Effect of Bending to the Strength of Reinforcement Steel Bar In the Peat Water Behavior

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ABSTRACT

Concrete reinforcement steel bar when it began ordering from manufacturers and further functionalized into the building structure experience bending process. Environmental conditions also affected to the physical and mechanical conditions of the reinforcement steel bar. Many varieties of corrosion environmental condition that was given, then the peat water scope was selected as a characteristic geographical condition in Riau Province. The research methodology was on experimental research. Concrete reinforcement steel bar was bent on angle (α) 20°, 40°, 60°, 80°, 100°, 120°, 140°, 160°, and 180°. It was soaking in the peat water and then the specimens is straightened for tensile test. The average tensile strength of concrete reinforcing steel structures increased variety depend on the angle of bending. The highest increasing in yield strength was on bending angle (α) of 180° at precentage 18.01% with an average value of 587.1286 MPa. The highest increasing of maximum tensile strength was on bending angle (α) of 180° at precentage 4.76% with an average value of 676.8660 MPa. The lowest elongation was on bending angle (α) of 180 ° with an average value of 6.67%.

KEY WORDS: *Bending, Steel Structures, Mechanical Properties*.

NOMENCLATURE

A_o	Initial Area (mm²)
ΔL	Length Increasing (mm)
D	Specimen Diameter (mm)
E	Modulus of Elasticity (GPa)
EL	Elongation ductility (%)
ε	Strain
F	Tensile Force (N)
σ	Normal Stress (N/mm²)
G	Gauge Length (mm)

1.0 INTRODUCTION

Riau province continues to accelerate infrastructure development is a key in spurring economic development of the people on Earth LancangKuning. Especially the construction of physical facilities in Riau Province is now increasing very rapidly, such as the construction of office buildings, bridges, apartment, hotel, plaza, shops, and residential-housing community. Construction of physical facilities that require concrete reinforcing steel structure as one of the main ingredients for the reinforcement of concrete buildings.

Concrete reinforcement steel structure production process of bending experienced either for a particular purpose or another. One goal is to reduce the size of bending length for ease of transport from the manufacturer in Jakarta or Medan to get to Pekanbaru Riau province or territory areas through ground transportation with vehicle size is limited. The reality on the ground there is also a bending that is not intentional that during the process of loading and unloading and unexpected actions in the course of concrete reinforcing steel is up to the consumer such as collision, crushed by heavy objects, and so on. So that in some places it was found that the steel bars are not perfectly straight. Most of the implementation of concrete progress on the ground is often encountered reuse of concrete reinforcing steel which has been bent.

Today is often seen primarily on development projects of buildings, dams, and so forth, that the materials making up the concrete, especially concrete reinforcing steel much corrode due to storage that is not good (let in the open without roof), thusindirectly steel The concrete reinforcement will be easily affected by environmental conditions (Wibowo&Gunawan, 2007). Judging from the environment in which the building was erected, the procurement process steel bar that takes a long time from ordering to use, the steel bar of the concrete reinforcement will be in touch with water vapor or the environment within one week to one month during storage or stacking, depending on the procurement process and the size of the building to be erected. According Riwandi (2003) region of the island of Sumatra and Borneo is surrounded by peat water. Peat water Sumatra and Kalimantan regions are acidic, reddish brown and contain plenty of organic matter (Fitria et al, 2007). Riau Province including the area contained water peat.

Viewed from a technical aspect, the influence of bending and straightening back and peat water on steel concrete reinforcing structure becomes a very important thing to note in consideration of changes in mechanical properties. Effect of peat water on steel concrete reinforcing structure is that the peat water lowers fatigue strength concrete reinforcing steel structures that undergo dynamic loading is much greater than the effect of distilled water (Dalil&Fatra, 2010). Although the effect of bending unlike the dynamic loading (cycle), but the mechanical properties are unchanged from the standards set under the influence of bending and straightening and peat water a top priority in consideration of the use of concrete reinforcing steel in Riau Province.

In this study will be reviewed influence of bending and straightening back which is also influenced by peat water completely. Environmental influences homogenous corrosion to a metal then soaking the desired solution. It has been proved by Muhsinin and kurniawan (2012) by dipping a test sample (AISI 1045 and SS 304) into the mouth of the river for 90 days to determine the rate of corrosion on the estuary of the river environment. While this research in addition to known corrosion rate, will also work force or the mechanical properties of the steel structure of the concrete reinforcement.

2.0 LITERATURE REVIEW

Z.T. Zhang and S. J. Hu (1997) had been calculating stress and residual stress methods in plane strain bending. The influence of deformation theory and incremental theory, repeating bending, unbending and re-bending, cyclic material models and springback calculation methods on the stress or residual stress distributions are examined and shown to be large [6]. H.X. Zhu (2006) had been compared the deformation theory, the flow theory with either isotropic hardening or kinematic hardening, and the shell theory (which ignores the transverse stress). The solutions reveal that large curvature bending can result in a significant thickness reduction of the bent plate, and therefore the non-dimensional bending moment initially increases with the non-dimensional bending curvature, reaches a peak point, and then drops with the further increment of the non-dimensional bending curvature [8].

2.1 Concrete reinforcement steel bar (metal forming)

Steel reinforcement for concrete construction is shaped steel round bars and deep for building construction materials. The manufacturing process begins with the raw material is steel molds (ingot / billet) which has soothed (normalizing). The next is the process of hot rolled forming process is then performed (metal forming) is the process of withdrawal and stretching.

2.2 Effect of Air Bending to the tensile Strength of reinforcement steel bar

In the case of tensile loading-press when bending and straightening, then the kinematic and isotropic hardening occurs in two different ways kinematic hardening occurs in the first load cycle.

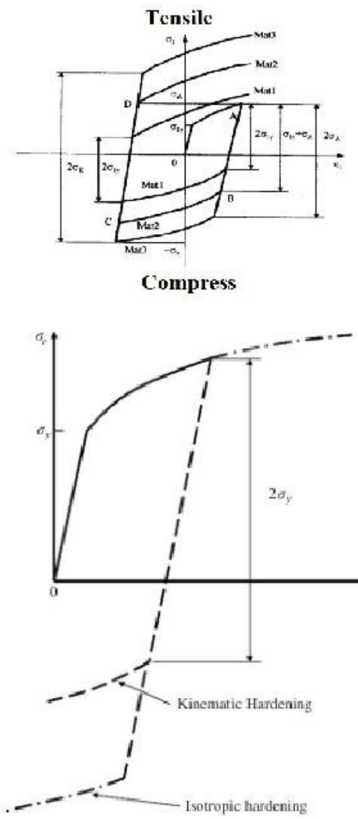


Figure 2.1 Comparison between Tensile and Compress test

2.3 Effect Strain hardening to the Corrosion rate

Strain hardening resulting in increased corrosion. Previous research has been done on the prediction of corrosion rate with major changes in the degree of plastic deformation and corrosion medium on carbon steel material by Suriadi and Suarsana (2007). The result is a corrosion rate increasing with increasing degree of deformation as shown in Fig 2.

Figure 2.2 Result of corrosion rate increasing with increasing degree of deformation

2.4. Characteristic of Corrosion effect to the reinforcement Steel bar

The concrete reinforcement steel bar is known as reinforcement steel bars or reinforced concrete (RC) is one of the compilers of composite building materials (concrete + metal) are indispensable in the field of civil engineering. The concrete reinforced Steel bar is additional material on the concrete where the mechanical properties required is the ability to absorb energy at a given load (strain energy). Various types of corrosion affect to the strain energy that disrupts the concrete reinforcing steel in concrete structures functionality. Definition of strain energy is the total amount of mechanical energy consumption by looking at the stress-strain curve extensive technical (engineering stress-strain) after tensile testing. Wide calculation method stress-strain curve technically could use methods simpson quadrature.

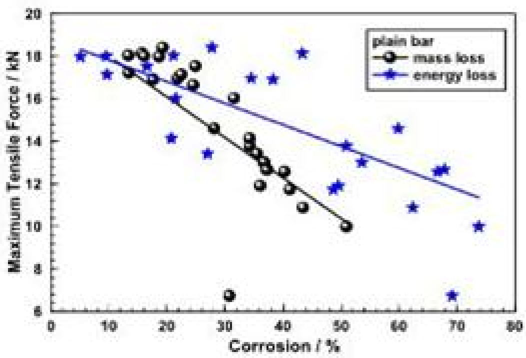
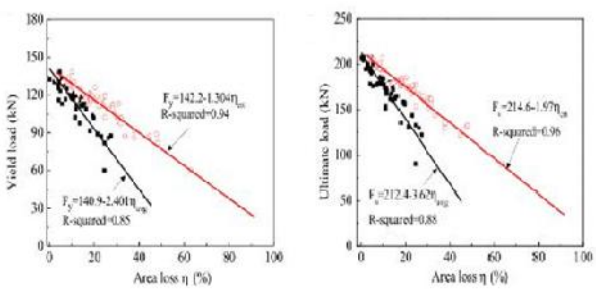


Figure 2.3 Degradation of Tensile Strength caused by corrosion (Zhang et al, 2010)



(a) Yielding load (b) Ultimate load

Figure 2.3 Function of area loss caused by corrosion (Tang et al. 2014)

3.0 METHODOLOGY

The methodology that used is experimental. The samples of material used is concrete reinforced steel structure production from PT. Krakatau Steel (Indonesia) is known enough to have credibility in issuing a product with consistent specifications. Steel structures are widely sold in the city of Pekanbaru and used in a variety of building construction.

The specimens were measured for Ø12 of mm diameter and to be machined (lathe) to obtain the size of the specimen as followed in ASTM E8M shown in Fig 3.1

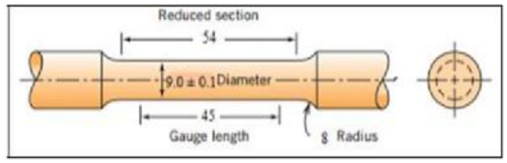


Figure 3.1 Dimensions of Specimen

3.1 Grouping Sample of Testing

Performed with varying bending angle, it is starting from the point (α) of 20°, 40°, 60°, 80°, 100°, 120°, 140°, 160°, 180°. The number of test specimens for each angle is not bent and bent test specimen is 5, so that for the test conditions are 45 test specimens. The number of specimen has been tested were45 specimens, and the number of unbend specimen were 5 specimens. Total Specimens for tensile test specimens were 50. Overall specimens after bending treatment were soaked in the peat water for 30 days.

3.2 Research Procedures

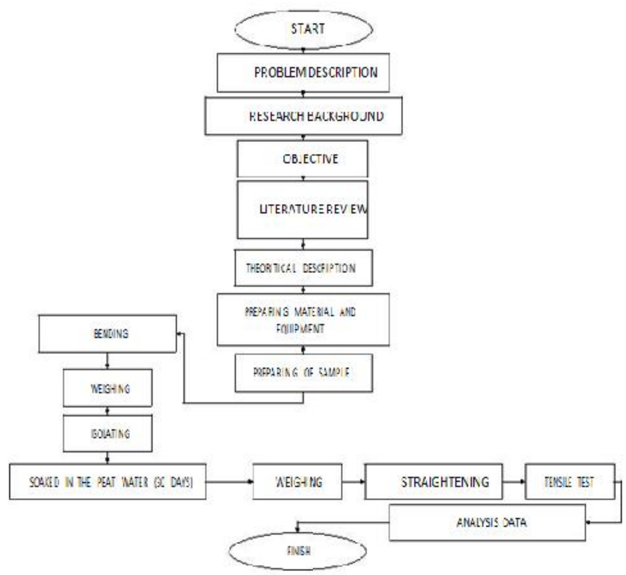


Figure 3.2: Flow Chart

3.3 Documentation

In this section will be shown some of the documentation in the research process was started from preparation of sample, sample treatment and data collection process.

(a) (b)

Figure 3.3 (a) specimens after bending, (b) Weighing before soaked

Figure 3.4 Isolation of all area except reduced section

(a) (b)

Figure 3.5 (a) Measuring the potential of hydrogen (pH scale) which contained, (b) The all specimen were soaked in the peat water

(a) (b)

Figure 3.6 (a) Cleaning process, (b) Weighing after soaked

(a) (b) (c)

Figure 3.7 (a) Straightening, (b) Tensile test, (c) After tensile test

4.0 RESULTS AND DISCUSSION

This research aims to develop previous studies of bending steel bars. The development is made by adding water soaking treatment in peat. Previous studies data has been compared with the results of this study.

The mechanical properties obtained from tensile test results of yield strength (yield strength), maximum tensile strength (ultimate tensile strength), breaking strength (fracture strength) and the percentage of the length (elongation). Specimen weight data is used to determine the rate of corrosion after immersion in water peat in order to obtain the relationship between the corrosion rates with a bending angle.

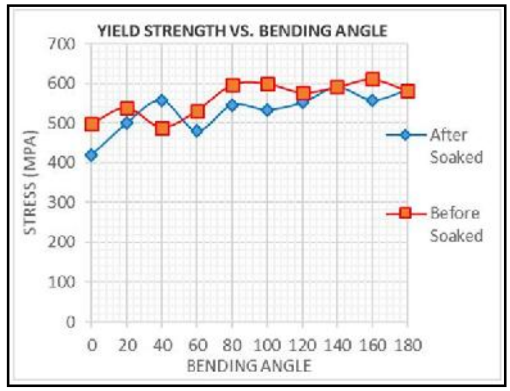


Figure 4.1 Comparison the yield strength between before and after soaked

In Figure 4.1 is shown a comparison between the strength of concrete reinforcing steel melting that is not soaked (red line) with that has been soaked in water peat (blue line). The yield strength of concrete reinforcing steel that has been soaked in water the peat has decreased compared to the yield strength of concrete reinforcing steel which is not soaked except the bending angle of 40°. Lowest decline lies in the bending angle of 0° (normal). The highest rise in yield strength concrete reinforcing steel that has been soaked lies in the bending angle of 180°. The percentage increase in the bending angle of 180° at 18.01% with a value of tensile strength is 587.1286MPa.

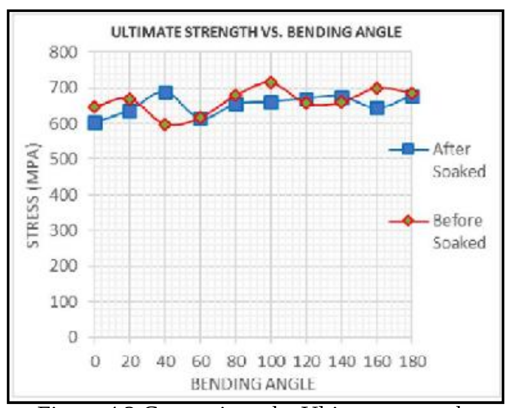


Figure 4.2 Comparison the Ultimate strength between before and after soaked

In the Figure 4.2 is shown the relationship between maximum tensile strength against bending angle of the two data soaked concrete reinforcing steel (blue line) with concrete reinforcing steel that is not soaked (red line). Based on the shape of the graph, the maximum value of the tensile strength of concrete reinforcing steel which has been soaked has peaks and valleys depending on the angle of bending. Look at the graph of concrete reinforcing steel which is not soaked that third chart topper on the bending angle of 20°, 100°, and 160° decreased after immersion in water peat so inclined horizontal blue line.

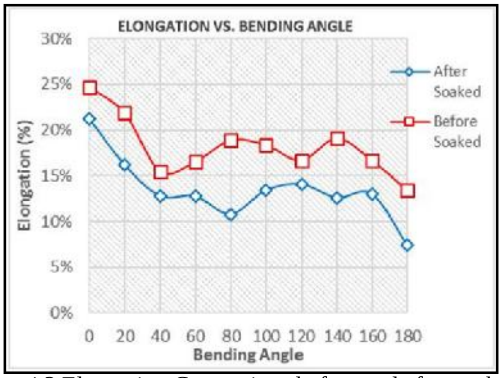


Figure 4.3 Elongation Comparison before and after soaked

The percentage value of the length of concrete reinforcing steel that is not immersed in water peat or peat has been soaked in water varies depending on the size of the bending angle. Starting from the bending angle of 0° (normal) to the bending angle of 180° elongation value of concrete reinforcing steel that has been soaked is under concrete reinforcing steel groups were not soaked. Fairly steep decline occurred until the bending angle of 40° and then proceed to the bending angle of 80°. The difference between the trend decline in the bending angle of 100° to 160° bending angle is not so much the value of the average elongation ranges from 12% to 14% and can also be seen from the shape of the hill-valley on the graph tend to be flat. Further decline occurred again in the bending angle of 180 °.

In the bending angle of 180 degrees is the highest elongation decrease compared to the other treatments. Percentage of reduction occurred in elongation of concrete reinforcing steel that has been soaked in peat water at an angle of 180° is 0.05%. The average of elongation on the bending angle is 7.39%.

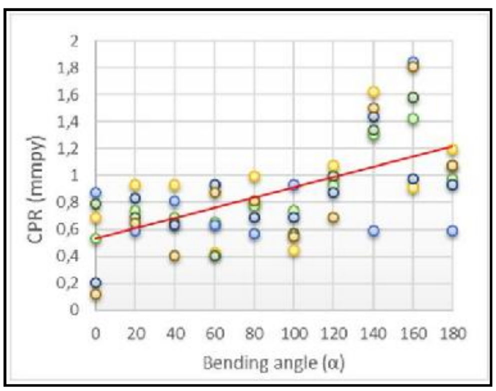


Figure 4.4 Corrosion rate vs bending angle

In the Figure 4.4 presented the relationship between the bending angle and rate of corrosion. Starting from concrete reinforcing steel corrosion rate that is not bent, until the bending angle of 160°, the corrosion rate tends to increase and reached the highest value on the bending angle of 160° with the average value reached 1.4246mmpy. In the bending angle of 180°, the corrosion rate of return lower than the bending angle of 160° with the average value obtained at 0.09741mmpy. The trend of the data in the figure showed an increasing of corrosion rate to the magnitude of the bending angle. The increase in the rate of corrosion is caused by the increase in the percentage of plastic deformation due to the increasing size of the bending angle.

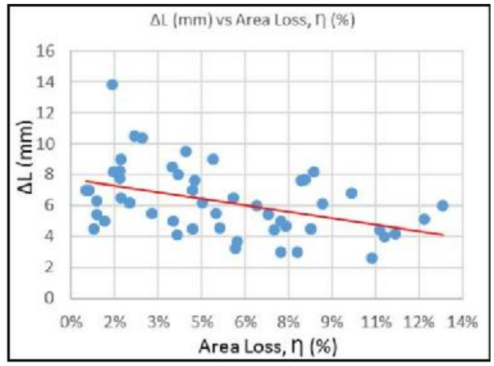


Figure 4.5 Elongation vs the percentage of area loss

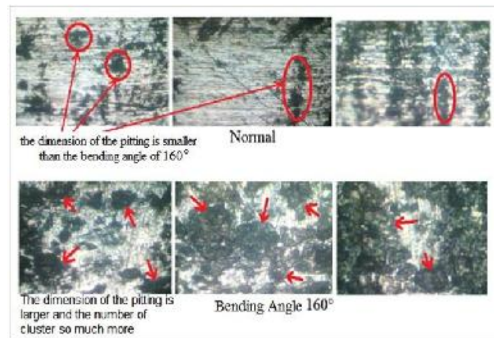


Figure 4.7 The compare macrostructure (magnitude 50x) of normal specimen with bending angle 160°

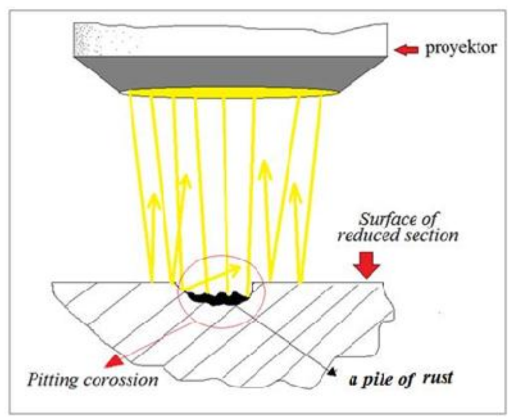


Figure 4.8 Macro structure observation mechanism with optic microscope

5.0 CONCLUSION

The specimens were immersed in the peat water. The increase of tensile strength value (yield strength, tensile strength and maximum breaking strength) does not exceed the group of reinforcing steel where the specimens were not soaked. The highest increase of yield strength due to bending and peat soaked in the peat water is at bending angle (α) of 180° at 18.01% with an average value of587.1286MPa. The highest increase of maximum tensile strength due to bending and peat soaked in the peat water is at bending angle (α) of 180° at 4.76% with an average value of 676.8660MPa. The highest increase of breaking strength due to bending and peat soaked in the water is at bending angle (α) 40° at 6.5% with an average value of 560.0266MPa. The elongation value of reinforcing steel that has been soaked showed a significant reduction in the magnitude of the angle of bending compared to the specimens were not soaked. The highest decline lies in the bending angle (α) of 180° with an average elongation value of 6.67%. As evidenced by the observation of the macro structure of the bending angle of 160°, that is found pitting craters formed on the surface of the specimen to corrosion. This also applies to the other bending angle which saw a decrease in tensile strength values for some of the bending angle including the angle (α) 180°. In the specimens with the highest rate of corrosion pitting was found more number and dimensions of craters larger than the surface of the specimen with the lowest corrosion rate. This causes a lot of stress concentration occurs resulting in lower energy absorption due to the loading time of tensile testing. This led to a decrease in energy absorption decrease in tensile strength and elongation as increasing the size of the bending angle.

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