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# ANALYSIS OF BOLT POSITION MODEL AS SUPPORT FOR INCREASING TENSILE STRENGTH OF CONNECTION COMBINATION DIRECTION OF WELD PLATE ST42

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ABSTRACT

The research objective to be achieved is to know the effect of the model position of (2, 3, 4) bolts to support the increased tensile strength of welded connection direction of transverse, longitudinal and combination direction (transversal + longitudinal) with strong currents 120Ampere.Method used is formed specimens of welded connections (longitudinal and transverse) with types of models bolt position. The manufacturing process produced a connection position 2 bolts model (Horizontal, Vertical, Leaning A and Leaning B), and the position of 3 bolts with the model (ΔA, ΔB, ΔC and ΔD) and position 4 bolts with the model (Square, rhombus, parallelogram A and parallelogram B). The process of testing the tensile test produced output value of load, extension, maximum tensile and maximum tensile strain with the best models bolt position. Tensile test results showed the highest maximum tensile strength at position 2 bolts occurred on slant model B of $\sigma_{U\_Transv\_2Bolt\_MB} = 340{,}556\ MPa$ and position for 3 bolts occurred in triangular model A (ΔA) of $\sigma_{U\_Transv\_3Bolt\_\Delta A} = 338{,}704\ MPa$ and for the 4-position bolts occurred in the model of parallelogram B with weld directions combination $\sigma_{U\_Transv\_4Baut\_\Im B} = 349{,}444\ MPa$. Position 4 bolts models of parallelogram B in combination connection of welding direction (transversal + longitudinal) with a current strength of 120 Ampere showed the highest value of the maximum tensile strength of tensile test result and the best model of bolts position.



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## INTRODUCTION

The strength of the connection is one of the determining factors in a construction, well construction shipbuilding, bridges, roof trusses and other construction uses metal material in the process of connecting. The amount of damage that occurred in the construction of the connection, whether through death or welding process connection or connection using bolts and nuts as a binder in use of construction of the connection. An increase in the tensile strength of the connection can be done through process of connection of weld combination and bolts to optimize the model and connection type, as well as variations in the use of electric current and vary the cooling medium after-treatment in welding process. Results of research and testing will be known the value of the ultimate tensile stress, strain value and the value reduction of the cross section through testing of the tensile test.The strength of the weld metal has the strength and tenacity were better or at least equal to the main metal and traction properties of welded connections blunt, essentially the same as the mains power as long as the selection of welding materials and welding in right way. Increased strength weld connection can be obtained through the variation of the electric current used in the welding process for steel materials.Suhemi and Syamsuri stated that the effect or impact of the use of the welding current connection process will affect the region of HAZ, which can cause a decrease in strength and hardness of metal materials.

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Decreased strength and hardness can cause damage to the local connection (HAZ) in use on the bridge structure, building, steel frame before the end of the lifespan, this may happen if the use of welded connections was not known yet of types of flow weld that matches the metal materials used, (research has not been done in the laboratory). The scope of the use of combination connection of bolts and welds in the construction field is very broad, covering the shipping industry, building, bridge structures, steel structures, pressure vessels, rail vehicles and so on. In addition to the manufacturing, welding process can also be used for repairs, filling the holes on the results of castings, making a hard coating on the tools and utensils, strengthen the parts that have been worn and various types of other improvements, (Wiryosunarto, Harsono). The results of previous research on tensile testing of welded connections of steel ST 42 was 464.50 N / mm2, with an increase of 0.15% strength, (Faith Pujo M *et al*) and the results of tensile testing of welded connections in robust welding current 110 A has a tensile strength values at 507, 33 N / mm2 tensile strength with an increase of 0.65%, (Fenoria Princess). While the results of testing a single bolt connection curling result in behavior which causes the pivot mechanism does not work perfectly, (WiryantoDewobroto).

The strength of welded connections in building construction are sometimes not able to accept the expenses incurred. Example: tensile load, stress or shear loads that occur suddenly which was never considered before. This will cause damage to the welded connections, which in turn will damage the structure of a building or bridge, because the loss of such construction elements. One of the methods to be able to add value to the tensile strength of the connection without changing the size and shape of the connection by combining a variation model of the position of the bolts into the weld connections direction of the longitudinal, transverse and combinations so if the welded connection damaged, the connection between the elements of the construction of the connection is not immediately broken or loose. To determine the increase of the metal material tensile strength in the utilization of the construction field, it is necessary to research into the use of configuration bolt position model connection in combination to obtain the best bolt position.

**Problems Statements**

Based on the explanation of the background outlined above, it can be formulated as follows:

1. How much is the effect of theposition model (2, 3,4) bolts as supporting efforts to increase the tensile strength of the weld connections direction of transverse, longitudinal and combination (transverse +longitudinal)of steel plate?
2. How is relationship between the model position (2, 3, 4) bolts and condition of welded connections direction of transverse, longitudinal and combination (transverse +longitudinal) to generate optimal tensile strength steel connection plates?

**Objectives of Research**

Based on the formulation of the problem, this study has the following objectives:

1. To analyze the effect of position models (2, 3, 4) bolts as supporting efforts to increase the tensile strength of the connection direction of transverse, longitudinal and combination (transverse +longitudinal) of steel plate;
2. Formulate a positional relationship models (2, 3, 4) bolts with condition of welded connections direction of transverse, longitudinal and combination (transverse +longitudinal) to obtain optimal tensile strength steel connection plates?

**Benefits of research**

**Results of this research has the following benefits**

1. For basic usage models connection bolt position and condition of the combination of the direction of welding for the industry engaged in the construction of ships, buildings and bridges or in the field of construction industry related to the use of the connection.
2. The study results of the effect of bolt position model and condition of the connection bolt combination of welding direction can be used as the base material for researchers who want to develop further innovations connection models and types of alloys in use for the development of the construction industry.
3. Guidelines for the construction of learning for technical implementing connections in implementing the appropriate and correct the use of current.
4. It can extend the lifespan for use in various connection in building construction, bridge structures or other construction related to welded connections and bolts.

**Basis theory**

**Bolts and Nuts**

Bolts and nuts are a very important tool fastener and a connection or a tool that can be removed at any time can be opened again. Bolts are classified according to the head, the hexagon and square head. Bolts and nuts can be divided into: bolt clamp, bolt for the special use, machine screws, settler screw, stopper screw and nuts. Connection with transverse loading occurs when two plates in connection with the use of bolts while the plates work gravity laterally bolt parts that receive the greatest tensile is the place where the two plates coincident. In this place as if in a pair of scissors by the second plate. Then the forces acting on the bolt was based upon the shift indicated at the Figure 1below.

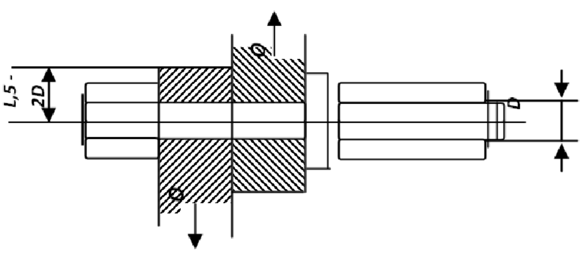


**Figure 1. Image Bolts with Transverse Loading**

$$D = \sqrt{\frac{4p}{\pi . n . \tau_d}} \quad \text{..............................} \quad (1)$$

By: P = Imposition in Kg
n = Number of bolts mounted
D = outside diameter of the bolts in mm
$\tau d$ = shear stress in $Kg/cm^2$
$\tau_t$= tensile stress ($N/mm^2$)

Hypothesis of WiryantoDewobroto, 2008, that the pivot mechanism can be developed on this thin plate connection system. Reasoning for generating innovation starts with understanding the behavior of the key of pivot mechanism. As it is known that the width of the plate, there is a critical part in the contact plate - bolts, and its performance is determined by the diameter of the bolt and plate thickness. In the mounting bolt, bolt hole diameter should larger, the yield gap condition. The new connection system with a special washer is based on a new mechanism, depending on the diameter of the groove and thick plate. Contacts are between the plates when the new channel is formed due to pretentioning at the washer men chant. Because the contact area can be formed without the role of the bolt, then during the transfer of forces on the plates, the bolt does not undergo shear stress. Therefore, the bolt does not determine the strength of the connection but it only plays a role in the formation of the new channel (if possible) and a tool to maintain the shape of the grooves in the plates continued, which serves as the contact area of the new with a size larger than the contact area abutting the previous (normal washer).An increase in the strength of the connection of new system to the old system is determined by the ratio of groove diameter than the diameter of the bolt. If the ratio of the diameter can be made not differ significantly then remain acquired increased performance because it can eliminate the slip factor that generally exist on pivot-type connection system. No need for slip phenomenon when the external load work on the connection causing the structure that uses the connection system becomes rigid, in which the connection system as it is more resistant to risk.

**Welding process**

Welding of the most popular in Indonesia, namely arc welding with electric flame (SMAW), in some areas of the construction industry that use advanced technology, has been using this type of TIG welding, MIG and electrical resistance welding (ERW). As well as submerged arc welding (SMAW). Length of the rod electrode is usually about 230 to 460 mm and a diameter of 2.5 to 9.5 mm. Filler metal is used as the electrode rod must be in accordance with the metal to be welded, the composition is usually very close to the composition of which is owned by the base metal. Wrapping layer consists of cellulose powder mixed with oxides, carbonates, and other elements that are then combined with the silicate binder. Metal powder is sometimes also used as a compound to increase the filler metal and adding elements of alloy. During the welding process flux material used to encapsulate the electrode, as a result of electric arc heat, melt to form a slag of molten metal which is then covered in a pooled connection and works as an oxidation barrier. Displacement of the metal electrode occurs when tip electrode melts to form grains carried by currents electric arc occurred. Electric current is used about 30 to 300 A at a voltage of 15 to 45 V. Selection of power used depends on the metal to be welded, type and length of the wire electrode, and the desired weld penetration.

**Welding Parameters**

In the welding process there are lots of welding parameters, where each parameter has a different influence on the welding results. Some of these parameters among other things:

1) Strong current; Direct effect on the penetration of the weld metal, bead shape, width of HAZ and dilution. The greater the welding currents can deepen the penetration of the weld metal and HAZ widen, and vice versa. Strong magnitude of electric current on the welding process depends on the type of man metal, dimensions and electrode diameter.
2) Welding speed; the higher welding speeds are usually influenced by the high welding currents. To melt the tip electrode/wire welding enough heat energy required. If the heat energy given more than enough for example to provide higher currents, then the process of melting of the electrode tip (feeding rate) is rapid. Electrode melting rate is not matched by the welding speed will cause liquid accumulation of weld metal on the surface of the main metal.
3) Long Welding; is a function of the time of the welding process. The longer the welding is done then the longer time required for welding the same speed. Because of the time required when the welding process is done for longer, then the heat absorbed by the main metal is also much more so it is likely the greater of the distortion occurred.
4) Heat Input; Disbursement of main metal and filler metal requires considerable energy. The energy generated in welding operations resulting from wide - range of sources depending on the welding process. In the electric arc welding, the source of energy comes from electricity that is converted into heat energy. This heat energy is actually the result of a collaboration of the welding current, welding voltage and welding speed.

The quality of welds are influenced by thermal energy which means influenced by three parameters: welding current, welding voltage and welding speed. The relationship between the three parameters that produce energy welding is often called heat input. The equation of heat input results from the merging of the three parameters can be written as follows:

$$HI(Heat\,Input) = \frac{Welding\,Voltage(E)\,x\,Welding\,Current(I)}{Welding\,Speed\,(V)} \ldots\ldots\ldots\ldots \quad (2)$$

From the equation it can be explained some understanding among others, if we want a high heat input the parameters that can be measured ie welding currents can be enlarged or welding speed is slowed. The size of the welding current can be measured directly on the welding machine. Welding tension generally can not be set directly on the welding machine, but their influence on heat input remains. To obtain the actual heat input from a welding process, the similarity of one multiplied by the welding process efficiency (η) so that the equation becomes:

$$HI\ (Heat\ \ Input\ ) = \eta\ x\ \frac{Welding\ \ Voltage\ \ (E\ )\ x\ Welding\ \ Current\ \ (I\ )}{Welding\ \ Speed\ \ (V\ )} \cdot (3)$$

The process of connecting steel buildings we recognize two types of welding, namely:

1) Weld Carbide (OTOGEN welding); welding using a propellant of oxygen gas (acid) and acetylene gas (acetylene). In welded steel construction is only for light work or secondary construction, such as; iron fence, trellis, and so on.
2) Weld Electricity (melted welding); Welding using electric energy. Required for welding, is needed the welding plane is equipped with two cables, one cable is connected to clamp the workpiece and the other one is connected with a cable clamp pliers welding rod/welding electrodes. If the welding electrodes are brought closer to the workpiece, the contact that generate heat that can melt steel and electrodes (welding rod) is also fused ends as well as a gap filler in the weld joint. For steel construction that is structurally (shoulder the burden of construction), the welding connection is not permitted to useOtogen welding, but it must be done with electric welding and must be done by a skilled professional workforce.

Testing the strength of welded connections can be done by two methods, namely:

1) Test without damaging materials (NDT-Non Destructive Test): This test is performed using X-rays or Gamma to examine the state of the inner weld join.
2) Testing by damaging materials (DT-Destructive Test): This test is done with material damage by way of: Tensile test, hardness test, and test arch.Welding connection is a fixed connection, which can produce great connection strength.

The calculation of the weld strength can be obtained through: Weld strength transversal connections consist of:

1)Single fillet; $F = \frac{t\ x\ L}{\sqrt{2}} x\ \overline{\sigma}_t = 0{,}707\ x\ t\ x\ L\ x\ \overline{\sigma}_t$ ………………… (4)

2)Double fillet; $F = 2\frac{t\ x\ L}{\sqrt{2}} x\ \overline{\sigma}_t = 1{,}414\ x\ t\ x\ L\ x\ \overline{\sigma}_t$ ………… (5)

Description;

A= Area minimumofwelding
t = Weldingthickness (mm)
L= Length ofthe welding(mm)
F=Tensile strength(N)
$\overline{\sigma}_t = Tensile\ stress\ welding\ \left( N/mm^2 \right)$

Weld strength parallel connections(longitudinal) consisting of:

1)The maximum shear force parallel fillet;

$$F_s = \frac{t\ x\ L}{\sqrt{2}} x\ \overline{\tau} = 0{,}707\ x\ t\ x\ L\ x\ \overline{\tau} \ \ldots\ldots\ldots\ldots\ldots\ldots\ldots (6)$$

2)The maximum shear force double parallel fillet;

$$F_s = \frac{t\ x\ L}{\sqrt{2}} x\ \overline{\tau} = 0{,}707\ x\ t\ x\ L\ x\ \overline{\tau} \ \ldots\ldots\ldots\ldots\ldots\ldots\ldots (7)$$

A material can be changed with the forces acting on it and will get resistance force in a material that tends to resist external forces. Results of the two styles of interaction is the tendency of a material to return to forms reversed when external forces eliminated the so-called flexibility (elasticity) of materials. Elastic deformation occurs when a piece of metal loaded style and if attempted pull objects will get longer, otherwise if the burden of the compressive force resulting in objects being short. Elastic strain is the result of the extension of the unit cell in the tensile stress direction or in the direction of pressure. If there is only elastic deformation, strain will be proportional to the tension. Comparison between tension and strain is called the modulus of elasticity. The greater the tensile force between the metal atoms, the higher the modulus of elasticity. When the test rod receiving the tensile force of F, with the first sectional area Ao, then the length of the rod will increase of ΔL, then causing tension force of;

$$\sigma = \frac{F}{Ao} \ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ (8)$$

with

F =Load(N)
Ao =Initial cross-sectional area(mm$^2$)

Comparison betweenthe length(lΔ=L1-Lo) withoriginal length(Lo) is called strain.

$$\varepsilon = \frac{Li - Lo}{Lo} \ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ (9)$$

With ε = Strain
L1 = length after a given load (mm)
Lo = initial length (mm)

Comparison between stress and strain is called the elastic modulus of elasticity (Young's modulus), the formulation as follows:

$$E = \frac{\sigma}{\varepsilon} \ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ (10)$$

By: E = Young's modulus (N/mm$^2$)
σ = Voltage (N/mm$^2$)
ε= Strain

In the tensile test, specimen loaded gradually, which grew little by little. Loading due to this, it changes the length of the magnitude to the load by tensile machine causing the relationship diagram (σ- ε). Up to a peak point called the proportional limit, when a tension proportional to the strain, then the graph will show a straight line. When it comes to the elastic limit, the voltage is no longer proportional to strain. If the load is removed, the length of the rod will be returned to its original state. For the record that could be considered the elastic limit and the limit of proportionality is no different. If the load acting on the test rod passed up beyond the elastic limit will happen suddenly extension permanently from a test rod, is called Yield point (limit melted), where the strain increases even if there is no increase in voltage (only occurs in soft steel), at this point the work load is equal to $F_y$, resulting in a tension of $\sigma_y = F_y/Ao$.

## MATERIALS AND METHODS

### Research design

The method used in this research is experimental research and literature review on the influence of the model analyzes the position (2, 3, 4) bolts to support the increase in tensile strength of connection of direction combination of steel plate. Stages of research conducted through the manufacture of test specimens for position models (2, 3, 4) bolts, welding of connection of direction combination, then performed tensile test.From the results of tensile test carried out analysis of the effect of each kind of position model (2, 3, 4) bolts, the condition of the weld connection direction of the longitudinal, transverse and combination (transverse +longitudinal) with a strong current of 120 amperes, where the results of the analysis of the influence of the bolts model position found this type of model position and the best bolt direction connection models.

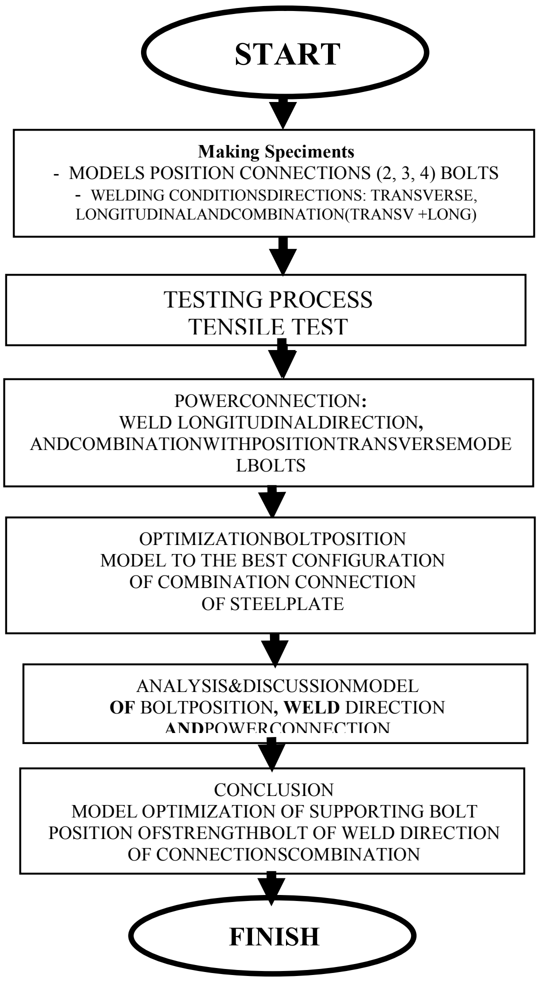


**Figure 2. Flow Chart Research**

### The analysis technique used

Analysis of each kind of the position model (2, 3, 4) bolts on the condition of the weld connection direction (transverse, longitudinal and combinations) from the welding process with the use of a strong current of 120 amperes, the process of tightening the bolt (torque remains). The process of connection tensile test generating a direct values of tensile strength, loading, stretching, and an extension of time ranging from proportionate conditions, ultimate and fracture condition (Break). From the test results known the effect of each model of bolt position, good direction condition, against an increase in tensile strength connection steel plates. The forms of the

equations used are; $\sigma = \dfrac{F}{Ao}$ and $\varepsilon = \dfrac{\Delta l}{lo}\, x\, 100\,\%$.

## RESULTS AND DISCUSSION

Results of testing the tensile strength of the maximum connection variation direction of welding (transverse, longitudinal and combined) to position of 2 bolts with a model of horizontal, vertical, slant A and slant B showed that the model of slant B connection on weld condition directions of transversal has the highest value of tensile strength maximum of $\sigma_{U\_Transv\_2Bolt\_MB} = 340{,}556\ MPa$ comparison with horizontal models of $\sigma_{U\_Comb\_2Bolt\_H} = 315{,}185\ MPa$, vertical of $\sigma_{U\_Comb\_2Bolt\_V} = 316{,}111\ MPa$ and slant A of $\sigma_{U\_Transv\_2Bolt\_MA} = 338{,}704\ MPa$. Phenomenon also occurs at position of 3 bolts with triangular model A, triangle B, C and triangle D shows that the triangular model A has the highest maximum of tensile strength values of $\sigma_{U\_Transv\_3Bolt\_\Delta A} = 338{,}704\ MPa$ comparison with the model of the triangular B $\sigma_{U\_Comb\_3Bolt\_\Delta B} = 328{,}333\ MPa$, of the triangular C $\sigma_{U\_Transv\_3Bolt\_\Delta C} = 323{,}148\ MPa$ of the triangle D $\sigma_{U\_Transv\_3Bolt\_\Delta D} = 322{,}407\ MPa$. While the 4-position bolt also occurred on the model square, rhombus, a parallelogram A and parallelogram B showed that the condition of the connection system on the model of the parallelogram B and has a value of tensile strength maximum high of $\sigma_{U\_Comb\_4Bolt\_\Im\_B} = 349{,}444\ MPa$ compared square model of $\sigma_{U\_Transv\_4Bolt\_P} = 3337{,}593\ MPa$, the rhombus model of $\sigma_{U\_Comb\_4Bolt\_K} = 323{,}519\ MPa$ and model of parallelogram A of $\sigma_{U\_Transv\_4Bolt\_MA} = 311{,}296\ MPa$. Results of testing the tensile strength of the model positions (2, 3, 4) bolts in the weld connection direction of transverse, longitudinal and combination (transversal+longitudinal) showed that the 4-position bolt models of parallelogram B on condition combination direction of welding (transversal+longitudinal) has the highest maximum tensile value compared with the model of positions 2 and 3 bolts of various types of welding connection direction.

In detail, the value of the maximum tensile strength of each bolt position in the direction of the weld connection variations were shown in the following table.

value and the best connection of test results of tensile test compared with the positions 2 and 3 models of bolts.

**Table 1. Values of maximum tensile strength of weld variation connection directions toposition models (2, 3, 4) of bolts**

| NUMBER OF BOLT | MODEL | KONDITION | TIME (S) | LOAD (Kn) | EXTENSION (mm) | STRESS (MPa) | STRAIN % |
|---|---|---|---|---|---|---|---|
| 2 BOLTS | H | COMB | 47,833 | 170,200 | 23,893 | 315,185 | 47,786 |
| | V | COMB | 68,513 | 170,700 | 22,690 | 316,111 | 45,380 |
| | MA | TRANSV | 54,527 | 182,900 | 27,278 | 338,704 | 54,556 |
| | MB | TRANSV | 38,941 | 183,900 | 22,546 | 340,556 | 45,092 |
| 3 BOLTS | ΔA | TRANSV | 35,145 | 182,900 | 20,356 | 338,704 | 40,712 |
| | ΔB | COMB | 72,410 | 177,300 | 23,997 | 328,333 | 47,994 |
| | ΔC | TRANSV | 43,338 | 174,500 | 25,128 | 323,148 | 50,256 |
| | ΔD | TRANSV | 39,041 | 174,100 | 22,690 | 322,407 | 45,380 |
| 4 BOLTS | P | TRANSV | 39,142 | 182,300 | 22,706 | 337,593 | 45,412 |
| | K | COMB | 34,547 | 174,700 | 20,003 | 323,519 | 40,006 |
| | JG_A | TRANSV | 47,634 | 168,100 | 27,551 | 311,296 | 55,102 |
| | JG_B | COMB | 41,240 | 188,700 | 23,829 | 349,444 | 47,658 |

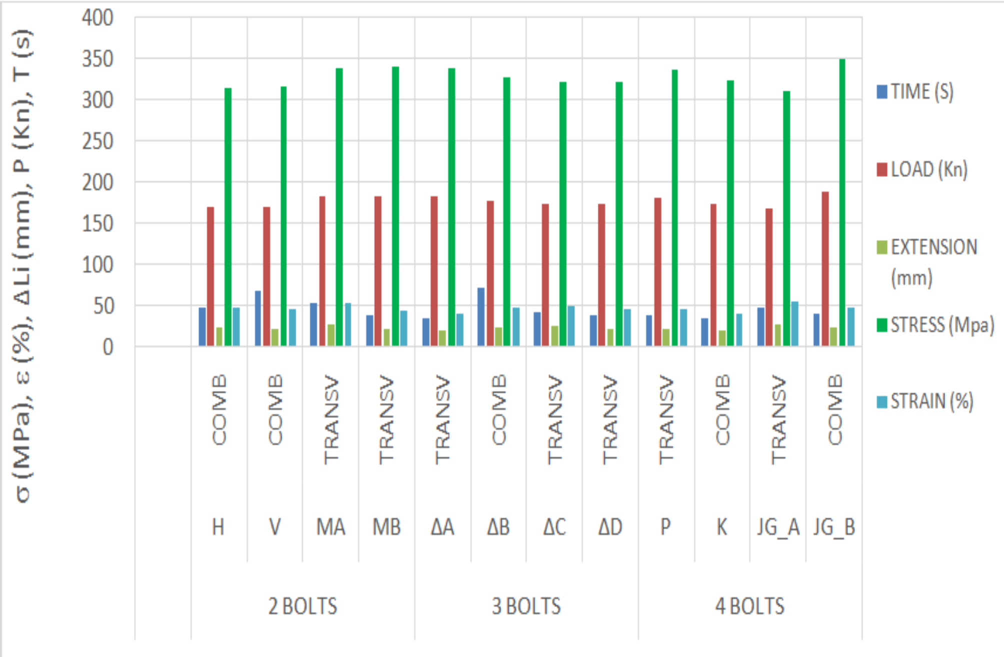


**Figure 3. Charts relationship between model bolt position on exposure to las stress, strain, expenses and extension of time**

Effect of position models (2, 3, 4) bolts was a supporting factorin increasing the tensile strength of weld connection, whether longitudinal direction, transverseor combination (transversal+longitudinal). A phenomenon that occurred from the welding process of transversal direction was the best connection modelinposition2and3whilethe welding process direction combination (transversal+longitudinal) was the best connection type for the position of supporting 4 bolts. Value of tensile strength, strain, load, extension and time while the maximum (ultimate) each bolt position against the direction of the longitudinal weld connections, the transverse and combination (transversal+longitudinal) was shown in the graph below. The tensile strength of the weld connection direction of transverse, longitudinal and combination (transversal + longitudinal) was influenced by the model positions (2, 3, 4) bolts, it was shown in the graph above that the position 4 bolts model of parallelogram B has the highest maximum tensile

## Conclusion

1) The highest maximum tensile strength of weld connections of transverse direction with a strong current of 120 amperes at position of 2 slant models B of $\sigma_{U\_Transv2_{Bolt-MB}} = 340{,}556\, MPa$, 3bolts position at triangle B model of $\sigma_{U\_Transv-3_{Bolt-\Delta A}} = 338{,}704\, MPa$; and 4 bolts position at the model of parallelogram B $\sigma_{U\_Comb\_4Bolt\_\Im\_B} = 349{,}444\ MPa$.
2) Relationship position 4 bolts models of parallelogram B as the best of bolt position model as supporting an increase in the tensile strength of the weld connection combination direction (transversal + longitudinal) of $\sigma_{U\_Comb\_4Bolt\_\Im\_B} = 349{,}444\ MPa$ compared with position models of 2 and 3 bolts.

## REFERENCES


Adriansyah, October 2007. *Effect of Temperature in Heat Treatment Process To Improve Wear Resistance Steel Karbor Low On Pena Spring Leaf. Scientific Journals Poly Rekayasa*., Volume 3. No. 1.

Agustinus Purna Irawan August 2009. *Papers of Machine Elements*. Department of Engineering Faculty of Engineering University of Tarumanagara

Ahmed Drai, *et al*. June 2012. *Analysis of plastic deformation behavior of HDPE during high pressure torsion process.* ELSEVIER. Engineering Structures.

Ali Shariati, *et al*. 9 June 2012. *Varios types of shear connectors in composite structures: A review. International Journal of Physical Sciences*, Vol. 7(22).

Al-Sarraf, Z. *et al*. 2012. *A numerical and experimental study of ultrasonic metal welding.* IOP Science. Materials Science and Engineering.

Chacon, R. *et al*. June 2012. *Transversally stiffened plate girdes subjected to patch loading Part 2. Additional numerical study and design proposal. Elsevier Journal of Constructional Steel Research*.

Chakherlou T. N.,* M. J. Razavi* and A. B. Aghdam, 2012. *On the Variation of Clamping Force in Bolted Double Lap Joints Subjected to Longitudinal Loading: A Numerical and Experimental Investigation. Strain. An International Journal for Experimental Mechanics*.

Johanes Leonard. *et al*. ________ *Analysis of Tensile and Flexural Strength of Epoxy Composites Reinforced With Fibers Bark Khombouw*.

*John Wiley & Sons, Inc 1965. "The Theoritical Engineering Statistic and Aplication"*. Hald.Jakarta.

Kuncoro Diharjo. March 2006. *Study of Effects of Hole Making Technique against Mechanical Tensile Strength of Composite Hybrid Glass Fiber and Plastic Sacks. Journal of Teknoin*, Vol. 11, No.1,

Mahmood Md Tahir. Et.al. 2008. *Experimental Tests on Extended End-Plate Connections with Variable Parameters.* SEEL STRUCTURES.

Mehdi Ghassemich. Dkk. February 2012. *Evaluation of Stiffened End-Plate Moment Connection Through Optimized Artificial Neural Network. Scientific Research. Journal of Engineering and Applications*.

Ramesh Kumar, B. *et al*. 2012. *Thick SS316 materials TIG welding development activities towards fusion reactor vacuum vessel applications. IOP Science. Journal of Physics*.

Saliba, N. *et al*. September 2012. *Coss – section stability of lean duplex stainless steel welded I-sections.* ELSEVIER. *Journal of Constructional Steel Research*.

Sami Rizkalla, *et al*. 2008. *Development of a carbon fiber reinforced polymer system for strengthening steel structures.* Elsevier composites. Part A: Applied Science and manufacturing.

Saripuddin, M. September 2015. *Analysis of Comparative Strength Model Connection Bolts And Weld To The Plate Materials ST. 42. International Journal of Engineering Research and Applications (IJERA)*, Volume 5-Issue 9 (Part-2).

Saripuddin, M. November 2014. *Optimation of Weld and Bolts Connection Combination For Improving Tensile Strength of Material Plates.* Prosiding KNPTS, ITB Bandung.

Saripuddin. M. November 2015. *Comparative Analysis of Connection Strength of Bolts Model Position with Weld Directions of Plate ST. 42.* Prosiding KNPTS, ITB Bandung.

Saripuddin. M. Oktober 2014. *Analysis of Effect of Weld and Bolts Combination Connection towards Material Strength.* Prosiding SNTTM XIII. Universitas of Indonesia.

Surdia Tata. 1985. *Knowledge of Materials Engineering.* Jakarta: PT. Pradnya Paramita. Suhemidansyamsuri. July 2007. Effects*of Changes in Weld Flow of TIG Against Impact Strength In Different Materials*. SAINTEK. VOL. 11. NO. 1.

Wiryanto Dewabroto. 2008. "*Pengaruh Bentukdan Ukuran Washer (Ring) pada Perilaku Sambungan Baut Mutu Tinggidengan Pretensioningdi Baja Cold-Rolled",* Disertasi Universitas Katolik Parahyangan.

Wiryosunarto, Harsono. 1994. *Technology of Metal Welding Technology* Jakarta : PT. Pradnya Paramita.


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