm and boundary condition that used hinge-roller at the both ends center of gravity and the working load is axial load. Data material that used for all model is shown in Table 1.

**Table 1.** Data material

Data	Value
Elastic Modulus	200000 Mpa
Poisson's Ratio	0,3
Weight Density	0,000077 N/mm <sup>3</sup>
Model Type	Von Mises
Plastic Strain	0; 0,05
Yield Stress	495 Mpa
Ultimate Stress	550 Mpa

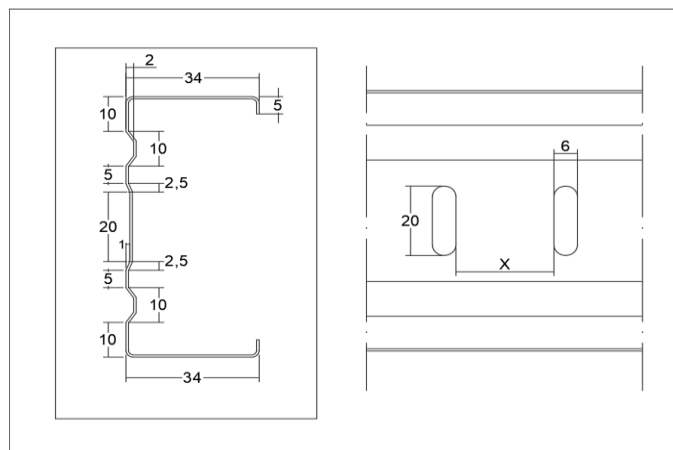
Model with and without stiffener that used shown in Figure 1.



**Figure 1.** Model with and without stiffener

### 2.3. Mild steel model with variation distance embossment

Model with variation distance embossment started in 15 – 150 mm and shown in Figure 2.



**Figure 2.** Model with Variation distance embossment

Embossment dimension width and distance is shown in Table 2.

**Table 2.** Data variation distance embossment

Model	Distance <i>Embossment</i> (mm)	Width <i>Embossment</i> (mm)
Model 4(15)	15	6
Model 4(20)	20	6
Model 4(25)	25	6
Model 4(30)	30	6
Model 4(35)	35	6
Model 4(40)	40	6
Model 4(45)	45	6
Model 4(50)	50	6
Model 4(55)	55	6
Model 4(60)	60	6
Model 4(65)	65	6
Model 4(70)	70	6
Model 4(75)	75	6
Model 4(80)	80	6
Model 4(85)	85	6
Model 4(90)	90	6
Model 4(95)	95	6
Model 4(100)	100	6
Model 4(105)	105	6
Model 4(110)	110	6
Model 4(115)	115	6
Model 4(120)	120	6
Model 4(125)	125	6
Model 4(130)	130	6
Model 4(135)	135	6
Model 4(140)	140	6
Model 4(145)	145	6
Model 4(150)	150	6

### 3. Result and discussion

#### 3.1. Result analysis effect of variation distance embossment

Failure in model with variation distance embossment 150 mm has shown in Figure 3.

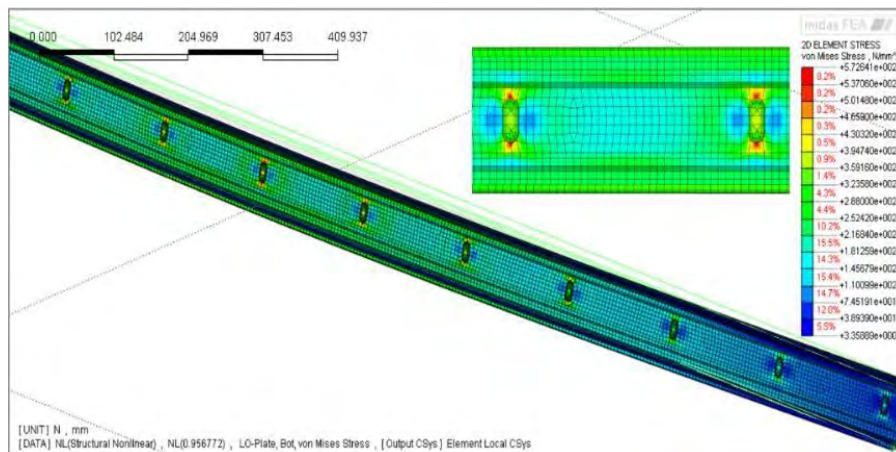


Figure 3. Failure model with embossment distance 150 mm

Embossment variation distance data result is shown in Table 3.

Table 3. Compression strength value with variation distance embossment

Model	Width Emboss (mm)	Distance Emboss (mm)	Compression Strength MIDAS FEA	Increase Percentage (%)
Model 1			6429,9115	1,6277
Model 2			6534,5754	
Model 4(15)	6	15	6291,9032	0,812
Model 4(20)	6	20	6342,9976	0,6985
Model 4(25)	6	25	6387,3085	0,6042
Model 4(30)	6	30	6425,8986	0,4595
Model 4(35)	6	35	6455,4269	0,3267
Model 4(40)	6	40	6476,514	0,2134
Model 4(45)	6	45	6490,3334	0,127
Model 4(50)	6	50	6498,5758	0,0991
Model 4(55)	6	55	6505,0144	0,0588
Model 4(60)	6	60	6508,8368	0,0948
Model 4(65)	6	65	6515,0069	0,0521
Model 4(70)	6	70	6518,3995	0,0541
Model 4(75)	6	75	6521,9288	0,0455
Model 4(80)	6	80	6524,8993	0,0575
Model 4(85)	6	85	6528,6514	0,0512
Model 4(90)	6	90	6531,9928	0,0635
Model 4(95)	6	95	6536,1381	0,0733
Model 4(100)	6	100	6540,9295	0,065
Model 4(105)	6	105	6545,1802	0,0827
Model 4(110)	6	110	6550,5944	0,0693
Model 4(115)	6	115	6555,1348	0,068
Model 4(120)	6	120	6559,5944	0,1654
Model 4(125)	6	125	6570,4432	-0,0207
Model 4(130)	6	130	6569,0808	0,0397
Model 4(135)	6	135	6571,6908	0,034
Model 4(140)	6	140	6573,9284	0,0198
Model 4(145)	6	145	6575,2316	0,0206
Model 4(150)	6	150	6576,5924	

Compression strength graph of mild steel is shown in Figure 4.

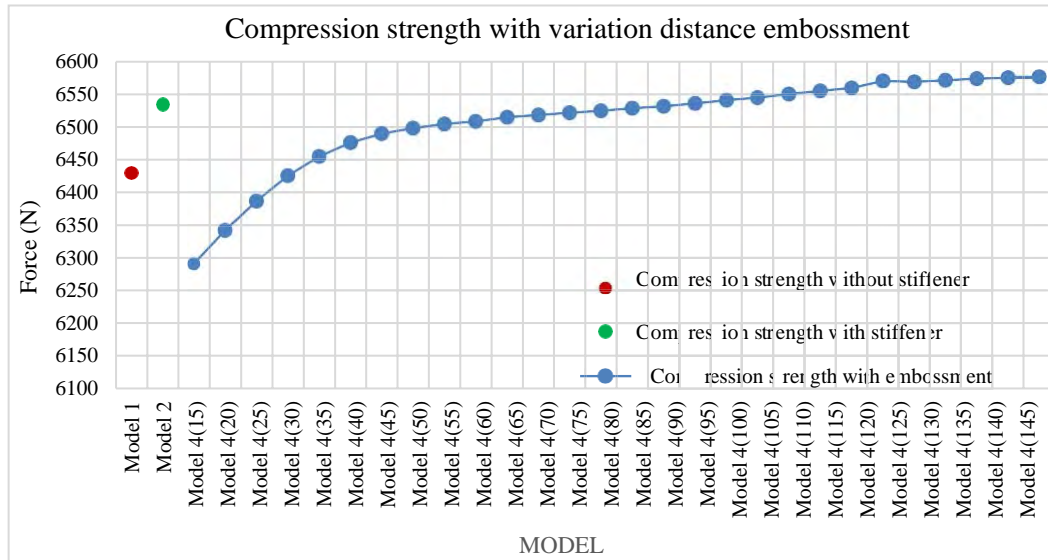


Figure 4. Comparison graph of compressive strength models with variations of embossment

From the result analysis the compression strength in model with distance 15 mm has decreased by 3,8569 % because the distance between embossment too close. At the distance 15 – 45 mm the increase is very steep and starting steady at distance 45 mm. The graph shown model with distance 95 mm has increased 1,5 N compared to the model with stiffener. Failure that occurred in model stiffener with embossment is lateral buckling and the stress concentration occurs at the top and bottom of the embossment.

Following deformation of the weak axis of the model with variations in embossment distance can be seen in Figure 5.

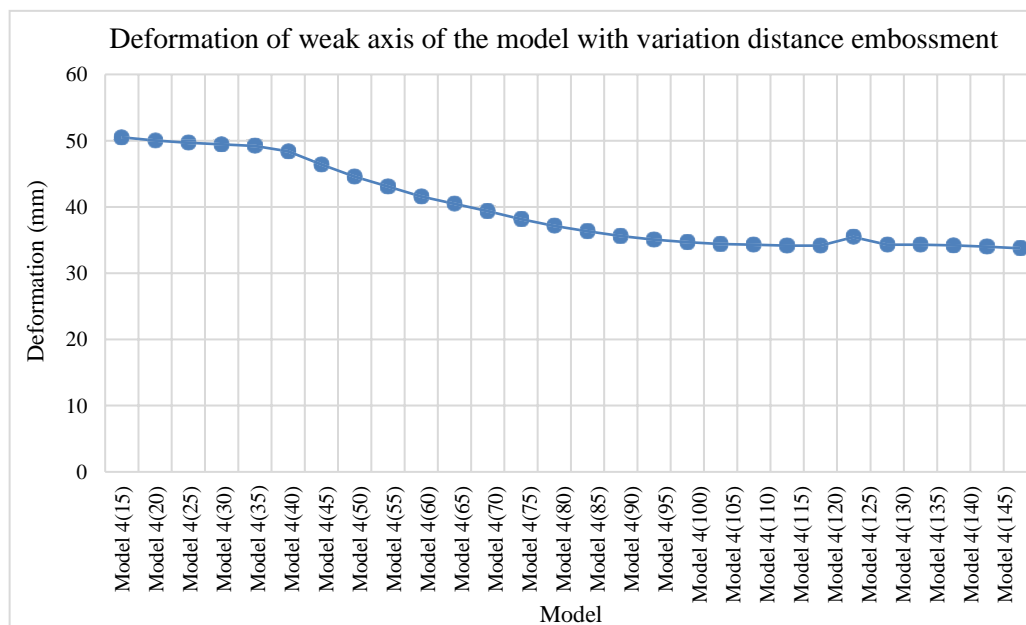


Figure 5. Graph of deformation to the weak axis on variations in embossment distance



Deformation that occurred in models with variations in embossment distance decreased by 49.6593% with a range of deformation between 33.75 - 50.51 mm. In the above graph anomaly occurred in the model with a distance of 125 mm where the deformation that occurred increased by 1.3 mm to the model with a distance of 120 mm. From the graph above it can be seen that the farther the embossment distance, the smaller the deformation produced.

#### 4. Conclusion

From the research results of numerical analysis of the stiffener profile using embossment at an embossment distance of 15 - 85 mm show the results of a compressive strength capacity smaller than the stiffener model only, and begin to increase after a distance of 90 mm to 150 mm. An increase in the compressive strength capacity at an embossment distance of 15 - 45 mm shows a fairly steep result of 3.1243%, while starting from a distance of 50 - 150 mm more ramps by 1.3290%. Beside from the analysis it was found that decreased in deformation that occurred in model with variation distance embossment is 49,66 %. Failure in mild steel with embossment is lateral buckling and there is a large stress concentration around the embossment especially at the top and bottom of the embossment. Because numerical analysis at embossment distance smaller than 90 mm gives a compressive capacity that is smaller than the model with a stiffener without embossment, it is better to have a physical test in the laboratory to get better comparison of validation results.

#### 5. References

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