Innovative products of concrete steel bone testing tools in the field of civil engineering building

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Abstract. Bending test is one type of material testing conducted to determine the mechanical properties of a technical material. In designing this bending test required a standard design method that uses standard machine elements as well as commonly found in the market. In practice in the field, there are only a few materials testing practitioners who pay attention to aspects and effects of variations in the dimensions of the test specimen on the data from the test results. The test is carried out with the intention to obtain information about fulfilling the quality requirements and the feasibility of the material to be used as construction material for buildings, bridges and other physical buildings. As for one application that can be done is to look at aspects of the problems that are around that are associated with practicum activities in the laboratory and in the work industry. Therefore it is necessary to adjust between making the final report with the needs needed in the industrial world. For this reason, the bending test is made to study the effect of dimensional variations on test specimens in arcing testing. For this reason, this study with the title "Innovative Products for Concrete Reinforcement Steel Curved Test Equipment in the Field of Building Materials in the Department of Civil Engineering" is very important to do. The research was conducted to improve the performance of tools in the building materials laboratory. The final results of the study are expected to function optimally and easily used for laboratory work.

1. Preliminary

1.1. Background
In this modern era many technologies have been developed to make it easier to support development. With the rapid development in Indonesia, the existing facilities such as the construction of buildings, hotels, supermarkets, homes and other buildings, so that more and more that require the use of concrete iron as the foundation framework of the building.

One way to strengthen buildings, especially concrete construction buildings that are widely known is to use reinforcing steel as reinforcement. Because the use of reinforcing steel is very closely related to the security and safety of buildings and especially the people around it, the government has determined that reinforcing steel produced and used in Indonesia must meet the concrete steel quality standards based on the Indonesian National standard, SNI 2052- 2014.

Reinforcing steel is a very important material in construction, especially in reinforced concrete construction is unavoidable considering reinforcing steel is one of the main determinants in the strength or failure of construction.
The bending and modulus of elasticity test on a material is carried out using a load where the main stress is in the form of bending. The modulus of elasticity in bending and tensile or compressive tests will experience a slight difference even though the specimens are the same. That is because the modulus of elasticity in the tensile or compressive test is in one direction, namely the tensile or compressive direction. Whereas in the bending test, the modulus of elasticity is in two directions, namely tensile and compressive.

So the research team wants to create a tool for testing that is the bending test, so the research team hopes that with this bending test tool we can find out the curvilinear strength of the products on the market even though it may not be fully. This curvilinear test tool (bending) can test products such as concrete reinforcement steel.

1.2. Research purposes
The proposed research has the aim to make the design of concrete reinforcing steel arch test equipment to support practicum equipment in the building materials laboratory. For specific purposes is:
- Making concrete reinforcing steel arch test equipment tangible and ready to use for the benefit of practicum in order to function optimally.
- Design of curved test equipment that has good performance.

In this overall stage it provides three measurable outcomes as contributions, namely:
- Prototype modification of concrete reinforcing steel arch test equipment.
- SOP (Standard Operating Procedure) or steps in operating the equipment.
- Publications in scientific journals and drafts for the submission of IPR.

1.3. Innovation
This research is an additional development as a support tool for building materials laboratory practicum test in Semarang State Polytechnic Department of Civil Engineering.

1.4. Urgency
With this research, it is expected that urgency can be realized in the final results of this study, namely:
- Improving the quality of practical learning in the building materials laboratory of the Semarang State Polytechnic Civil Engineering Department.
- Adding a collection of tools in the Laboratory of Building Materials, Civil Engineering Department, Semarang State Polytechnic.

2. Literature review
2.1. Bending test definition
Curvature test is one form of testing to determine the mechanical ability of a material that can be seen visually [1]. In principle, this test is done to measure the strength of the material due to axial loading that can be seen from the shape and deflection that occurs in the specimen at a certain unit of length between the support / support. The bending test (bending test) is a process of testing the material by pressing to get results in the form of data about the bending strength (bending test) of a material being tested.
2.2. Basic theory of bending
Bending is a process of plastic deformation of a metal against a linear axis with little or no change in surface area [2]. A piece of iron can be bent using a press machine. This bending process usually uses a die in the form of V, U, W or other patterns. The bending process causes the metal which is on the outside of the neutral axis to pull, while on the other side experiences pressure.

2.3. Bending test process
Bending process (Bending) is a work by putting pressure on a particular part so that plastic deformation occurs on the part under pressure [3]. While the bending process is the process of bending or bending using a manual bending tool or using a bending machine.

The bending process that works on the design of this tool, which is adopting techniques or bending processes by means of rotary or rotation contained in the pipe bending machine. Then the types of bending machines that will be used when designing and building will be explained at the next point.

2.4. Definition of concrete reinforcement steel
Concrete reinforcement steel is steel in the form of a circular rod that is used for reinforcing concrete, which is produced from billet raw material by hot rolling [4]. Based on its shape, concrete reinforcing steel can be divided into 2 (two) types, namely plain concrete reinforcing steel and fin / threaded reinforcing steel.

![Figure 1. Plain concrete and fin steel reinforcement.](image)

2.5. Physical-mechanical characteristics of reinforcing steel
The mechanical properties of a material including reinforcing steel become information parameters in the basic design of a material's strength and as supporting data for material specifications [5]. The mechanical properties of a material obtained from a tensile test result give a bigger picture than other mechanical tests, including the parameters of yield stress (deformation), tensile strength, breaking stress, strain, modulus of elasticity, percentage increase in length, percentage reduction in size, toughness, plasticity, elasticity, plasticity, yield type and fracture shape experienced by material.

Other material properties can be obtained from impact tests that produce toughness, hardness tests that provide information about the resistance of a material when penetrated by other objects and have a correlation with tensile testing, and bending tests which provide information about material plasticity.

The mechanical properties of a material need to be well known, because the material is used for various purposes in various circumstances. Mechanical properties are determined by the type and comparison of the atoms that compose the material which includes the types of elements and their composition, and the environment at the time of testing in obtaining mechanical properties [6].

2.6. Research road map
Research road map in this research can be seen in figure 2.

![Figure 2. Research road map.](image)
3. Research methods
In accordance with the objectives of the study, namely, to make a pendrol plug, carried out by the following methods. The research begins with the preparation of materials and design of work drawings. Construction of a foundation, support pillars, permanent support and foundation. Continuing the initial hydraulic push jack assembly and hydraulic pressure booster system.

Manufacture of tanks and oil pipe installations, pressure regulating faucets and curved test object mounting aids. Furthermore, the arrangement of electric motors, pressure gauge dial and other electrical accessories. The final stage after everything is installed is tested by the tool. The research flow process can be seen in the following flowchart.

3.1. Flowchart
Flowchart in this research can be seen in figure 3.

![Flowchart](image)

Figure 3. Flowchart research implementation flow.

3.2. Place and time of research
The study was conducted in fiscal year 2019 in the laboratory and workshop majoring in civil engineering Semarang State Polytechnic which is located at JL. Prof. Soedarto, SH. Tembalang, Semarang.

3.3. Equipment material
The materials needed in this study include: plain concrete iron, screw concrete, bottom foundation, support pipe, hydraulic jack, hydraulic pressure strengthening system, top runway, electric motor, pressure speed regulating valve, load gauge manometer.

3.4. Research equipment
Equipment used in this study include: welding machines, lathe equipment, drilling machines, screw making equipment, painting equipment.
3.5. Drawing of proposed tool design
Proposed tool design in this research can be seen in figure 4.

![Proposed Tool Design](image)

**Figure 4.** Proposed tool.

3.6. Data analysis
Data of laboratory test results in some time needed in one test compared to the conditions before the concrete bearing bending test equipment is shorter and the calculation is more optimal.

3.7. Stages in research
The steps in testing include:
- Prepare a bending test device according to the size settings on the diameter
- The material being tested is buckled according to the diameter size
- Prepare the bending needle according to the size of the diameter of the steel bar
- Begin the buckling testing process with the condition that the sample being tested results bend at an angle of 180 degrees (U-shaped)
- Start the buckling test process.
- After finishing the test, bending the results of the test diameter is seen visually with a magnifying glass. Can be seen in the print out of the test results the results are okay or broken.

4. Results and discussion

4.1. Research results
The result in this research can be seen in figure 5 - figure 20.

![Team Installing Test Equipment](image)

**Figure 5.** The team is installing the test equipment that has been modified.
Figure 6. The test object is attached to the modified test equipment.

Figure 7. Installation of test specimens before testing.

Figure 8. Test object results after testing.

Figure 9. Output results from testing.
Figure 10. The test object is the result of testing.

Figure 11. Specifications of objects to be tested.

Figure 12. Initial test table.
Figure 13. Test results with a diameter of 8 mm.

Figure 14. Test results with a diameter of 10 mm.

Figure 15. Test results with a diameter of 13 mm.
Figure 16. Test results with a diameter of 16 mm.

Figure 17. Test results with a diameter of 19 mm.

Figure 18. Test results with a diameter of 22 mm.
4.2. Discussion

- All the reinforcing iron that will be bent / bending is tested its tensile strength in order to obtain the Stress yield in units of Kgf / mm².
- Prepare a bend test according to the size settings on the diameter
- The material being tested is buckled according to the diameter size
- Prepare the bending needle according to the size of the diameter of the steel bar
- Begin the buckling testing process with the condition that the sample being tested results bend at an angle of 180 degrees (U-shaped)
- Start the buckling test process.
- After finishing the test, bending the results of the test diameter is seen visually with a magnifying glass. Can be seen in the print out of the test results the results are okay or broken.
- If it is observed getting cracks and even broken results, the reinforcement is recommended not to be used in buildings.
5. Conclusion

- BJTP reinforcement 8 mm in diameter. Yield Stress results are 30,070 kgf / mm². With conclusions OK / good buckling results.
- BJTP reinforcement iron 10 mm in diameter. Yield Stress results are 47,409 kgf / mm². With conclusions OK / good buckling results.
- BJTP reinforcement diameter of 13 mm. Yield Stress results are 49,876 kgf / mm². With conclusions OK / good buckling results.
- BJTP reinforcement diameter 16 mm. Yield Stress results are 45,240 kgf / mm². With conclusions OK / good buckling results.
- BJTP reinforcement diameter 19 mm. Yield Stress results are 47,370 kgf / mm². With conclusions OK / good buckling results.
- BJTP reinforcement 22 mm in diameter. Yield Stress results are 50,779 kgf / mm². With conclusions OK / good buckling results.
- BJTP reinforcement 25 mm in diameter. Yield Stress results are 48,996 kgf / mm². With conclusions OK / good buckling results.
- BJTP reinforcement 32 mm in diameter. Yield Stress yields 42,490 kgf / mm². With conclusions OK / good buckling results.

From the conclusions of the test, for all concrete reinforcement diameters, if the tensile test results where Yield Stress <55,000 kgf / mm², it will get a good buckling test result.

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