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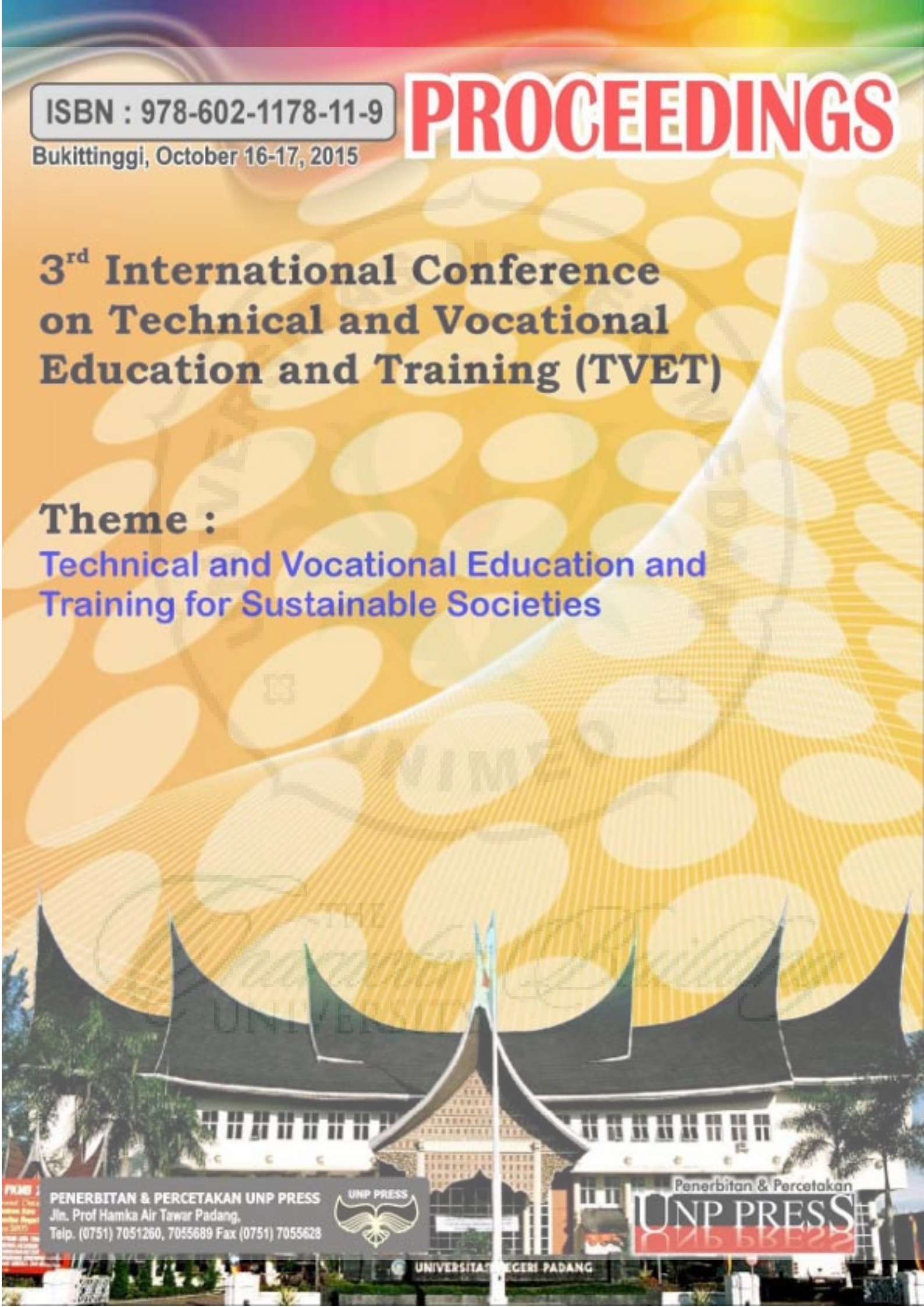
PROCEEDINGS

Bukittinggi, October 16-17, 2015

3rd International Conference on Technical and Vocational Education and Training (TVET)

Theme :

Technical and Vocational Education and Training for Sustainable Societies



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FOREWORDS

This proceeding aims to disseminate valuable ideas and issues based on research or literature review in the field of vocational, technical and engineering studies, which have been presented in 3rd International Conference on TVET. This conference have taken place in Rocky Hotel Bukittinggi West Sumatra, october 16 and 17, 2015.

The theme of Conference focused on the perspective of technical and vocational education and training for sustainable society to face the chalenges of 21st century, globalization era, and particularly Asian Economic Community. To overcome the challenges, we need the innovation and change in human resources development. Vocational and technical education and training have essential roles to change the world of education and work in order to establish sustainable society.

Undoubtedly, TVET need to enhance the quality of learning by developing various model of active learning, including learning in the workplace and entrepreneurship. Create innovation and applied engineering as well as information technology. Improvement of management and leadership in TVET Institution, and develoment of vocational and technical teacher education.

Many ideas and research findings have been shared and discussed in the seminar, more then 70 papers hava been collected and selected through scholars, saintists, technologist, enginers .as well as teachers, profesors,and post graduates students who participated in the conference.

Five keynote speakers have taken apart in the conference, namely Prof. D. Stein Ph.D (Ohio State University-USA), Prof. Yusuke Ono (Tottori University- Japan), and Prof. Nashruddin A. Rahim Ph.D (University of Malaya, Malaysia), and Prof. dr. Ali Gufron Ph.D (Directorate General of Human Resources Development in Higher Education-Indonesia), and Syahril Ph.D (Dean of Faculty Engineering UNP-Padang). They all have a great contributions for the success of the conference.

Finally, thank a million for all participants of the conference who supported the success of 3rd International conference onTVET 2015. and most importantly, our gratitude to all scholars who support and tolerated our mistake during the conference.

Padang, 9 Oktober 2015

Prof. Dr. Nizwardi Jalinus, M.Ed
Chair of Scientific Committee

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IMPLEMENTATION OF IMPACTS TEST AND MODELING SIMULATION OF CAR RIM ON COURSES OF EQUIPMENT ENGINEERING AND MACHINERY

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Abstrak: Collision rim car at high speeds can result in failure, on the surface of the rim which has experienced a failure indicates the solidification structure, it is assumed to occur due to the fluctuating loading. Techniques Split Hopkinson Pressure Bar (SHPB) is a measurement method of impact strength of the most popular today. Modeling simulations using MSC-NASTRAN can predict the failure to find out the stress concentration of failure criterion method. The ability of design on equipment engineering and machine are a requirement of competencies that expected by users of vocational education graduates. From the research results can be informed that during the acceleration of the pace of the ongoing strain on impact test, have an impact like an increase in ultimate strength. simulated rim without load and have been given the burden it is known that the maximum voltage in the critical region. Stress concentration occurs in the trunk area rim and damage/failure rim of car is more dominated by compressive stress but did not rule out the possibility that the dynamic tensile stress very influential to failure of structural components of car rims. Re-design dimensions and geometric of the car rim which is adapted to the mechanical properties of materials can reduce the impact of dynamic impact loads experienced by structural component. Designing alternative machine or modified, develop the design, such as setting dimensions, shapes based on mathematical equations is more effective to be done by using the software of Solid Work and MSC-NASTRAN.

Key words: Dynamic impact, Modeling simulation, SHPB, Solid Work, MSC-NASTRAN.

1. INTRODUCTION

Quality graduates of higher education is an important requirement to enter the global competition, limited opportunities to enter employment for university graduates either because the impact of economic conditions in the country as well as the automation of the company / industry in the future, then the demands for higher education graduates able to creat their own job opportunities are key factors. Creation of employment opportunities can only be realized if they have high competence. Thus, how the learning model can be developed to produce quality graduates, in the sense of competence corresponding to industrial expertise required.

Panitz (2004) confirmed the collaboration as an interaction of philosophy and lifestyle is not only seen as a classroom management technique. Thus the collaboration based learning can also be seen as a social interaction that combines the objectives that have been agreed and the distribution of knowledge within a group. Thus through social interaction, students are expected to explain the concepts, theories, ideas and thoughts in a group to complete a job [1].

Dynamic impact test and the design of structural components using simulation modeling is one of the studies on the subject of equipment engineering and machines. Collaborative learning model used to study the case of a failure of a car rim. Failure rim car suddenly cracked /broken could result in accident.

In general, car rim material is aluminium alloy, where aluminum is classified in soft and brittle material.

Rim can not be used again when broken, cracks, corrosion or defects in the locking ring, rim flange, groove lock ring on rim, the surface of the rim facing the flap or rim base, nut hole.

Such phenomenon can be regarded as a failure that occurs in a state of dynamic loads is called the fatigue failures, generally these failures occur only after long usage periodik[2].

Loading fluctuate continuously on the structural components of aluminum materials has resulted in fatigue. This brings a negative effect on the material, namely a decrease in the mechanical properties and the occurrence of undesired fatigue crack. So that when the component receives impact loads (high strain rate), then it is feared will happen fracture in the area of the fatigue crack. Therefore it is necessary to do a series of impact tests on the material of aluminum as the car rim material that has experienced fatigue in order to know how much reduction in impact strength occurred. Is the decline in impact strength occur significant or not.

The achievement of the quality of higher education graduates especially vocational education

surely must have the skills and specific skills, therefore therefore the approach of collaborative learning model in car rim failure study from implementation the impact test and modeling car rim using MSC-NASTRAN simulations to know the amount and concentration of stress which causes failure on car rim.

2. Literature Review

2.1. Failure Identification

A component or device is declared a failure / damage, if the device is not fully operational or still able be operated, but it is not able to provide the satisfaction of performance as a function planned, or the situation has deteriorated seriously, so to arrive at a condition that makes it no longer reliable or unsafe to be forwarded the operation.

Conditions that can cause damage that is when working stress such as tensile, compressive stress, bending stress, torsional stress, shear stress or a combination thereof in excess of the planned load.

In this study prioritized on failure caused by fatigue failure, in general there are three basic factors that caused the failure-weary, namely: (1) the maximum stress is high enough, (2) variations or fluctuations in stress is large enough, and (3) cycle of implementation is large enough[2]. In addition there are a number of other variables, namely: stress concentration, corrosion, temperature, overload, metallurgical structure, residual stresses, and stress combinations that are likely to alter the conditions of fatigue.

2.2. The Stress on Rim

according to the cases that have been identified in the subject matter in the form of failure (fracture) on a car rim which is expected due to the loads received by the rim, it is necessary to analyze the internal stress on the rim[1]-[3]. Besides internals stress can also be sought from von mises stress maximum and minimum during the cycles loading is given, where the stress that occurs is σ_m and *amplitude* stress is σ_a, [4].

2.3. Fatigue

Fatigue failure is very dangerous, because it happened without the initial instructions. Fatigue resulted in fractures that look fragile, with no deformation at the fracture.

However, a wide range of criteria used to count and calculate the fatigue failure, for example, Goodman and Gerber's criteria [4].

Fatigue that occurs in metals has been studied for more than 150 years ago. One of the early researchers but not the first, namely August Wohler, in the period from 1850 to 1875 various experiments have been carried out in order to obtain a safe alternative stress so the failure will not occur. Almost a hundred years researchers have shown in experimental efect andi some variables that affect to the length period of metal strengthi [5].

S-N method is an approach that was first used in an attempt to understand and calculate the metal fatigue. This method has become the standard method for the design of fatigue during a period of nearly 100 years[4]. Approach with S-N method is still widely used in design applications where the stress that occur into a major factor and is within the elastic limit of the material and the resultant very long service life.

The basis of the stress-life method is a diagram S-N also called Wohler diagram depicting alternate stress (S) against the number of rounds until broken (N). The most common procedure for getting data S-N is through testing Rotating Bending and Axial Tension [6]-[7].

2.4. Impact

One method of measuring the impact strength of the most popular today is the method Split Hopkinson Pressure Bar, which uses long rods elastic to study the compressive stress generated by the impact of a bullet or blast explosives[8]. In this equipment, Hopkinson concludes that during the press rod is elastic, the displacement in the press rod directly related to stress, and that the length of the stress waveform in rod corresponding to the time of impact.

Stress wave is a mechanical wave, the waves require a medium to transmit it. The speed of propagation of a wave is determined by the properties of the media path.

From the theory of one-dimensional elastic wave propagation known [9]-:

$$u = c_0 \int_0^t \varepsilon dt' \qquad (1)$$

where u is the displacement at t time, c_0 is elastic wave velocity and ε is the strain. Displacement u_1 on the inputs rod surfaces is the second result of an incident pulse strain ε_i through x positifs area and reverse stress pulse ε_r through x negatifs area. So that:

$$u_1 = c_0\int_0^t \varepsilon_i dt' + (-c_0)\int_0^t \varepsilon_r dt' = c_0\int_0^t (\varepsilon_i - \varepsilon_r)dt' \quad (2)$$

In the same way, the displacement u_2 on the surface of the rods incident can be obtained from the incident pulses transmitted strain ε_t as follows:

$$u_2 = c_0\int_0^t \varepsilon_t dt' \quad (3)$$

Thus, the nominal stress in the specimen is;

$$\varepsilon_s = \frac{u_1 - u_2}{l_0} = \frac{c_0}{l_0}\int_0^t (\varepsilon_i - \varepsilon_r - \varepsilon_t)dt' \quad (4)$$

where l_0 is initial length of the specimen. The above equation can be simplified further if we assume that the voltage passing through the specimen is constant. With this assumption:

$$\varepsilon_r = \varepsilon_i - \varepsilon_t \quad (5)$$

and by substituting into the equation (4), the obtained:

$$\varepsilon_s = -\frac{2c_0}{l_0}\int_0^t \varepsilon_r dt' \quad (6)$$

Load that goes in P1 and P2 at each edge of the specimen is:

$$P_1 = E\,A\,(\varepsilon_i + \varepsilon_r) \text{ dan } P_2 = E\,A\,\varepsilon_t$$

Then the average stress tha goes into the specimen (σ_s) is:

$$\sigma_s = \frac{P_1 + P_2}{2A_s} = \frac{1}{2}E\left(\frac{A}{A_s}\right)(\varepsilon_i + \varepsilon_r + \varepsilon_t) \quad (7)$$

where E is modulus elasticity of the rod press, A/A_s is a cross-sectional area ratio between the rods press with the specimen. Again, using equation (5), can be simplified into:

$$\sigma_s = E\left(\frac{A}{A_s}\right)\varepsilon_t \quad (8)$$

2.5. Learning Collaborative

Skills needed by participants who participated in the collaborative learning model is illustrated in Figure 1[10].

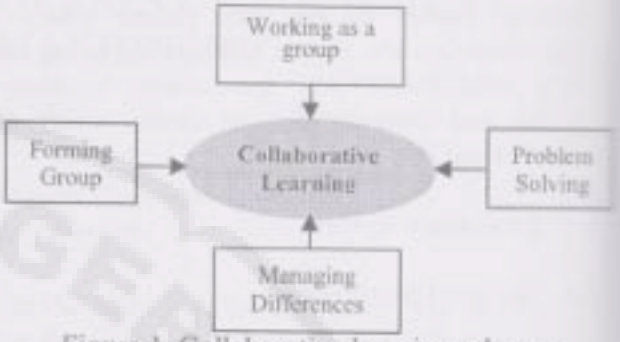


Figure 1. Collaborative learning scheme

The learning model based collaboratives for students of Mechanical Engineering in the field of production is through several phases, namely agreements, exploration, transformation, presentation and reflection [11]-[12].

3. Method

The method in this study using the Research and Development oriented in a product. Research and Development is a strategy or research method that powerful enough to improve practice[13].

The early stages of this research by identifying the characteristics of the material used in the dynamic impact test. Then impact test results as the input data in the simulation process using Solid Work software and MSC-NASTRAN.

The material used in this study is aluminum alloy round bar. The dimensions and geometry of impact test specimens are shown in Figure 2.

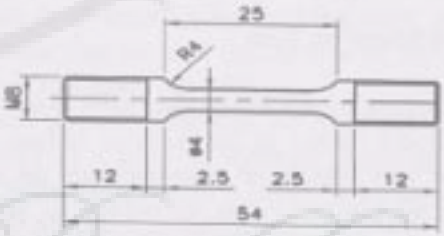


Figure 2. Impact test specimens

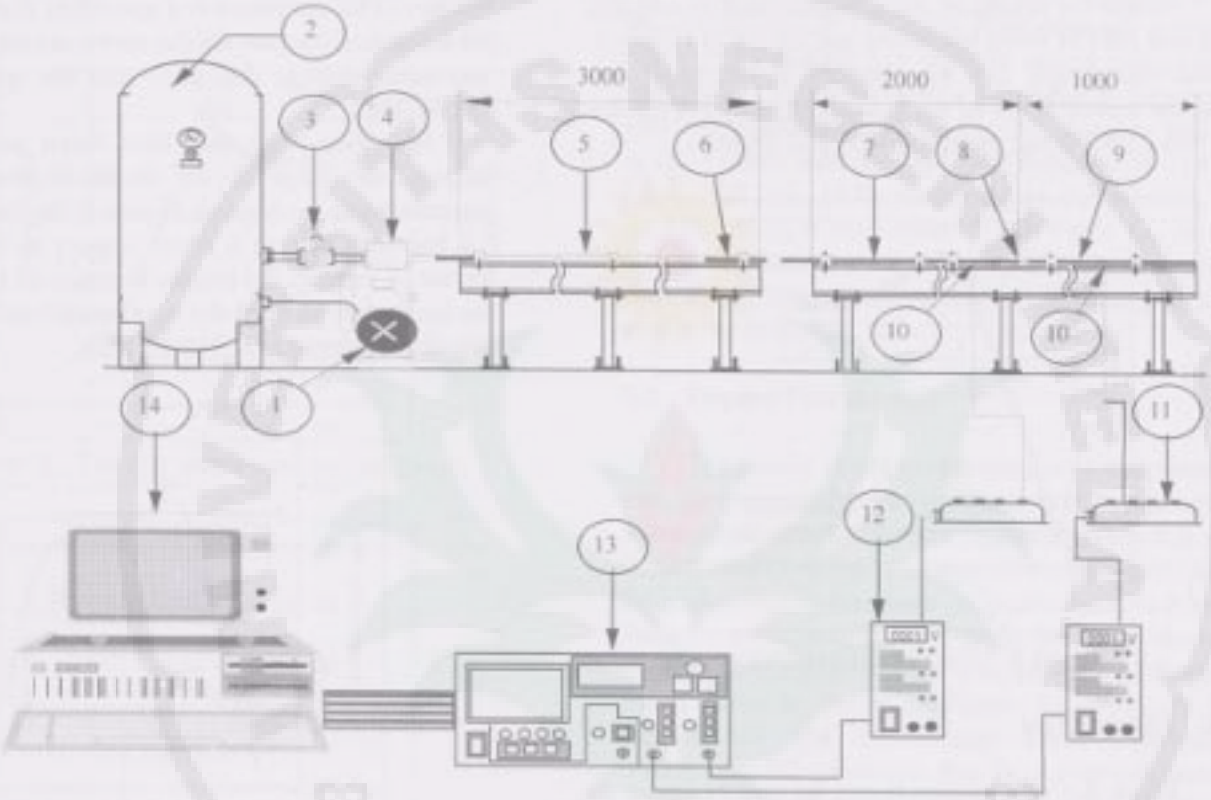
3.1. Impacts test

In principle, this equipment consists of a rods beater and two rods press Hopkinson that placed in line at the top of a stiff beam as illustrated schematically and detail in Figure 3 and Figure 4.

Specimens flowed into the input rod and the rods incident. A split-shoulder or collar enveloped threaded specimen until becoming rod press binding tight against the collar. Pulse waves pressure will entry pass *collar* even though without specimen, then Pulse waves pressure continues to spread until reach the free edge of the rods incident.

At this edge, The waves are reflected and propagates in the form of pulse tensile stress (σ) and pass by strain gage.

compressive stress past by around the specimens are not able to receive and channel the pull wave due to the collar does not have a strong bond with these rods.



1. Compressor
2. Air tank
3. Pressure Regulator
4. Solenoid Valve
5. Pipe barrels
6. Impact Bar
7. Input Bar
8. Speciment
9. Incident Bar
10. Strain Gage
11. Bridge Head
12. Signal Conditioning
13. Transient Converter
14. Personal Computer

Figure 3. Set-up impact test

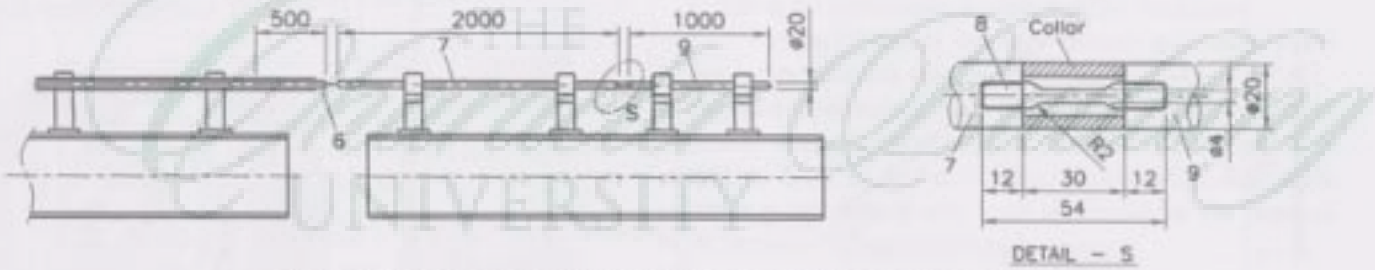


Figure 4. Details arrangement of Split Hopkinson Pressure Bar

Pull pulse wave partially transmitted through the specimen and partly reversed to rods incident. It should be noted that the collar has channeled

4. Results

4.1. Verification Test

Graph the results of static tensile tests on impacts test and ASTM E466 specimen, are shown in Figure 5. From this graph can be obtained information that utimate tensile stress of the aluminum alloy has a price of 454.33 MPa and yield stress of 322.68 MPa.

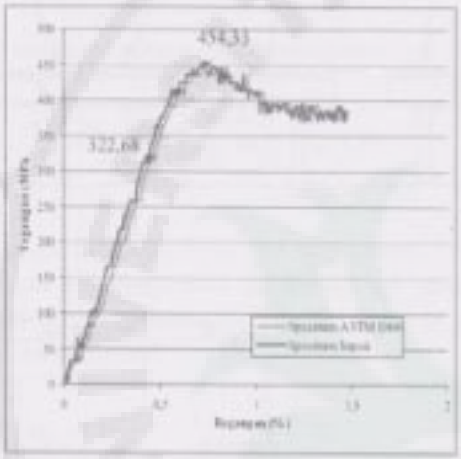


Figure 5. Graph verification test

4.2. Fatigue Test

From the test results it can be a S-N curve as shown in Figure 6, where the endurance limit obtained is at 143 MPa of amplitudes stress. At this point specimens have been saddled with more than 107 cycles and do not undergo fracture. At this point the material aluminum alloy car rims lokalan product has a maximum life time.

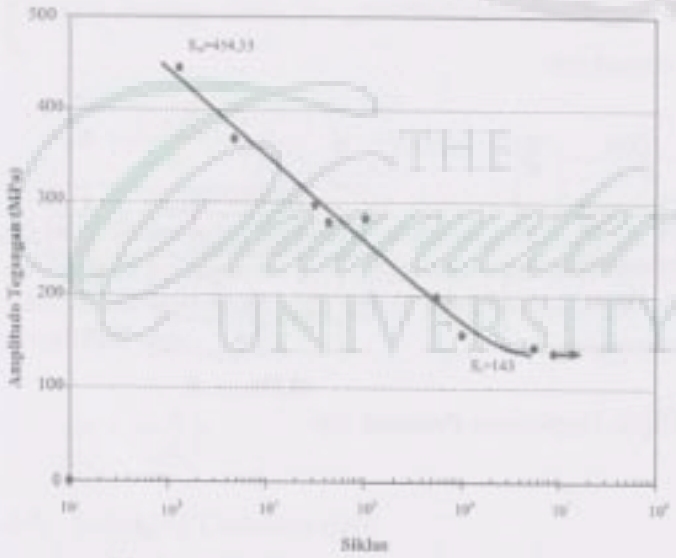


Figure 6. S-N Curves for AA2024-T3

4.3. Impact Test

Incident stress curve shown in Figure 7 is the shape of a curve of a specimen that has suffered fracture. This specimen is a specimen that is not given the burden of fatigue. Of the curve can be read that the maximum voltage that goes into the specimen is at 482.32 MPa.

For specimens that have been burdened with fatigue, the shape of the incidents pressure curve generated can be seen in Figure 8. In the pressure of 0.4 bar with having a lower impact so the specimen fractured, namely the impact distance of 100 mm. And the curve can be read the maximum incident pressure into the specimen is at 312.61 MPa.

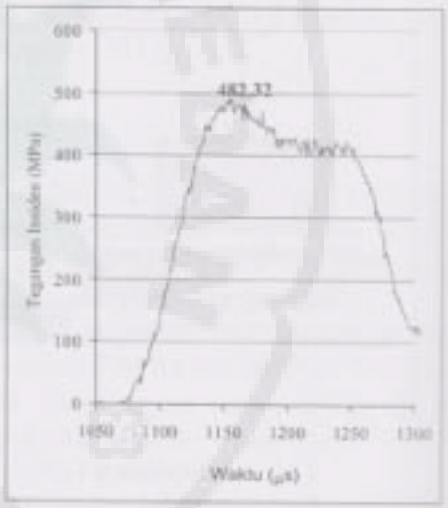


Figure 7. The incidence stress graph of time for the specimens non-fatigue

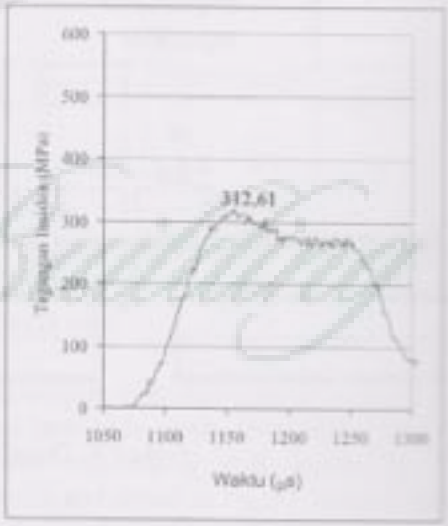


Figure 8. The incidence stress graph of time for the specimens pre-fatigue

The specimens that are not burdened with fatigue and successfully recorded the results of the test were

...in the form of stress-strain curve, obtained an ...value of 482.32 MPa (Figure 9) with a ...deviation of 5.25%. Then for specimens that ...been burdened with fatigue, average value of ...MPa (Figure 10) with a standard deviation of ...

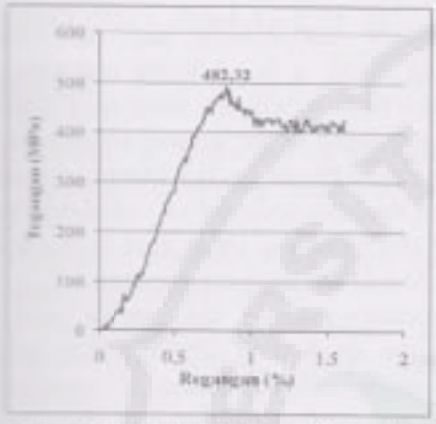


Figure 9. Tension-stress *non-fatigue* curve

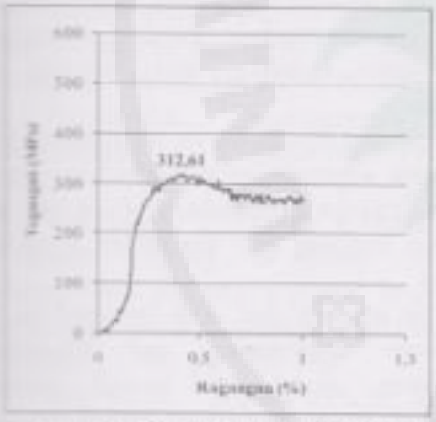


Figure 10. Tension-stress *pre-fatigued curve*

MSC-NASTRAN Simulation

Before analyzing the stress concentration using ...MSC-NASTRAN simulation, the modeling of car ...according to the data field needs to be done using ...software Solidwork (Figure 11).

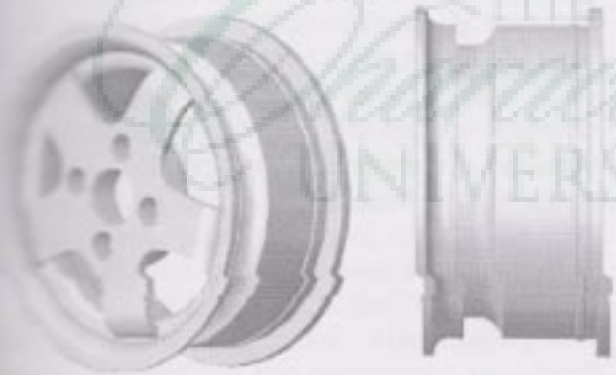


Figure 11. Re-design of cars rim model

5. Discussion

5.1. Fatigue Test Results

S-N curve shown in Figure 6 informs the endurance limit of 380 MPa. If we compare it with the result of the fatigue test of static tensile test as shown in Figure 5, it can be seen a relationship between the ultimate tensile strength (S_{ut}) with endurance limit (S_e) in accordance with the statement Itabashi, M [14] and Chao, Y.J., etl., [15]. According to Bannantine, Julie A., [5] that S_e is equivalent to half times S_{ut}. In other words, the endurance limit of 143 MPa was smaller than a half times its ultimate tensile strength, which amounted to 454.33 MPa.

5.2. Impact Test Results

The results of impacts testing have been obtained can be compared to a literature that becoming this research reference. Namely research conducted by T. Yokoyama[7]. A typical stress-strain waveform shown by Yokoyama in his paper is almost equal to a typical voltage waveform incident and the time shown in Figure 7 and Figure 8. Likewise the form of the stress-strain curve as shown in Figure 9 and Figure 10 is almost like the stress-strain curve reported by Yokoyama. This indicates that the set-up equipment of impact test in this study have been correct. Calculation and calibration are in accordance with what has been done by previous researchers.

According to Nicholas[8], in any Hopkinson rod testing, the fracture will always occur in the middle of the specimen (gage section). The minimum distance is one times the specimens diameter from the middle of the specimen itself. From the series of impacts test which have been carried out can be seen that the fracture occurring generally located in the central area of the specimen. This proves that the set-up testing has fulfilled the provisions established by Nicholas.

Figure 12 shows that non-fatigue specimens have the most ultimate tensile strength. Followed by pre-fatigued specimens and the lowest is the ultimate tensile strength results of the static test. This indicates that as long as the strain rate acceleration that took place in the impact test, have an impact in the form of an increase in ultimate tensile strength.

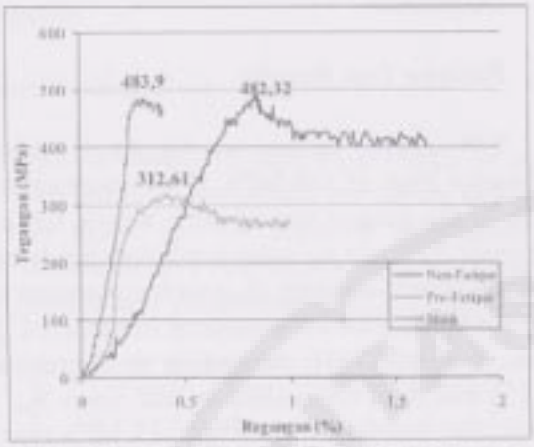


Figure 12. Tension-stress curve of static and impact test results

5.3. MSC-NASTRAN Simulation Results

Using the MSC-NASTRAN simulations can be estimated that stress concentration occurs at the rim, to get the amount of voltage received by each mesh element in the results of simulation can be done with showing on one node or element you want to display. Figure 13 shows the simulation results rim without load, while Figure 16. simulated rim has been given a load of 395 kg and using equation (8) it is known that the maximum voltage in the critical area of 34.67 MPa.

Figure 13. Mesh configuration

Figure 14. Configuration for the stress concentration

Figure 14. clearly provide the information that the stress concentration at the rim trunk area, most likely the rims failure is always on the edge area.

5.4. Learning Design

Impact test results and car rim simulation modeling using a Solid Work and MSC-NASTRAN softwares then it will be used as a prototype in the learning process in the course equipment engineering and Machine. Based on the literature study conducted believed that the strategy of collaborative learning is one of the creative ideas that will be used in the application of the learning process.

Development of the device and the content models are done with identification procedures, the development and validation of experts and device models test. Identification of the device models produce the type of device models, namely in the form of learning matters equipment ngineering and machine production that include learning strategies based on collaborative learning, and learning matters are complete.

Learning strategies to be applied to subjects of Equipment engineering and Machine are expected to generate charge information about the procedure or sequence learning that developed from collaborative learning.

The matters that will be used in the field of Equipment engineering and Machine contain information about the overall learning matter developed from procedure based on collaborative learning.

6. Conclusion

From the results and discussion described above can be concluded that the damage/failure of car rim is caused by the compressive stress characteristic of solids structure and tensile stress there are void deprived porous structure. The decrease in tensile strength impact that is happened because of the factor of 35.19%, suggests that the impact tensile strength is strongly influenced by the homogeneity of the structure stresses (residual) component. Fluctuations of stress which occur in car rim structural component was made from aluminum alloy greatly affects the strength impact, tend to decline more than 50% of the tensile strength limit of the material.

Collaborative learning strategy on subjects Equipment engineering and Machine for case studies of the car rim simulation modeling is using software Solid Work and MSC-NASTRAN, that is expected to produce vocational graduates who have skills and creativity, especially in the design and simulation.

Acknowledgement

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