

Square Bar Bending Chasis for Indonesian Rural Transport Vehicles “Static Analisis & Testing”

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ABSTRACT: Chasis is an important part of the vehicle, because it will be to support of all the loads on it, ranging from engine, vehicle body and human or goods transported. In this paper we will describe the results of static analysis and static test of chassis of rural transport vehicles according to maximum load. Structure strength analysis is performed at 10 (ten) points along the chassis that are considered critical by using Ansys software which is followed by static test. Ansys analysis results show that the deformation behavior is linearly proportional to the load cause up to 2500N. For bending load, chasis deformed of 1.37 mm dengan a maximal voltage of 268.39 MPa. For torque load, chasis deformed of 5.045 mm, at two side. Result of static test, deformation behavior also linear proportional to load cause up to 2500N. for bending load, chasis deformed of 12 mm and for torque load, chasis deformed of 7.5 mm, at two side. Difference value deformation between ansys simulation and static test is likely due to the simplification of some parameters when simulated with ansys and the existence of changes in the microstructure in chasis material, when done hot bending process is seen from the location of a very large strain occurs in strain gauge no 1,2, 5 and 6.

KEYWORDS: Chasis, Static analisis, Static test, Deformation.

I. INTRODUCTION

Rural transport vehicles are vehicles designed to be used in rural areas of Indonesia. Its main function is as a vehicle for transporting crops and / or increasing the mobility of people in rural areas. Thus, the vehicle chassis is an important part that must be designed in such a way as to be able to pass through rural road terrain. In the paper will be reported the results of analysis and test prototype chassis rail transport vehicles are designed to build with bending method. Bending is a metal working process where objects with straight shapes are converted into curved or curved shapes [1]. Usually this process uses the aid of a press machine. The accuracy of the resulting product will greatly depend on the quality of the press dies and the sheet metal, but the production speed depends on the speed up from the slide (ram) of the press machine or often called SPM stroke per minute. The type of press machine used in the industry can be classified by the type of propulsion of the slide, the mechanical press (mechanical press) pneumatic press [2] and the hydraulic press [3][4]. The press machine can be classified also based on the mechanism used to operate the mold, ie crank press, knuckle press, friction press, screw press, and link press. Mean while, based on the number of machine slide action (number of action), press machine can be classified as single action, double action, and triple action. Then the types of press machines can also be classified based on the direction of the movement of the mold (die operation direction), namely vertical, horizontal, and oblique. In this research, the type of dies used for the rearing of rural transport vehicle chassis is a type of hydraulic press machine with a motion mechanism using hydraulic with horizontal movement.

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In this paper will be discussed static analysis and static test of chasis prototype which is fabricated with bending dies method of hydroulic machine. Section III will discuss the meshing & boundary conditions, the static load analysis model performed with the Ansys software will be discussed in section IV, while eksperimen the static test on the prototype is done by giving the loads hydroulically discussed in section V. Finally, Section VI presents conclusion.

II. RELATED WORK

A. Hari Kumar CS [5] used ANSYS 14.5 Softwareis to find out best material and most suitable cross-section for an Eicher E2 TATATruck ladder frame chasis with the constraints of maximum shear stress, equivalent stress and deflection of the chasis under maximum load condition. Dhandapani Cs [6] performs a torque load analysis by providing a load on the front and the back of the dump truck chasis, diagonally vertical upward and vertical downward directional loads acts on the chasis. In this research the torque load test is performed only on the front of the chasis, by giving the load on two sides of the frame opposite, while the back of the chasis is clamped.

To measure the torsional stiffness, Mr. Navnath V. Cs [7] used two dial indicators was used at front end to measure the opposite resultant vertical deflection at the left and right front knuckles and two at rear end. The load was added at load at the side rear right to avoid the tilting of test rig and fixed the rear part of test rig. The chasis is twisted in increments by loading masses at load at the side front left in steps with deflection data recorded by using dial indicator at each step at front and rear side. After adding the load equal to require torque final deflection was measure and then the twist angle is reversed until reaching zero by unloading masses in steps. In this research, to know the magnitude of deformation and strain occurring on the chasis as a result of static load bending and torque, it will be measured with a strain gauge and dial indicators sensor. Placement of strain gauge sensors on chasis is done based on the critical position obtained from ansys simulation result.

III. MESHING AND BOUNDARY CONDITION

By using SS400 carbon steel material, which has a maximum tensile strength of 450 MPa and a yield stress of 250 MPa, Numerical computation with the model, configuration and loading conditions as described above. The simulation is done using Ansys software and with loading parameter. The first step is to create a 3D model image of the rural transport vehicle chasis structure with the addition of areas for pedestal and bend loading as follows:

The components of the bending load and pedestal provided include (Figure 1) :

- 1) Bending load of 2500 N (see area C in figure below).
- 2) Fixed staples on the front suspension holder area (see area B in the picture below)
- 3) Roll support on the rear suspension mount area (see area D in figure below).

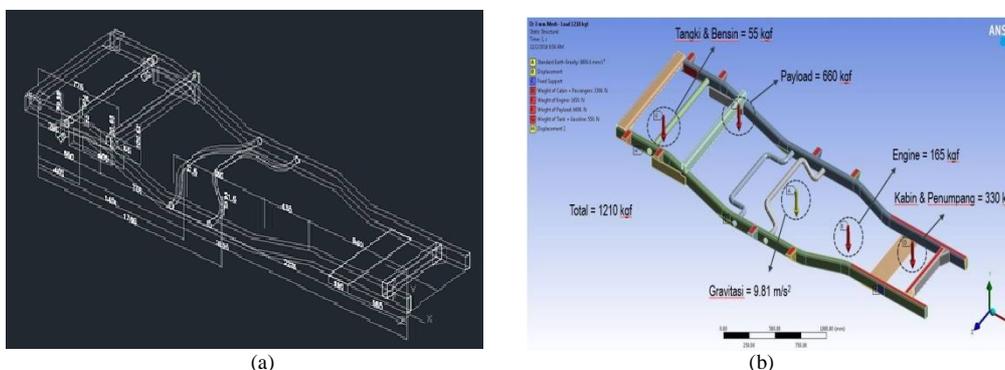


Figure 1. (a) Chassis modeling for load simulation; (b) chasis load distribution

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Figure 2. Form of pedestal and loading configuration on the Rural Transport Vehicle chassis:

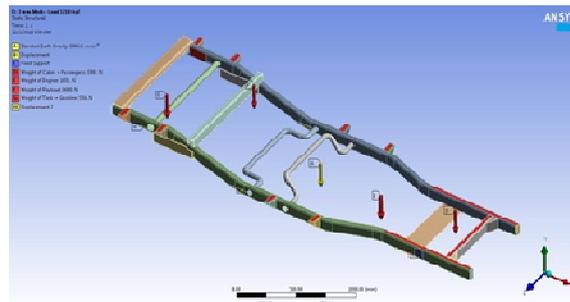


Figure 2. Configuration of pedestal and loading

Performance calculations and calculations are also performed using ANSYS Mechanical software to obtain accurate results and can complete the data of actual bending test results.

3.1. Contact condition

The contact linear type bonded is used to connect between parts of the rural transport vehicle chassis model, thus the connection is conditioned perfectly where the effect of hot bending and welded joint on the strength of the structure is assumed to be not decreased in strength.

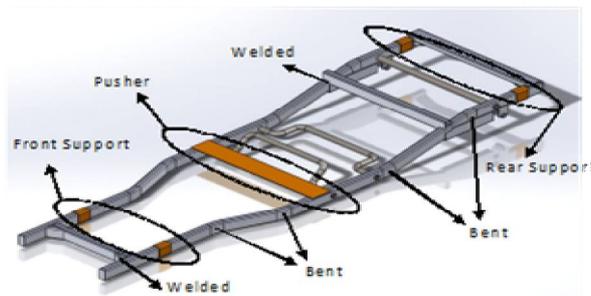


Figure 3. Bending chasis and bonded contact between side rail and cross member

3.2. Mesh Condition

The mesh used is a combination of tetrahedron and hexagonal forms with a density of 920,600 elements, 2,250,704 nodal, and 5,331,300 degrees of freedom.

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Based on the picture above, obtained a maximum tensile strength of 268.39 MPa.

4.1.c. Minimum Security Factor

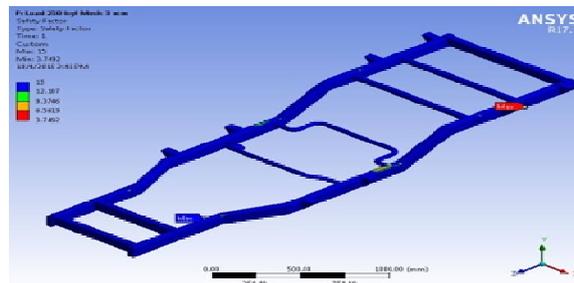


Figure 7. The result of safety factor

Based on the picture above, obtained a minimum security factor of 3.7492.

The results of some chass static load analysis using Ansys software can be seen in Table 1

Table. 1. The result of static load analysis of chassis with Ansys

| No. | Description | Chassis |
|-----|--------------------------|------------|
| 1 | Load | 250 kgf |
| 2 | Meshing | |
| | - density | 920.600 |
| | - Nodal | 2.250.704 |
| | - Degree of freedom | 5.331.300 |
| 3 | Deformation | 1.370 mm |
| 4 | Maximum Tensile Strength | 268,39 MPa |

4.2. Torque Load Analysis

3D_ model drawing of chassis structures with the addition of areas for pedestal and torsional loading as follows:

The components of the torsional load and pedestal provided on the chassis include :

- 1) Torsional load of 250 kgf or 2500 N Torsion loading consists of, left and right torsional racking conditions .
- 2) Fixed clasps on the rear suspension mount area

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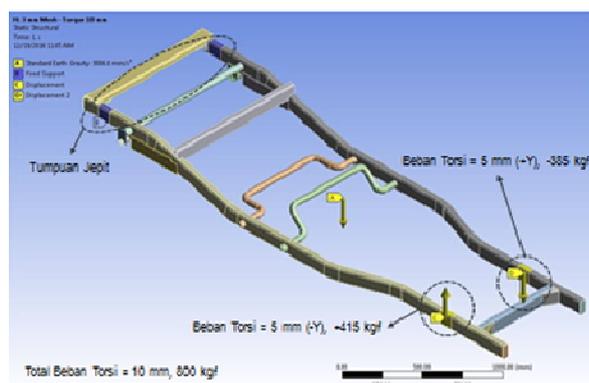


Figure 8. The configuration form of loading on the chassis

The torsional loading component assigned to the rural transport vehicle chassis is based on the result of a previous simulation with a bending load having a load value of 2500 N and a maximum total deflection that should not exceed 10 mm. This loading is given with the intention of being a critical point reference for the mounting of the geuge strain and also as a comparison to the actual torsional test. In the calculation also has been considered the gravity of the earth of 9.81 m/s^2 . Performance that is important to calculate include:

- 1) A torsional load of 2500 N is given to simulate load conditions equal to bending bending.
- 2) 2. Trial and error is performed for the torsional load value so that the maximum deflection achieved does not exceed 10 mm.
- 3) 3. The load obtained is then used as the reference for the actual torsional test load. The load obtained is then used as the reference for the actual torsional test load.

4.2.1. Maximum Deformation

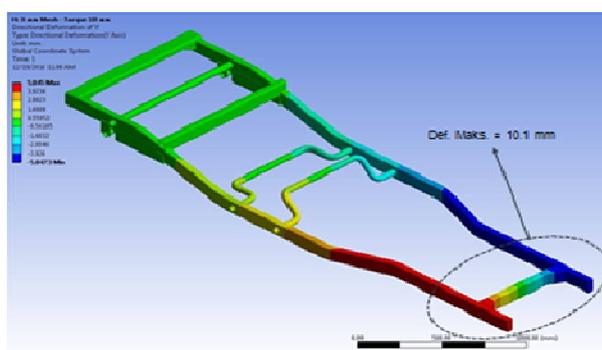


Figure 10. Maximum total deformation results.

Based on the picture above, a maximum total deformation of 5.045 mm is obtained on each side.

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The results of torsion analysis can be seen in Table 2

Table 2. Results of chassis torque load analysis with Ansys

| No. | Description | spesification |
|-----|---------------------|---------------|
| 1 | Load | 250 kgf |
| 2 | Meshing | |
| | - Density | 920.600 |
| | - Nodal | 2.250.704 |
| | - Degree of Freedom | 5.331.300 |
| 3 | Deformasi | 5.045 mm |

V. CONSTRUCTION TEST OF CHASIS

Testing of chassis construction is intended to verify the design result and simulation of numerical computation on the real condition that happened. Testing is done by 2(two) methods, namely static load testing (bending) and torque testing, the following is the design of requirement in testing. To know the magnitude of deformation and strain occurring on the chassis as a result of static load bending and torque, it will be measured with a strain gauge sensor. Design placement of strain gauge sensors on chassis is done based on the critical position obtained from ansys simulation result. Figure 11 shows the strain gauge position on the chassis of the rural transport vehicle.

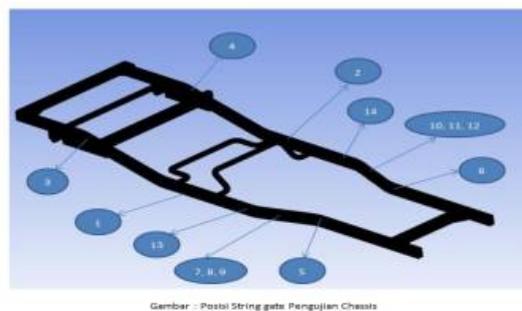


Figure 11. Position of strain gauge sensors on the chassis

As for some test parameters, distance pedestal and maximum load weight can be seen in table 3.

Table 3. Paramater and equipment spesification static and torque test.

| No. | Description | spesification |
|-----|---------------------------|---------------------------------|
| 1 | Distance beetwen pedestal | 3100 mm |
| 2 | Load | Up to 4,5 kN |
| 3 | Number strain gauge | 10 buah |
| 4 | Machine | Hidroulic 1 dan 2 Silinder |
| 5 | Log book | 0.1/data (deformation and load) |

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5.1. Static Test Chassis

The static test (bending) is performed on the center side of the chassis or at the Center of Graviti (CoG) position of the vehicle, with a Deformation limit of 25 mm. Figure 12, shown static test chasis prototipe configuration



Figure 11. (a) Static Test Prototype Chassis, (b) Data Record Equipment

The result analisys data record can be seen in graph of the Force Deformation function on chasis static test, the Figure 12.

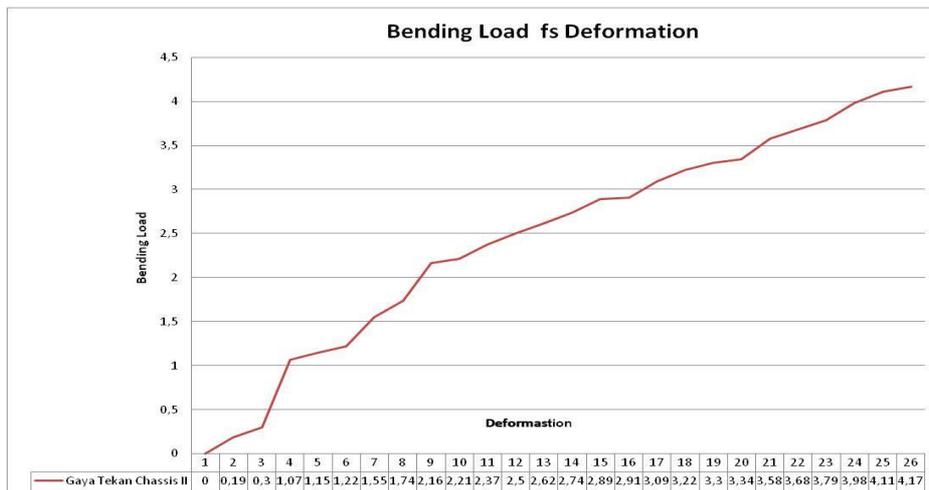


Figure12. Force VS Deformation Graph on Chasis Static Test

The bending test results show that up to 25 mm deformation, the load relation pattern of the deformation function is still linear. At 250 Kgf loading there is a deformation of 12mm. The value is much larger than the simulation analysis (1.37 mm).

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5.2. Torque Chasis Test

Torque testing is performed on the front side of the chassis, with a deformation limit of 6 mm.



Figure 13. Chasis Torque Test

Force VS deformation graph on chasis torque test, the result analysis data record can be seen in the Figure 14

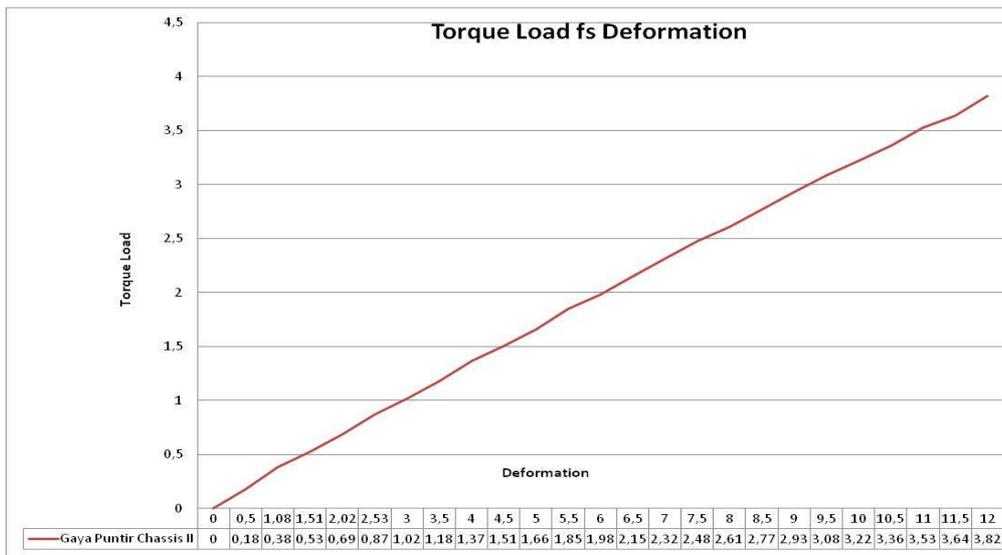


Figure 14 Torque Load vs Deformation Graph on Chasis Torque Test

The torque test results show that up to 12 mm deformation, the load relation pattern of the deformation function is still linear. At 250 Kgf loading there is a deformation of 7,5 mm. The value is also much larger than the simulation analysis (5,045 mm).

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Difference value deformation between ansys simulation and static test is likely due to :

1. The simplification of some parameters when simulated with ansys and
2. The existence of changes in the microstructure in chasis material, when done hot bending process is seen from the location of a very large strain occurs in straingauge no 1,2, 5 and 6.

VI. CONCLUSIONS AND SUGGESTIONS

From some data result of finite elemen analysis and test of chasis bending construction above, can be concluded as follows:

1. Ansys analysis results show that the deformation behavior is linearly proportional to the load cause up to 2500N. for bending load, chasis deformed of 1.37 mm dengan a maximal voltage of 268.39 MPa. For torque load, chasis deformed of 5.045 mm, at two side.
2. Result of static test, deformation behavior also linear proportional to load cause up to 2500N. for bending load, chasis deformed of 12 mm and for torque load, chasis deformed of 7.5 mm, at two side.
3. Difference value deformation between ansys simulation and static test is likely due to the simplification of some parameters when simulated with ansys and the existence of changes in the microstructure in chasis material, when done hot bending process is seen from the location of a very large strain occurs in strain gauge no 1,2, 5 and 6.

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