JIG & FIXTURE DESIGN FOR ROUGHNESS TESTER SJ-210

by Sufiyanto Sufiyanto

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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 work work, 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.

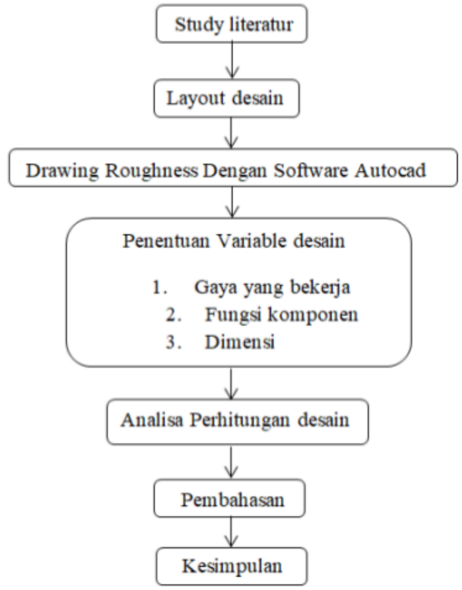


Figure 1. **Research Flowchart**

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.

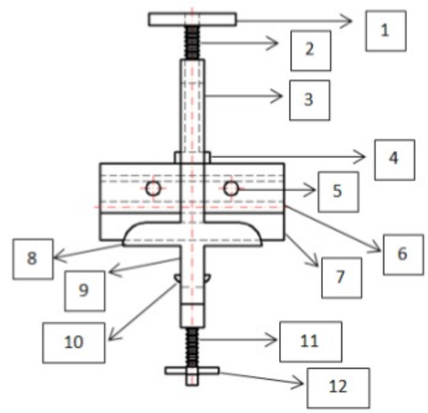
e. Access to each feature can be password protected, which prevents undesired operations and allows you to protect your settings.

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.

h. Surftest SJ-210 meets the following standards: JIS (JIS-B0601-2001, JIS-B0601-1994, JIS B0601-1982), VDA, ISO-1997, and ANSI.

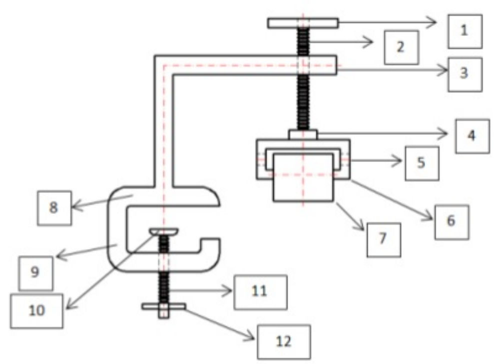
Design



Keterangan :

1. Setir
2. Ulir setir
3. Lengan dudukan
4. Bantalan
5. Mur baut
6. Catokan Roughness tester
7. Roughness tester
8. Dudukan
9. Lengan ragum
10. Penahan Ragum
11. Ulir ragum
12. Tuas Ragum

Side View Image



Keterangan :

1. Setir
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7. Roughness test
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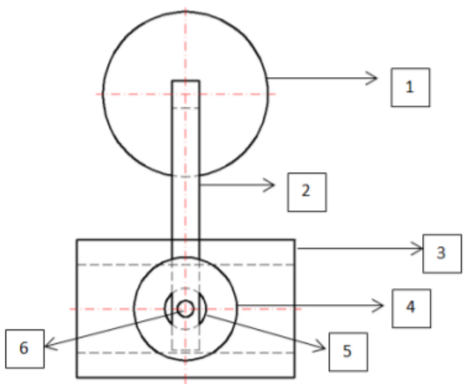
9. Lengan ragum
10. Penahan Ragu
11. Ulir ragum
12. Tuas Ragum

Front View Image



Keterangan :

1. Dudukan
2. Lengan Dudukan
3. Pencatok Roughness Tester
4. Setir
5. Bantalan
6. Ulir setir

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 mm^2 = 9,5 kg

1524 mm^2 = X

$X => \frac{1524\, mm^2\, x\, 9,5}{96000\, mm^2} = \frac{14478\, kg}{96000}$

= 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 mm^2 = 9,5 kg

876 mm^2 = X

$X => \frac{876\, mm^2\, x\, 9,5}{96000\, mm^2} = \frac{8322\, kg}{96000}$

= 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 mm^2 = 9,5 kg

300 mm^2 = X

$X => \frac{1524\, mm^2\, x\, 9,5}{96000\, mm^2} = \frac{14478\, kg}{96000}$

= 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 => $\frac{96000\ mm^3\ x\ 140\ kg}{17280000\ mm^3} = \frac{14478\ kg}{1728}$

= 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 => $\frac{41280\ mm^3\ x\ 140\ kg}{17280000\ mm^3} = \frac{57792\ kg}{172800}$

= 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 => $\frac{7680\ mm^3\ x\ 140\ kg}{17280000\ mm^3} = \frac{10752\ kg}{172800}$

= 0,06kg = 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 => $\frac{72000\ mm^3\ x\ 467\ kg}{57600000\ mm^3} = \frac{33624\ kg}{57600}$

= 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 => $\frac{48000\ mm^3\ x\ 467\ kg}{57600000\ mm^3} = \frac{22416\ kg}{57600}$

= 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 => $\frac{226080\ mm^3\ x\ 467\ kg}{57600000\ mm^3} = \frac{10557936\ kg}{5760000}$

= 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 => $\frac{20000\ mm^3\ x\ 467\ kg}{57600000\ mm^3} = \frac{934\ kg}{57600}$

= 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 => $\frac{48000\ mm^3\ x\ 467\ kg}{57600000\ mm^3} = \frac{22416\ kg}{57600}$

= 0,4 kg = 400 gram

20 mm x 1200 mm x 2400 mm = 467 kg

20 mm x 15 mm x 20 mm = X

57600000 mm^3 = 467 kg

6000 mm^3 = X

X => $\frac{6000\ mm^3\ x\ 467\ kg}{57600000\ mm^3} = \frac{2802\ kg}{57600}$

= 0,05 kg = 50 gram

Total weight o vise160 gram + 400 gram + 50 gram = 610 gram

Bolt nut (Locking Roughness Tester)

Thread diameter 10 mm (S45C steel) rough symmetrical thread on the table

4 d_1 = 8,376 mm , d_2 = 9,026 mm ,

D = 10 mm , p = 1,5 mm , H_1 = 0,812 mm.

RESULT AND DISCUSSION

a. Tensile of Thread

$$\sigma t = \frac{W}{A} = \frac{W}{\frac{\pi}{4}.d1^2} \quad (kg/mm^2)$$

(Sularso's book p 296 no 7.1)

Where: σ_t = tensile stress (kg/mm²).

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

$$\sigma t = \frac{W}{\frac{\pi}{4}.d1^2}$$

$$= \frac{1,82\ kg}{\frac{3,14}{4}.8,376\ mm^2}$$

= 3,3 kg/mm²

b. Shear stress permission

$$\tau_a = (0,5 s.d\ 0,75)\ \sigma_a\ (kg/mm^2)$$

(Sularso's book p 297)

Where: τ_a = shear stress permission (kg/mm²)

τ_a= 0,5 x 4,8 kg/mm²

= 2,4kg/mm²

c. Number of Nut Threads

$$Z \geqq \frac{W}{\pi\ d_2 H_1 q_a}$$

(Sularso's book p 297 no.7.5)

where: H_1 = height of hook (mm)

$$Z = \frac{1,82\ kg}{3,14\ x\ 9,026\ mm\ x\ 0,812\ mm\ x\ 3\frac{kg}{mm2}}$$

=3

d. Nut Height

$$H = z.\ p\ (mm)$$

where: H = nut height (mm)

standard: H = (0,8 s.d 1,0). 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 x 2,5 mm

= 7,5 mm

e. Thread Root Shear Stress on Bolt

$$\tau_b = \frac{W}{\pi.d_1.k.p.z} \quad (kg/mm^2)$$

(Sularso's book p 297 no 7.8)

where: τ_b = thread root shear stress on the bolt (kg/mm²)

k.p = outer root thread thickness

k = 0,84

$$\tau_b = \frac{1.82\ kg}{3,14\ x\ 8,376\ mm\ x\ 0,84\ x\ 1,5\ mm\ x\ 3}$$

τ_b = 2kg/mm

f. Thread Root Shear Stress in Nuts

$$\tau_n = \frac{W}{\pi.D.j.p.z} \quad (kg/mm^2)$$

(Sularso's book p 297 no. 7.9)

where: τ_n = thread root shear stress on the nut (kg/mm²)

j = 0,75 (symmetrical thread) Sularso's book p. 297

$$\tau_n = \frac{1,82\ kg}{3,14\ x\ 10\ mm\ x\ 0,75\ x\ 1,5\ mm\ x\ 3}$$

τ_n = 2kg/mm²

Thread (Vise Roughness Tester) Thread diameter 12 mm (made of S45C steel) coarse metric thread on the table

d_1 = 10,106 mm , d_2 = 10,863 mm ,

D = 12 mm , p = 1,75 mm , H_1 = 0,947 mm.

a. Thread Tensile Stress

$$\sigma t = \frac{W}{A} = \frac{W}{\frac{\pi}{4}.d1^2} \quad (kg/mm^2)$$

(Sularso's book p 296 no 7.1)

where :σ_t = tensile stress (kg/mm²).

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

$$\sigma t = \frac{W}{\frac{\pi}{4}.d1^2}$$

$$= \frac{1,82\ kg}{\frac{3,14}{4}.10,106\ mm^2}$$

$= 2,3$ kg/mm^2

b. Shear stress permission

$\tau_a = (0,5s.d\ \ 0,75)\ \sigma_a$ (kg/mm^2)
(Sularso's book p 297)

where: τ_a = shear stress permission (kg/mm^2)

$\tau_a = 0,5 \times 4,8$ kg/mm^2
$= 2,4$kg/mm^2

c. Number of Nut Thread

$$Z \geqq \frac{W}{\pi\, d_2 H_1 q_a}$$

(Sularso's book p. 297 no.7.5)

where: H_1 = height of hook (mm)

$$Z = \frac{1,82\ kg}{3,14\ x\ 10,863\ mm\ x\ 0,947\ mm\ x\ 3\ \text{kg/mm2}}$$

= 2

d. Height of Nut

H = z. p (mm)

where: H = height of nut (mm)
standard: H = (0,8 s.d 1,0). d (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 x 2,5 mm
= 5 mm

e. Thread Root Shear Stress on Bolt

$$\tau_b = \frac{W}{\pi.d_1.k.p.z} \quad (kg/mm^2)$$

(Sularso's book p 297 no 7.8)

where: τ_b = screw root shear stress on the bolt (kg/mm^2)
k.p = claw thick outer threaded
k = 0,84

$$\tau_b = \frac{1.82\ kg}{3,14\ x\ 10,106\ mm\ x\ 0,84\ x\ 1,75\ mm\ x\ 2}$$

$\tau_b = 2$kg/mm^2

f. Thread Root Shear Stress in Nuts

$$\tau_n = \frac{W}{\pi.D.j.p.z} \quad (kg/mm^2)$$

(Sularso's book p 297 no. 7.9)

where: τ_n = screw root shear stress on the nut (kg/mm^2)
j = 0,75 (metrical thread) Sularso's book p. 297

$$\tau_n = \frac{1,82\ kg}{3,14\ x\ 12\ mm\ x\ 0,75\ x\ 1,75\ mm\ x\ 2}$$

$\tau_n = 2$kg/mm^2

Thread (Vise)

Thread diameter 12 mm (steel S45C) coarse metric thread on the table
$d_1 = 10,106$ mm , $d_2 = 10,863$ mm ,
D = 12 mm , p = 1,75 mm , $H_1 = 0,947$ mm.

a. Thread Tensile Stress

$$\sigma t = \frac{W}{A} = \frac{W}{\frac{\pi}{4}.d1^2} \quad (kg/mm^2)$$

(Sularso's book p 296 no 7.1)

where: σ_t = tensile stress (kg/mm^2).
W = axial tensile load on the bolt (kg).

$$\sigma t = \frac{W}{\frac{\pi}{4}.d1^2}$$

$$= \frac{0,4\ kg}{\frac{3,14}{4}.10,106\ mm^2}$$

$= 0,005$ kg/mm^2

b. Shear Stress Permission

$\tau_a = (0,5s.d\ \ 0,75)\ \sigma_a$ (kg/mm^2)
(Sularso's book p 297)

where: τ_a = shear stress (kg/mm^2)

$\tau_a = 0,5 \times 4,8$ kg/mm^2
$= 2,4$kg/mm^2

c. Number of Nut Threads

$$Z \geqq \frac{W}{\pi\, d_2 H_1 q_a}$$

(Sularso's book p 297 no.7.5)

where : H_1 = height of hook (mm)

$$Z = \frac{0{,}4\ kg}{3{,}14\ x\ \ 10{,}863\ mm\ x\ 0{,}947\ mm\ x\ \ 3\ \mathrm{kg/mm2}}$$

= 0,004

d. Height of Nut

H = z. p (mm)

where: H = height of nut (mm)

standadr: H = (0,8 s.d 1,0). 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 x 2,5 mm

= 0,007 mm

e. Thread Root Shear Stress on Bolt

$$\tau_b = \frac{W}{\pi . d_1 .k.p.z} \quad (\mathrm{kg/mm^2})$$

(Sularso's book p 297 no 7.8)

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

k.p = claw thick outer threaded

k = 0,84

$$\tau_b = \frac{0{,}4\ \mathrm{kg}}{3{,}14\ \mathrm{x}\ 10{,}106\ \mathrm{mm\ x}\ 0{,}84\ \mathrm{x}\ 1{,}75\ \mathrm{mm\ x}\ 2}$$

τ_b = 2 kg/mm^2

f. Thread Root Shear Stress in Nuts

$$\tau_n = \frac{W}{\pi . D.j.p.z} \quad (\mathrm{kg/mm^2})$$

(Sularso's book p 297 no. 7.9)

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

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

$$\tau_n = \frac{0{,}4\ \mathrm{kg}}{3{,}14\ \mathrm{x}\ 12\ \mathrm{mm\ x}\ 0{,}75\ \mathrm{x}\ 1{,}75\ \mathrm{mm\ x}\ 2}$$

τ_n = 2kg/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.

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