DESIGN A LOAD BEARING CONVERTIBLE STRUCTURE FOR MOTORCYCLE

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PENGAKUAN

"Saya akui laporan ini adalah hasil kerja saya sendiri kecuali ringkasan dan petikan yang tiap-tiap satunya saya jelaskan sumbernya"

Tanadatagan : ……………………………

Nama Penulis :……………………………

Tarikh : ……..…………………………

DEDICATION

To my beloved mother, father, brother and sister, and all my friends
All member of Bachelor of Mechanical Design Innovation Engineering (BMCA)
All lecturers from BMCA department
Staff of Faculty Mechanical Engineering
Staff of Universiti Teknikal Malaysia Melaka (UTEM)

Do You Have Time To Pray?
God Have Time To Listen

ACKNOWLEDGEMENT

With the name of Allah, The Most Gracious and Most Merciful

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ABSTRACT

Design a load bearing convertible structure for motorcycle is my project for the PSM 1 and PSM2. The objective of this project is to design a system that manages to hold the appropriate load and stable enough to have a good ride and riding. Besides that this system also easy to convert the system structure for the usage at the different location. This product is design to make sure that the motorcycle rider in safety situation when carrying the load. This product also can be as a children seat in motorcycle, when the rider wants to take their children with them, they just need to change or turn the load bearing as a baby seat. Actually this product also designs not only just as a load bearing but as children seats. In designing this product, the aspect likes bending moment, load test, and cornering need to cover up. It is because, these aspect is very important to make sure that this product will produced in good condition. This project also will use the software such as Catia and Nastran Patran. Catia software will use in design the load bearing. Beside that, this software also will used to complete the engineering drawing. For the analysis, the Nastran Pastran and Catia will be used.

ABSTRAK

Mereka penampung beban bagi kegunaan motosikal adalah projek saya pada PSM1 dan PSM2. Objektif projek ini adalah untuk membina satu sistem yang dapat menampung beban dan mampu memberikan keselesaan kepada penunggang motosikal. Disamping itu juga, sistem dapat ditukar mengikut kesesuaian keadaan. Produk in dicipta untuk memastikan penunggang motosikal sentiasa berada dalam keadaan selamat semasa membawa muatan. Produk ini juga boleh digunakan sebagai tempat letak kanak-kanak pada motosiakal, apabila penunggang mahu membawa anak-anak mereka bersama, mereka hanya perlu menukarkan penampung berat kepada tempat letak kanak-kanak. Semasa menyiapkan produk ini, faktor-faktor seperti kelenturan, ujian beban, membelok perlu diambil kira. Ini adalah kerana semua faktor-faktor ini amat penting untuk memastikan produk ini dihasilkan dalam keadaan baik. Projek ini juga menggunakan perisian seperti Catia dan Nastran Patran. Perisian Catia digunakan untuk melengkapkan lukisan kejuruteraan dan membuat anlisis, manakala perisian Nastran Patran hanya intuk analisis sahaja.

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CHAPTER 1

1.1 Introduction

In this modern day, motor vehicle transport has become a necessity in human life. Transport vehicle has become the most convenient mechanism for ordinary people's movement. There are several of transports in Malaysia namely bus, motorcycle, train, aeroplane and ship. Extensive used had caused the increased number of this freight transport. Besides that, the number of registered. However the number of accident also increased in proportion to the number of vehicle. Good vehicle design is a must nowadays and safety features are becoming the attractive point for costumer.

The objective of this work is design a product that could give more comfort and safety to the motorcycle passenger especially for the children. If the product is convertible, then this structure could be modified as a luggage carriage for the motorcycle rider. Proper goods placement or storage would help in one way or another thus pretending accident.

In planning design, this product will set up in the side body of a motorcycle. It will produce seating for two children. Besides that, this product also will become a luggage carriage.

In this project, a motorcycle model HONDA, Honda EX5 is a part of the design of convertible structure. This motorcycle is used widely in our country. The convertible structure could be easily attached to body of the motorcycle,

1.2 Objective

The objective of this project is to produce a product that will handle the mass or weight load that carriage by the rider. The criteria is to design a product attached to a motorcycle passenger that could station children of 3-5 years old. It is also importan that they are in comfortable and safe during a ride. Apart from that, the convertible structure is easy to modify and can be use for other purposes.

In this project, procedure of using tools like measuring tools, welding machine will be studied and practice in a correct way. Knowledge in software such as like CATIA and AUTOCAD will be improved. Theories like the Bending Moment theory, Cornering theory and Load test theory will be studied appropriately.

1.3Scope

In this project there are three scopes to be considered. The first and the most important is to design the product based on the engineering design theory.

The engineering theory like bending moment theory, cornering theory and load test theory will be look at in their respective view. The bending moment theory will be use to determined the maximum force that cause the bending in the structure member and chassis. The cornering theory is to find the stability for motorcycle during carrying this product. The load test is to determine the maximum load that can be support by the product.

The last scope is to gain more knowledge and practicing the skill in software like CATIA, NASTRAN and PATRAN. The CATIA is used to draw the product parts. These all parts will be joined together and this process calls the part assembly drawing will be produced. Further analysis will be done using NASTRAN and PASTRAN.

1.4 Problem statement

In Malaysia, motorcycle has become the most need mode of transport in the city and the small town. The motorcycle is cheap compared to other transport mode. However motorcycle has the disadvantage that might cause accident to the passenger and to the driver if not handle properly.

Usually the problem faced by motorcyclist is that not enough space for more than two passengers. As an example, several motorcyclists carried more than one passenger regardless of their safety and placed them inappropriately. This action might cause unnecessary stress the accident

In a traffic jam, people will try to be at the front line. Motorcycle with heavy load will cause many problems.

Sometime the luggage will distract their views and the road in front is blind. With heavy luggage,the rider might lost stability control and may cause the accident.

1.5 Project information

This product design based on the problem that faced by the motorcyclist and the main idea is to design for child safety. In this design, extra carrier will be designed for two seats that suitable for children from 4 to 5 years old. This product is suppose to the ergonomic can be easily modified and suitable for load carriage as well. The product is designed to support load up to 500N.

The load carrier will be placed at side motorcycle body. This will give a good cornering and enough stability to avoid lost control. At the same time, the carrier can be supporter the motorcycle. By placing at the side the motorcycle, the rider view will not be blocked. The rider knows the traffic situation. Additionally, by placing at side of the motorcycle, more space can be provided for the rider.

The load carrier design will use hollow square steel 1 inch times 2 inch is for the main chassis and structure. The actual design will be explain in the methodology section of the report. The steel plate also will be use in this design for the wall and floor. The wood or plywood will be selected for the load carrier seat.

1.6 Report outline

Chapter 1, the information will presented. The project was study the load and the passenger (mostly children) more safety that related to the motorcycle design. The objective of study will be stated and the problem statement will be discussed. The scope and the benefit of the study will also be discussed in more details.

In chapter 2, the literature review is presented. The physical theories such as bending moment, cornering, and impact test will be discussed. These theories are very important, because in design a load bearing structure there is well to know the function of the parts such as bending in chassis.

Besides that, the previous design works and study will referred too. The information about the material used in the design will be define. The selected material should be light in weight, has a good stiffness and suitable to use as a load bearing for motorcycle. The data of a motorcycle that be collected. The Honda EX 5 motorcycle will be chosen as a reference. Sketches of the design structure will also show here.

In the methodology section, description of how the work project was conducted is being literate. It was shown in term of flow chart.

In chapter 4, the data and information obtained from analysis and simulation will be discussed. The result from Nastran and Patran, CATIA, and simulation using ADAM software will presented separately.

In chapter 5, the conclusion and recommendation for result and suggestion the further work were being listed.

Chapter 2

Literature review

2.1 Bending moment

In general, bending induces compression and tension axial stresses through resolution of the internal bending moments into a force couple as shown in the Figure 2.1. These axial stresses act normal to the beam cross-section. In ordinary wood beams, these axial stresses are acting parallel to the grain of the member. The distribution of axial stresses is linear with maximum stresses at the extreme fibers (outer edges of beam) and zero stress at the beam's neutral axis. For simply supported members with normal downward external loads, the beam experiences a positive internal bending moment condition; resulting in compression in the top fibers above the neutral axis and tension in the bottom fibers below the neutral axis. The more common loading condition is to stress the beam about its strong axis, (also known here as the x-axis), taking advantage of the larger moment of inertia that works to reduce bending stresses. This is the condition shown in the Figure2.1.

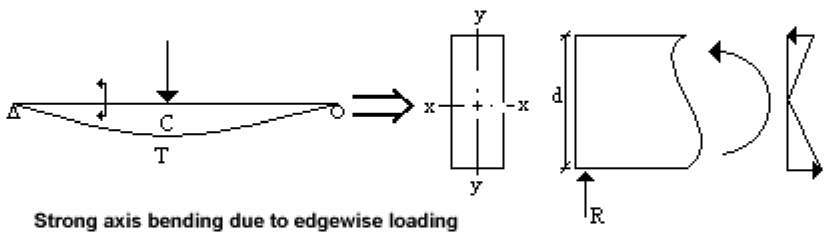

Figure 2.1

In beam design, one important criterion is to examine the beam's critical bending stress conditions. This is done by ensuring that the actual critical stress, developed as a function of loading, support conditions, span, and cross-section is ≤ the factored allowable stress. .

Since much of the bending problem, except for the adjustment factors, is a review from strength of materials, we will jump right into a bending example problem. For this and the following topics, the provided example problem is an analytical one, and not a design problem.

This is done to build your confidence with the basic stress techniques prior to the selecting and optimizing tasks that are done in design. The design aspects will be covered under the Design Example topic area of this Design module.

2.1.1 **Bending criteria**

Beams, joists, and rafters are ‘bending members’, and are perhaps the most common structural members. They are called ‘bending’ because their primary function is to resist bending forces. This is in contrast to say ‘tension’ members (cables, tie-rods, etc.) or ‘compression’ members (posts, studs, columns).

Bending members come in many shapes, sizes, and materials (wood, steel, and reinforced concrete are most common). Their primary function is to carry gravity loads over an opening or open area.

- **Stresses in Bending Members.**

There are two basic types of stresses in all bending members that must be considered in design.

- **Shear Stress**.

The best way to think of shear stress is to imagine a beam made of many thin boards stacked on top of each other, but not nailed or glued together. Now, if a downward (gravity) load is applied to the middle of this ‘beam’, it will sag considerably because the boards slide relative to each other. However, if you were to glue or nail the boards together, then apply the same load, now the beam would not sag nearly as much. It is the glue and / or nails which keep the boards from sliding that is resisting the shear stresses. You can perform a similar experiment yourself by bending the pages of a book. If you don't squeeze the pages together, thus allowing them to slide on top of each other, the book bends easily; very little shear resistance. But if you squeeze the pages so they can't slide, now it is much harder to bend the book.

- **Bending Stress**.

A good way to think of bending stress is to imagine a long, heavily loaded experiencing large bending stresses at the sag. Try this experiment. Gently bend the tip of your index finger upward while keeping the knuckle stationary (i.e. bend it in the direction it won't bend naturally). Notice the bottom of the finger, directly under the knuckle has stretched skin, i.e. skin that is in tension. The skin on top of the knuckle is wrinkled, i.e. it is in compression. There are bending stresses in your finger analogous to this tension and compression .Bending stresses are nothing more than tension on one side of a bending member simultaneous with compression on the other side. This simultaneous tension and compression is called a bending moment.

The best ways to keep bending stresses low is to use deep beams, and / or short spans. For example, in the experiment above, if your finger were twice as tall (thick) as normal and you applied the same amount of force, the tension / compression would be considerably less. Also, if your finger was very short, and you applied the same amount of upward force as someone with a very long finger, you would feel much less tension / compression than the long-fingered person. Their 'lever arm' (also called moment arm) is longer, resulting in higher bending stresses.

2.1.2 The most common mistake in design load bearing carriage

- Stress
- Hostile environment
- Shrinkage

2.1.3 Design for service life and service condition

The design requirements of product expected to be used only once or few times are very different than for product that have to perform for a very long time. A problem arise if a product designed for every short life or mild service condition is placed into much more severe service conditions or is expected to survive much longer the anticipated service life for which is it was designed. If the product fails under those strained circumstances, it is not fair to consider its demise a failure because it was exposed to service conditions far greater than expected. Nevertheless, courts have made judgments against manufacturers of products if such misuse is reasonably foreseeable.

2.2.1 Load test theory

Load Tests are end to end performance tests under anticipated production load. The objective such tests are to determine the response times for various time critical transactions and business processes and ensure that they are within documented expectations (or Service Level Agreements - SLAs). Load tests also measures the capability of an application to function correctly under load, by measuring transaction pass/fail/error rates. An important variation of the load test is the Network Sensitivity Test, which incorporates WAN segments into a load test as most applications are deployed beyond a single LAN.

Load Tests are major tests, requiring substantial input from the business, so that anticipated activity can be accurately simulated in a test environment. If the project has a pilot in production then logs from the pilot can be used to generate ‘usage profiles’ that can be used as part of the testing process, and can even be used to ‘drive’ large portions of the Load Test.

Load testing must be executed on “today’s” production size database, and optionally with a “projected” database. If some database tables will be much larger in some months time, then Load testing should also be conducted against a projected database. It is important that such tests are repeatable, and give the same results for identical runs. They may need to be executed several times in the first year of wide scale deployment, to ensure that new releases and changes in database size do not push response times beyond prescribed SLAs.

2.2.2 What is the load test?

Load testing is the process of creating demand on a system or device and measuring its response.

In mechanical systems it refers to the testing of a system to certify it under the appropriate regulations (LOLER in the UK - Lifting Operations and Lifting Equipment Regulations). Load testing is usually carried out to a load 1.5x the SWL (Safe Working Load) periodic recertification is required.

Load testing generally refers to the practice of modeling the expected usage of a software program by simulating multiple users accessing the program's services concurrently. As such, this testing is most relevant for multi-user systems, often one built using a client/server model, such as web servers. However, other types of software systems can be load-tested also. For example, a word processor or graphics editor can be forced to read an extremely large document; or a financial package can be forced to generate a report based on several years' worth of data. The most accurate load testing occurs with actual, rather than theoretical, results.

When the load placed on the system is raised beyond normal usage patterns, in order to test the system's response at unusually high or peak loads, it is known as stress testing. The load is usually so great that error conditions are the expected result, although no clear boundary exists when an activity ceases to be a load test and becomes a stress test.

2.2.3 Why Conduct a Load Test?

A successful custom load test can ensure that the performance requirements of a complex software application, including the hardware landscape and the communication network infrastructure, have been met. Load tests are a best practice for large, highly customized, and mission-critical SAP system implementations.

2.2.4 What is the purpose of a Load Test?

The purpose of any load test should be clearly understood and documented. A load test usually fits into one of the following categories:

1. **Quantification of risk.** - Determine, through formal testing, the likelihood that system performance will meet the formal stated performance expectations of stakeholders, such as response time requirements under given levels of load. This is a traditional Quality Assurance (QA) type test. Note that load testing does not mitigate risk directly, but through identification and quantification of risk, presents tuning opportunities and an impetus for remediation that will mitigate risk.
2. **Determination of minimum configuration.** - Determine, through formal testing, the minimum configuration that will allow the system to meet the formal stated performance expectations of stakeholders - so that extraneous hardware, software and the associated cost of ownership can be minimized. This is a Business Technology Optimization (BTO) type test.

What functions or business processes should be tested?

The following table describes the criteria for determining the business functions or processes to be included in a test.

Table 2.1: Criteria for determining function process

Basis for inclusion in Load Test	Comment
High frequency transactions	The most frequently used transactions have the potential to impact the performance of all of the other transactions if they are not efficient.
Mission Critical transactions	The more important transactions that facilitate the core objectives of the system should be included, as failure under load of these transactions has, by definition, the greatest impact.
Read Transactions	At least one READ ONLY transaction should be included, so that performance of such transactions can be differentiated from other more complex transactions.
Update Transactions	At least one update transaction should be included so that performance of such transactions can be differentiated from other transactions.

2.3 Cornering

As we negotiate a curve, centrifugal (centripedal for the purists, although these terms only represent the action and reaction to each other) forces are generated as a consequence of the bike's desire to travel on in a straight line. To counter this desire the road must react with the tyre to produce a force in toward the centre of the curve. Now it is obvious that the road does not know when we wish to turn so it must be the tyre, through the signals that the rider feeds to it, that starts the process. The detail mechanisms of how this actually happens are less obvious and more involved than may appear at first sight. Those who drive as well as ride may have wondered why it is necessary to turn the front wheels more on a car, than on a bike, to take the same corner at the same speed. The essential difference is that a bike must lean inwards when cornering to maintain balance, whereas a car remains substantially upright. Consider a wheel, held upright as on a car, following a curved path as in fig.1., if this wheel is aligned with the direction of the curve at any particular point on it (i.e. pointing in the direction of travel) then the wheel will tend to go straight on along a tangent to the curve and will generate no cornering force.

The angle between the direction of the tyre and the tangent to the curve is known as the 'slip angle'. As the wheel is now no longer travelling exactly in the direction in which it is pointing, we can resolve its velocity tangent to the curve into components aligned with the wheel and at right angles to it. This means that the peripheral tyre speed will be slightly less than the road speed around the turn but there is now a sideways speed to the tyre, i.e. is it is sliding sideways. This lateral movement produces a force at right angles to the wheel direction. The magnitude of this force depends on the amount of slip angle, increasing up to about 15° and then falling off rapidly, that's when the driver has lost it. This wheel lateral force can now be resolved into a component at right angles to the direction of travel, cornering force, and into one aligned with the direction of travel, a drag force. It is this drag force which causes a car to slow when driven hard around a bend under constant power. So, we can now see what generates and controls the forces that cause a car to corner, and why the wheels must turn more than the amount just necessary to align with the direction of the curve.

2.3.1 The cornering force is provided from two sources:

1. Camber thrust and slip angle

As the inside edge of the tyre is forced to adopt a smaller radius than the outer edge, then for a given wheel rotational speed, the inner edge would prefer to travel at a smaller road speed, this happens if the wheel is allowed to turn about a vertical axis through the point of the cone. Just as a solid cone on a table if given a push. But if the bike was leaning over at 45° then for a normal size tyre the horizontal radius to the cone axis would be approximately 1.5 feet, an impossibly tight turn. However, attempting this turn will generate a centrifugal force which tends to throw the bike away from the centre of the turn and hence it will describe a larger radius. This then is the main mechanism for generating the cornering force on a bike, and is often referred to and misunderstood as "camber thrust".

2. The component of the engine supplied driving force that acts toward the centre of the corner. This driving force itself, acts in line with the rear wheel, but as this is at a