JIG & FIXTURE DESIGN FOR ROUGHNESS TESTER SJ-210
Nanda Rahmaniar Siswanda, Sufiyanto*, Sudjatmiko
Department of Mechanical Engineering, Faculty of Engineering, University of Merdeka Malang
*Email corresponding author: sufiyanto@unmer.ac.id

Abstract
The rapid development of the industry gave rise to better technological innovations to develop the quality capacity of a production. Jig & fixture is a production tool used in the manufacturing process, so that accurate part duplication is produced. Jigs & fixture specifically designed to facilitate the setup of materia; which ensures uniformity in the shape and size of products in large quantities (mass products), and commemorate the time of production [2-4]. Jig & fixture functions to hold and direct the workpiece, so that the manufacturing process is more efficient and product quality can be maintained as specified quality. Rong and Zhu (1999) in Ahmad Rizki (2003) state that an object consists of several surface surfaces. In the use of a fixture, the placement process (locating) is the process of placing multiple surfaces of a workpiece until it touches the locator, which is then followed by the clamping process of the workpiece that comes in contact with the locator called a locating surface. In a workpiece there are 6 degrees of freedom (degree of freedom) of movement, ie linear motion in the direction or counterclockwise with the X, Y, Z axis and rotational movements towards the X, Y, and Z axis in a clockwise or counterclockwise direction.

Keywords : locator, clamping, degree of freedom

INTRODUCTION
The rapid development of the industry has given rise to better technological innovations to develop the capacities of the quality of production. In order to reduce the production wing, increasing the efficiency of the manufacturing process of a product is very influential, especially by reducing the time of the manufacturing process. Almost the entire production process uses machines that match the specifications of the product being made. The more complex the product, the more complicated the tools used. Improving product quality can only be achieved by using production process aids, such as jigs & fixtures, molds, and dies.

Jigs & fixtures are production tools used in the manufacturing process, so that accurate part duplication results. The jig & fixture is specially designed to simplify the setting of material; which guarantees the diversity of shapes and sizes of the product in large quantities (mass product), as well as reducing the timing of production. Jig & fixture functions to hold and direct the workwork, so that the manufacturing process is more efficient and the quality of the product can be maintained according to a predetermined quality.

According to Edgrand G. Hoffman (1996), jigs & fixtures are production tools used in the manufacturing process, resulting in accurate part duplication. Jigs & fixtures are usually made specifically as a means of assisting the production process to simplify the setting of materials which ensure the diversity of shapes and sizes of the product in large quantities (mass product) and to shorten the production time. Jigs & fixtures are one type of auxiliary tool found in the manufacturing process so that they are obtained by a uniform product with high accuracy.

Rongdan Zhu (1999) in Ahmad Rizki (2003) states that a bendater consists of several
surfaces. In the use of a fixture, the process of placing (locating) is the process of placing multiple surfaces of the workpiece until it is in contact with the locator, which is then followed up by the clamping process of the workpiece in contact with the locator is called the locating surface. In a work, there are 6 degrees of freedom of movement, which is linear movement in the direction of or against direction of the X, Y, Z axes and the movement of the rotation to the X, Y, and Z axes or against the clockwise direction.

**Research Question**

Based on the background of the problems how to design a Jig & Fixture for the SJ-210 Roughness Tester?

**Research Limitation**

As for the research, it will limit the problems to its parts, namely:

1. The discussion focused on the design of the Jig & Fixture for the SJ-210 Roughness Tester
2. Process on work using conventional welding and milling machines
3. The process of making the clamping board

**METHODOLOGY OF RESEARCH**

**Research Flowchart**

The following is research flowchart for this study.

![Research Flowchart](image)

**Tools and Materials**

The tools used in this research are as follows:

1. Thread
2. Bolt
3. Bearings
4. Vise
5. Cast Steel Rod

While the materials used in this study are as follows:

1. S45C Steel (For Shaft Holder and plate clamp)
2. Bearing no.6001 (d12, D = 28, b = 8, r = 0.5, c = 400, co = 229)
3. Steel bolt
Figure 2. **Roughness Tester SJ-210**

**Tools Specification**

a. The 2.4-inch color graphic LCD provides excellent readability and an intuitive display that is easy to negotiate. The LCD also includes a flat cover for improved visibility in dark environments.

b. The Surftest SJ-210 can be operated easily using the buttons on the front of the unit and below the slide cover.

c. Up to 10 measurement conditions and measured profiles can be stored in the internal memory.

d. Memory cards can be used as additional memory to store a large number of the profile and conditions being measured.

e. Access to each feature can be password protected, which prevents undesired operations and allows you to protect your settings.

f. The interface supports 16 languages, which can be changed freely.

g. An alarm warns you when the cumulative measurement distance exceeds the set limit.


**Design**

**Side View Image**
Calculation

Planned equipment specifications:

Thread diameter 10 mm (made of S45C steel) coarse symmetrical thread at tabled1 = 8.376 mm, d2 = 9.026 mm, D = 10 mm, p = 1.5 mm, H1 = 0.812 mm, thread diameter 12 mm (made of S45C steel) rough thread d2 = 10.863 mm, D = 12 mm, p = 1.75 mm, H1 = 0.947 mm.

7 mm S45C plate roughness tester.

Bearing no. 6001 (d = 12, D = 28, b = 8, r = 0.5, c = 400, co = 229).

Jig arms and fixtures 2 cm (plow plate S45C).

Drive 400 grams.

Power: 25 kg area

Vise holder 200 grams

Lever Vise 200 grams

a. Thread Weight Diameter 12 with a length of 127 mm

16 mm x 6000 mm = 9,5 kg

12 mm x 127 mm = X

96000 mm² = 9,5 kg

\[ X \approx \frac{1524 \text{ mm}^2 \times 9.5}{96000 \text{ mm}^2} = \frac{14478 \text{ kg}}{96000} \]

= 0,15 kg = 150 gram

b. Thread Weight Diameter 12 with a length of 73 mm

16 mm x 6000 mm = 9,5 kg

12 mm x 73 mm = X

96000 mm² = 9,5 kg

\[ X \approx \frac{876 \text{ mm}^2 \times 9.5}{96000 \text{ mm}^2} = \frac{8322 \text{ kg}}{96000} \]

= 0,08 kg = 80 gram

c. Thread Weight Diameter 10 with a length of 30 mm

16 mm x 6000 mm = 9,5 kg

10 mm x 30 mm = X

96000 mm² = 9,5 kg

\[ X \approx \frac{1524 \text{ mm}^2 \times 9.5}{96000 \text{ mm}^2} = \frac{14478 \text{ kg}}{96000} \]

= 0,15 kg = 150 gram
Iron weight, roughness tester
A black steel plate 100 x 160 = 1 piece
43 x 160 = 2 pieces
8 x 160 = 2 pieces
6 mm x 1200 mm x 2400 mm = 140 kg
6 mm x 100 mm x 160 mm = X
17280000 mm$^3$ = 140 kg
96000 mm$^3$ = X
\[ X = \frac{96000 \text{ mm}^3 \times 140 \text{ kg}}{17280000 \text{ mm}^3} = \frac{14478 \text{ kg}}{1728} \]
= 0.7 kg = 700 gram
6 mm x 1200 mm x 2400 mm = 140 kg
6 mm x 43 mm x 160 mm = X
17280000 mm$^3$ = 140 kg
41280 mm$^3$ = X
\[ X = \frac{41280 \text{ mm}^3 \times 140 \text{ kg}}{17280000 \text{ mm}^3} = \frac{57792 \text{ kg}}{172800} \]
= 0.3 kg = 300 gram
= 300 gram x 2 = 600 gram
6 mm x 1200 mm x 2400 mm = 140 kg
6 mm x 8 mm x 160 mm = X
17280000 mm$^3$ = 140 kg
7680 mm$^3$ = X
\[ X = \frac{7680 \text{ mm}^3 \times 140 \text{ kg}}{17280000 \text{ mm}^3} = \frac{10752 \text{ kg}}{172800} \]
= 0.06 kg = 60 gram
= 60 gram x 2 = 120 gram
The total weight of the roughness tester = 700 gram + 600 gram + 120 gram = 1.42 Kg

Weight arm straightener
Iron steel black plate 100 x 160 = 1 piece
43 x 160 = 2 pieces
20 mm x 1200 mm x 2400 mm = 467 kg
20 mm x 100 mm x 160 mm = X
57600000 mm$^3$ = 467 kg
72000 mm$^3$ = X
\[ X = \frac{72000 \text{ mm}^3 \times 467 \text{ kg}}{57600000 \text{ mm}^3} = \frac{33624 \text{ kg}}{57600} \]
= 0.6 kg = 600 gram
20 mm x 1200 mm x 2400 mm = 467 kg
20 mm x 120 mm x 20 mm = X
57600000 mm$^3$ = 467 kg
72000 mm$^3$ = X
\[ X = \frac{48000 \text{ mm}^3 \times 467 \text{ kg}}{57600000 \text{ mm}^3} = \frac{22416 \text{ kg}}{57600} \]
= 0.4 kg = 400 gram

Weight of Circle Standing
20 mm x 1200 mm x 2400 mm = 467 kg
20 mm x 3,14 mm x 60$^2$ mm = X
57600000 mm$^3$ = 467 kg
226080 mm$^3$ = X
\[ X = \frac{226080 \text{ mm}^3 \times 467 \text{ kg}}{57600000 \text{ mm}^3} = \frac{10557936 \text{ kg}}{5760000} \]
= 1.8 kg = 1800 gram

Weight of Vise
20 mm x 1200 mm x 2400 mm = 467 kg
20 mm x 50 mm x 20 mm = X
57600000 mm$^3$ = 467 kg
20000 mm$^3$ = X
\[ X = \frac{20000 \text{ mm}^3 \times 467 \text{ kg}}{57600000 \text{ mm}^3} = \frac{934 \text{ kg}}{57600} \]
= 0.16 kg = 160 gram
20 mm x 1200 mm x 2400 mm = 467 kg
20 mm x 120 mm x 20 mm = X
57600000 mm$^3$ = 467 kg
72000 mm$^3$ = X
\[ X = \frac{48000 \text{ mm}^3 \times 467 \text{ kg}}{57600000 \text{ mm}^3} = \frac{22416 \text{ kg}}{57600} \]
= 0.4 kg = 400 gram
RESULT AND DISCUSSION

a. Tensile of Thread

\[ \sigma_t = \frac{W}{A} = \frac{W}{\pi d^2} \text{ (kg/mm}^2) \]
(Sularso's book p 296 no 7.1)

Where: \( \sigma_t \) = tensile stress (kg/mm\(^2\)).

\( W \) = axial tensile load on the bolt (kg).

\[
\sigma_t = \frac{W}{\pi \frac{d^2}{4}} \frac{1.82 \text{ kg}}{8,376 \text{ mm}^2} = 3.3 \text{ kg/mm}^2
\]

b. Shear stress permission

\( \tau_a = (0.5 \times d \times 0.75) \sigma_a \text{ (kg/mm}^2\)\)
(Sularso's book p 297)

Where: \( \tau_a \) = shear stress permission (kg/mm\(^2\)).

\( \sigma_a = 0.5 \times 4.8 \text{ kg/mm}^2 \)
\( = 2.4 \text{ kg/mm}^2 \)

c. Number of Nut Threads

\[ Z \geq \frac{W}{\pi d_2 H_1 q_a} \]
(Sularso's book p 297 no.7.5)

where: \( H_1 \) = height of hook (mm)

\[ Z = \frac{1.82 \text{ kg}}{3.14 \times 9,026 \text{ mm} \times 0.812 \text{ mm} \times 3 \text{ kg/mm}^2} \]
\( = 3 \)

d. Nut Height

\[ H = z \times p \text{ (mm) } \]

where: \( H \) = nut height (mm)

standard: \( H = (0.8 \times d \times 1.0) \text{ d (mm) } \)
\( p \) = distance divider (mm)

(look at the table of 7.1. a & 7.1. b & table7.2 Sularso’s book p 289-291)

\( H = 3 \times 2.5 \text{ mm } \)
\( = 7.5 \text{ mm } \)

e. Thread Root Shear Stress on Bolt

\[
\tau_b = \frac{W}{\pi d_1 k p z} \text{ (kg/mm}^2) \]
(Sularso's book p 297 no 7.8)

where: \( \tau_b \) = thread root shear stress on the bolt (kg/mm\(^2\))
\( k, p \) = outer root thread thickness

\( k = 0.84 \)

\[
\tau_b = \frac{1.82 \text{ kg}}{3.14 \times 9,026 \text{ mm} \times 0.812 \text{ mm} \times 3 \text{ kg/mm}^2} \]
\( \tau_b = 2 \text{ kg/mm}^2 \)

f. Thread Root Shear Stress in Nuts

\[
\tau_n = \frac{W}{\pi D j p z} \text{ (kg/mm}^2) \]
(Sularso's book p 297 no. 7.9)

where: \( \tau_n \) = thread root shear stress on the nut (kg/mm\(^2\))
\( j = 0.75 \) (symmetrical thread)

Sularso’s book p. 297

\[
\tau_n = \frac{1.82 \text{ kg}}{3.14 \times 10 \text{ mm} \times 0.75 \times 1.5 \text{ mm} \times 3 \text{ kg/mm}^2} \]
\( \tau_n = 2 \text{ kg/mm}^2 \)

Thread (Vise Roughness Tester) Thread diameter 12 mm (made of S45C steel) coarse metric thread on the table
\( d_1 = 10.106 \text{ mm } \), \( d_2 = 10.863 \text{ mm } \)
\( D = 12 \text{ mm } \), \( p = 1.75 \text{ mm } \), \( H_1 = 0.947 \text{ mm} \).

a. Thread Tensile Stress

\[
\sigma_t = \frac{W}{A} = \frac{W}{\pi d^2} \text{ (kg/mm}^2) \]
(Sularso's book p 296 no 7.1)

where: \( \sigma_t \) = tensile stress (kg/mm\(^2\)).
\[ W = \text{axial tensile load on the bolt (kg)} . \]
\[ \sigma_t = \frac{W}{\frac{\pi}{4} d_1^2} \]
\[ = \frac{3.14 \cdot 1.016 \text{ mm}^2}{0.4} \]
\[ = 2.3 \text{ kg/mm}^2 \]

b. Shear stress permission
\[ \tau_a = (0.5s.d \ 0.75) \ \sigma_a (\text{kg/mm}^2) \]
(Sularso's book p 297)
where: \( \tau_a \) = shear stress permission (kg/mm\(^2\))
\[ \tau_a = 0.5 \times 4.8 \text{ kg/mm}^2 \]
\[ = 2.4 \text{ kg/mm}^2 \]

c. Number of Nut Thread
\[ Z \geq \frac{W}{\pi d_2 H_1 \tau_a} \]
(Sularso's book p. 297 no.7.5)
where: \( H_1 \) = height of hook (mm)
\[ Z = \frac{1.82 \text{ kg}}{3.14 \times 10.863 \text{ mm} \times 0.947 \text{ mm} \times 3 \text{ kg/mm}^2} \]
\[ = 2 \]

d. Height of Nut
\[ H = z \cdot p \ (\text{mm}) \]
where: \( H = \) height of nut (mm)
standard: \( H = (0.8 \ \text{s.d} \ 1.0) \cdot d \ (\text{mm}) \)
\( p = \) distance divider (mm)
(look at the table 7.1. a & 7.1. b & table 7.2 Sularso's book p 289 s.d 291)
\[ H = 2 \times 2.5 \text{ mm} \]
\[ = 5 \text{ mm} \]

e. Thread Root Shear Stress on Bolt
\[ \tau_b = \frac{W}{\pi d_1 k_p z} \ (\text{kg/mm}^2) \]
(Sularso's book p 297 no 7.8)
where: \( \tau_b \) = screw root shear stress on the bolt (kg/mm\(^2\))
\( k_p = \) claw thick outer threaded
\( k = 0.84 \)
\[ \tau_b = \frac{1.82 \text{ kg}}{3.14 \times 10.106 \text{ mm} \times 0.84 \times 1.75 \text{ mm} \times 2} \]
\[ = 2 \text{ kg/mm}^2 \]

f. Thread Root Shear Stress in Nuts
\[ \tau_n = \frac{W}{\pi D j p z} \ (\text{kg/mm}^2) \]
(Sularso's book p 297 no. 7.9)
where: \( \tau_n \) = screw root shear stress on the nut (kg/mm\(^2\))
\( j = 0.75 \) (metrical thread)
Sularso's book p. 297
\[ \tau_n = \frac{1.82 \text{ kg}}{3.14 \times 12 \text{ mm} \times 0.75 \times 1.75 \text{ mm} \times 2} \]
\[ = 2 \text{ kg/mm}^2 \]

Thread (Vise)
Thread diameter 12 mm (steel S45C) coarse metric thread on the table
\( d_1 = 10.106 \text{ mm} , \ d_2 = 10.863 \text{ mm} \)
\( D = 12 \text{ mm} , \ p = 1.75 \text{ mm} , \ H_1 = 0.947 \text{ mm} \)
a. Thread Tensile Stress
\[ \sigma_t = \frac{W}{A} = \frac{W}{\frac{\pi}{4} d_1^2} \ (\text{kg/mm}^2) \]
(Sularso's book p 296 no 7.1)
where: \( \sigma_t \) = tensile stress (kg/mm\(^2\)).
\( W = \) axial tensile load on the bolt (kg).
\[ \sigma_t = \frac{W}{\frac{\pi}{4} d_1^2} \]
\[ = \frac{3.14 \cdot 0.4 \text{ kg}}{0.4} \]
\[ = 0.005 \text{ kg/mm}^2 \]

b. Shear Stress Permission
\[ \tau_a = (0.5s.d \ 0.75) \ \sigma_a \ (\text{kg/mm}^2) \]
(Sularso's book p 297)
where: \( \tau_a \) = shear stress (kg/mm\(^2\))
\[ \tau_a = 0.5 \times 4.8 \text{ kg/mm}^2 \]
\[ = 2.4 \text{ kg/mm}^2 \]
c. Number of Nut Threads

\[ Z \geq \frac{W}{\pi d_2 H_1 q_a} \]

(Sularso’s book p 297 no. 7.5)

**where:** \( H_1 = \) height of hook (mm)

\[ Z = \frac{0.4 \, kg}{3.14 \times 10.863 \, mm \times 0.947 \, mm \times 3 \, kg/mm^2} = 0.004 \]

d. Height of Nut

\[ H = z \cdot p \ (mm) \]

**where:** \( H = \) height of nut (mm)

**standard:** \( H = (0.8 \, s.d \ 1.0) \cdot d \ (mm) \)

\( p = \) distance divider (mm)

(look at the table of 7.1. a & 7.1. b & table 7.2 Sularso’s book p 289 s.d 291)

\[ H = 2 \times 2.5 \, mm = 0.007 \, mm \]

e. Thread Root Shear Stress on Bolt

\[ \tau_b = \frac{W}{\pi d_1 k_p z} \ (kg/mm^2) \]

(Sularso’s book p 297 no 7.8)

**where:** \( \tau_b = \) thread root shear stress on bolt (kg/mm^2)

\( k_p = \) claw thick outer threaded

\( k = 0.84 \)

\[ \tau_b = \frac{0.4 \, kg}{3.14 \times 12 \, mm \times 0.84 \times 1.75 \, mm \times 2} = 2 \, kg/mm^2 \]

f. Thread Root Shear Stress in Nuts

\[ \tau_n = \frac{W}{\pi D j p z} \ (kg/mm^2) \]

(Sularso’s book p 297 no. 7.9)

**where:** \( \tau_n = \) screw root shear stress on the nut (kg/mm^2)

\( j = 0.75 \) (metrical thread) Sularso’s book p 297

\[ \tau_n = \frac{0.4 \, kg}{3.14 \times 12 \, mm \times 0.75 \times 1.75 \, mm \times 2} = 2 \, kg/mm^2 \]

**CONCLUSION**

Based on the results of research and discussion, it can be concluded that:

1. Jig & Fixture is a tool that functions to help job seekers are faster, easier, and have good accuracy.

2. The design of this Jig & Fixture can increase engineering, productivity, and ensure the quality of product results, as well as provide efficiency and lower costs on the manufacture of machinery.

**REFERENCES**


Aa Santosa, Jurnal Perancangan Jig dan Fixture Sistem Pneumatik untuk proses pemasangan Bearing dan Absorber pada Velg Rear Wheel, 2017.

Muh Alfatih Hendrawan, Pramuko Ilmu Purbopotro, Jurnal Rancang Bangun Jig Drilling Sebagai Solusi Pembuatan Lubang Chassis Minitruk yang di produksi, 2016

Ft.unsada.ac.id/wpcontent/uploads/2008/04/ba b9-pp2.pdf