# Energy Absorption Capability of Steel Type 304 and Type 316

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***Abstract*** **--** This study is focusing on analyzing the specific energy absorption base on stainless steel type 316 with thickness of 3 mm and 6 mm and stainless steel 304 with thickness 3 mm. Tensile tests were conducted by using 100 KN load. Result shows that, thicker specimen is capable of absorbing more specific energy. Stainless steel type 316 is also found to better energy absorber due to its high yield strength.

***Index Terms*** **--** energy absorption, stainless steel, tensile, compression

## I. Introduction

Worldwide, in industry in business and in the home, metals called stainless steels are used daily. Stainless steel is iron-base alloy that contain a minimum of about 12% chromium, the amount needed to prevent the formation of rust in unpolluted atmospheres. Traditionally, stainless steels are classified mainly by their microstructure. The major basic groups of stainless steel are ferritic, martensitic, austenitic and duplex. Stainless steel type 304 and type 316 is in austenitic group. For these two stainless steel, the maximum carbon content are 0.08%.

Stainless steel can replace carbon steel, saving weight without compromising the properties needed to protect occupants in a crash. Stainless steels show very good combinations of strength and ductility which is of special interest in automotive applications [1].

## II. Methodology

Specific energy absorption (SEA) is the ratio between the absorbed energy and the mass of the specimen. The area as a result of crushing the load-displacement curve is given by Eq. (1) [2]:

$$\mathrm{SEA} = \frac{\int F.d}{\mathrm{m}} \quad (1)$$

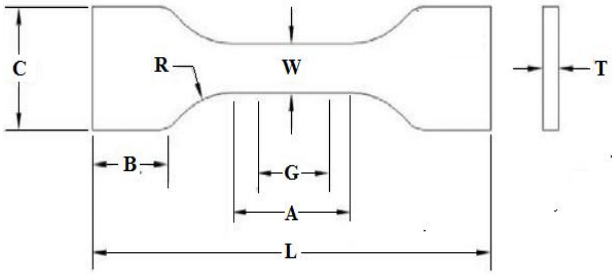
Where, $F$ is the crush load, $d$ is the length of the displacement and $m$ is the mass of the specimen.

Table I shows the mechanical properties for the materials used. Two types of stainless steels are used that is stainless steel type 316 and type 304.

TABLE I
MECHANICAL PROPERTIES OF STAINLESS STEELS [3]

| Material | Yield Strength(MPa) | Ultimate Tensile Strength (MPa) | Fracture Strain |
|---|---|---|---|
| Type 316 | 555 | 725 | 1.73 |
| Type 304 | 325 | 650 | 1.61 |

In order to obtain uniform and accurate results, it is important that all tests have to be conducted under standard conditions. The American Standard for Testing and Materials (ASTM) has set up standards. Standard that is used in this study is ASTM 370 as prescribed in Figure 1




| | Dimension (mm) |
|---|---|
| C - Width of grip section | 20 |
| R - Radius of fillet | 13 |
| W - Width | 12.5 |
| L - Overall length | 200 |
| B - Length of grip section | 50 |
| A - Length of reduced section | 60 |
| G - Gauge length | 50 |

Fig.1. Specimen Dimension According to ASTM 370

Experiments have been conducted by using two types of stainless steel having different thickness. Initial condition of specimens is same. Experiment conduct using tensile test Shimadzu 100 kN.

## III. Result

Fig. 2 and fig. 3 show the force-displacement curves for stainless steel type 316. Each of this figure is having three curves representing three specimen that have been tested for each of the specification.

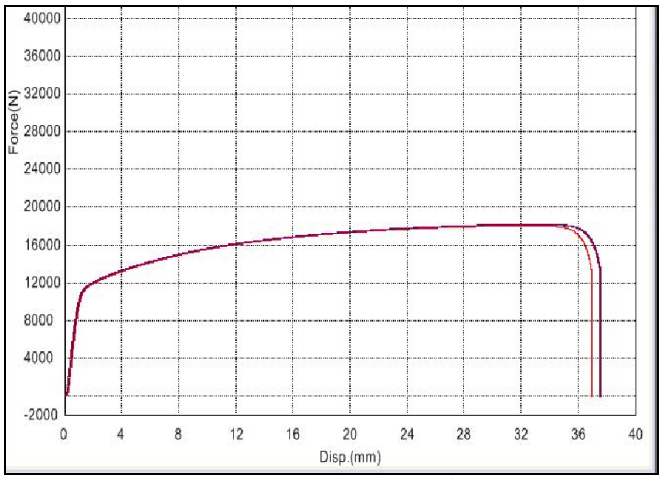



Fig.2. Force over Displacement Graph of Stainless Steel 316 with 3 mm Thickness

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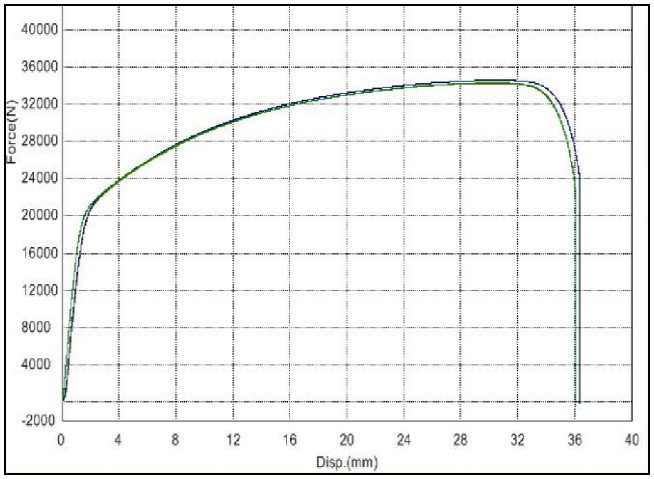


Fig.3. Force over Displacement Graph of Stainless Steel 316 With 6 mm Thickness

Fig. 4 show the force-displacement curves for stainless steel type 304. This figure is having three curves representing three specimen that have been tested for each of the specification.

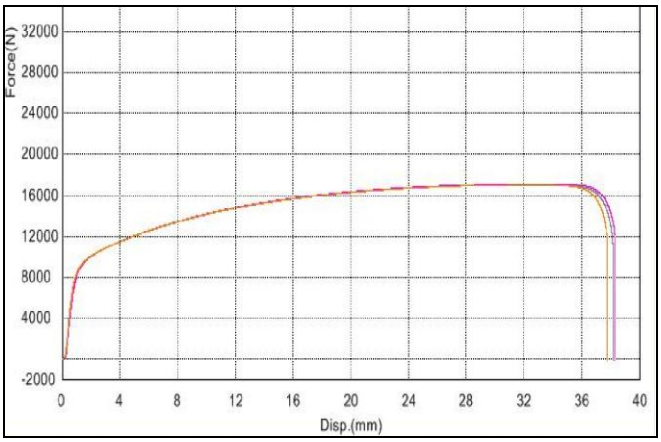


Fig.4. Force over Displacement Graph of Stainless Steel 304 With 3 mm Thickness

Energy absorbed can be calculated based on the area under the curve of force over displacement. Table 2 summarized calculated results from the experiment.

TABLE II
SPECIFIC ENERGY ABSORPTION

| Grade | Thickness (mm) | Specimen No | S.E.A (MJ/kg) |
|---|---|---|---|
| 316 | 3 | S1 | 7 |
| | | S2 | 6.9 |
| | | S3 | 6.9 |
| | 6 | S1 | 7.56 |
| | | S2 | 7.64 |
| | | S3 | 7.64 |
| 304 | 3 | S1 | 6.4 |
| | | S2 | 6.5 |
| | | S3 | 6.5 |

Based on TABLE II, it can be seen that stainless steel type 316 and type 304 of the same thickness produce different result in terms specific energy absorption. The amount of energy absorbed per mass by stainless steel type 316 with thickness of 3 mm is high compared to the stainless steel type 304, average by 6.93 MJ/kg and 6.47 MJ/kg. This is due to the mechanical properties of stainless steel type 316 which is high in ultimate strength and fracture strength compared to stainless steel type 304 (please refer TABLE I). It is also worth noting that increasing the specimen thickness from 3mm to 6 mm for stainless steel type 316 has increased the energy absorption as well.

## IV. CONCLUSIONS

As a conclusion, Stainless Steel 316 have higher energy absorption compared to Stainless Steel 316 of the same thickness. The energy absorption of specimen will also increase when the thickness of specimen is increased.

## ACKNOWLEDGEMENTS

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