



**UNIVERSITI TEKNIKAL MALAYSIA MELAKA**

**DESIGN OPTIMIZATION OF DRAIN COVER USING FINITE  
ELEMENT ANALYSIS**

This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor Degree of Manufacturing Engineering (Manufacturing Design) (Hons.)

by

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## **APPROVAL**

This report is submitted to the Faculty of Manufacturing Engineering of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Manufacturing Engineering (Manufacturing Design) (Hons.). The member of the supervisory is as follow:

.....  
(EN. ABDUL HALIM HAKIM BIN ABDUL AZIZ)

## **DECLARATION**

I hereby, declared this report entitled “Design Optimization of Drain Cover using Finite Element Analysis” is the results of my own research except as cited in references.

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## ABSTRAK

Rekabentuk adalah merupakan peringkat yang paling penting dalam sektor pembuatan. Semua produk digalakkan terlebih dahulu melalui peringkat ini dimana peringkat rekabentuk ini mengandungi konsepsi rekaan, pemilihan rekabentuk, mengenalpasti keperluan pengguna, pemilihan konsep, fasa analisis dan sebagainya. Beberapa factor yang perlu diberi perhatian didalam rekabentuk diantaranya rekaan produk yang akan memenuhi kehendak pengguna, bahan yang digunakan dan sebagainya. Kesemua produk hendaklah mencapai keperluan dan kehendak pelanggan dan pengguna. Namun rekabentuk juga berupaya memberi kesan kepada syarikat samada keuntungan, kerugian atau reputasi prestasi syarikat itu sendiri. Projek ini membuat kajian dalam memperkasakan (optimum) rekabentuk dengan menggunakan analisis elemen finiti. Dimana produk yang dikaji adalah penutup longkang. Projek ini juga menjalankan survei keatas penutup longkang yang sedia ada, merekabentuk semula dan meningkatkan rekaan sehingga mencapai keputusan yang baik dalam menganalisis suatu rekabentuk. Selain itu projek ini juga melibatkan proses perkasaan (optimum). Proses perkasaan ini terhasil didalam pproses merekabentuk semula, dimana rekaan asal akan diubah dari segi, bentuk saiz dan lain-lain sifat sehingga penutup longkang mencapai keputusan analisa yang terbaik. Sepanjang projek ini bahan yang digunakan didalam penutup longkang adalah komposit habuk kayu kerana untuk mengelakkan kecurian bahan berunsurkan keluli.

## ABSTRACT

Design is important stage in manufacturing. It is because any product produced must be through design stage where in design stage consist conceptual design, concept selection, identify customer need, concept selection, analysis and others. In design, it should be consider many factors such as product design must be satisfied by customer, material used the ability product to work and others. All part in design is to fulfill customer need. Beside that design will give an effect to company such as profit, loss and reputation of the company. This projects study deep on design optimization using finite element analysis. Where the product to be study is drain cover design. In this project consist the survey the existing drain cover, redesign and improve the existing drain cover until the drain cover get the better design and best of result analysis. Beside that this project also provides optimization process. This optimization process done in redesign process, where the current design will change the shape, size or others until the drain cover have best result of analysis. In this project material to be used is sawdust composite material because the drain covers to be design just for avoid the stolen case if using the steel material for standard.

## **DEDICATION**

*This report is dedicated to my beloved parents, brothers and sisters for their endless love, support and encouragement. I also dedicate this work to my supervisor and friends who have supported me throughout the process. in completing this thesis. I will always appreciate all they have done.*

*Thank you.*

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I hope that this project report will fulfill the conditions as requested in Final Year Project in UTeM.

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## **LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE**

CAD	-	Computer Aided Design
CAE	-	Computer Aided Engineering
CW	-	Chip wood
Cm	-	Centi Meter
C1	-	Composite 1
C2	-	Composite 2
C3	-	Composite 3
FEA	-	Finite Element Analysis
FEM	-	Finite Element Method
GPa	-	Giga Pascal
J	-	Joule
kg	-	Kilogram
kN	-	kilo Newton
$\text{kJ/m}^2$	-	kiloJoule per meter square
mm	-	Mili Meter
Min	-	Minimum
Max	-	Maximum
MPa	-	Mega Pascal
N	-	Newton
SW	-	Sawdust
3D	-	3 Dimension

# **CHAPTER 1**

## **INTRODUCTION**

This chapter will explain about the background of the project study, problem statement, the objective of the study and also the scope of the project study.

### **1.1 Project Background**

PSM project mainly focused on design optimization of drain cover and to propose the best design and analysis. Main drain cover is important part in a draining system. It is because drain frame become a main body or main frame at drain. As an important part at road, Drain cover frame must be high strength, tough and durability. It is because, the body frames usually applied with large force where the force comes from weight of the average people who walks along the pedestrian walk. The Drain cover frame usually applied with load around 100kg-300kg of the weight of the Malaysian people who normally use the pedestrian walk and also the light weight of the vehicle such as bicycle. So for this PSM project it is focus on design and improve the current Drain cover frame design and do the analysis to the Drain cover frame design by using Finite Element Analysis.

Then optimize the Drain cover frame design by redesign Drain cover frame until get the best result of analysis. This project tries to propose the best design and analysis of Drain cover frame. The optimization to increase quality, reduce product cost and full fill the customer satisfaction. For this project CAD tools as tools to design drain cover and FEA tools for the analysis. For this project software to be used are SOLIDWORKS as CAD software and NASTRAN PATRAN software as analysis software.

## **1.2 Finite Element Analysis**

The limited component investigation (FEA) is an influential examination apparatus, which can be connected to a scope of building issue. The limited component displaying procedure considered defaming the multifaceted geometries into little principal volumes called limited component. It is then conceivable to compose the representing comparisons and material properties for these components. These comparisons are then amassed by taking fitting consideration of comes about that depict the conduct of the first unpredictable body being dissected. Application of FEA is no constrained to mechanical framework alone yet to scope of designing issue, for example, stress investigation, dynamic examination, and twisting studies liquid stream examination, high temperature stream investigation and other. With the FEA programming it is conceivable to attempt various option plans before really striving for a model production. The utilization of FEA instruments can changing over the geometry into discrete component and figuring different properties for every component, for example, geometry, material properties, imperative and stacking. This structures the data for the investigation. It additionally can producing the limited component work by making a suitable rough guess to the geometry. At that point it can figure the hubs and component properties and permitted the material properties to be detailed. Under FEA it has steps included in the utilization of limited component system for tackling a physical issue. The product utilized for run this Finite Element Analysis such PATRAN and CATIA.

### **1.3 Problem Statement**

The issue of the innovation of this product is stated according to the massive loss of steel drain cover since early 1990's. According to the police report, the thieving activities of the drain cover are influenced by value of steel that increasing gradually year by year. Until today, this unhealthy activity is still out of control by the authority even though some city council starts to restrict their drain cover with bolt to the concrete cement. Hence, the problem of the drain cover loss do affected the safety of citizen. There are many cases of citizen (mostly affected the elders and children) fell down into a drain caused by the disappearance of the drain cover, and most of the cases are caused by the loss of the drain cover mostly at their residential area and some of it ashamedly happen at public area like city area. The seriousness of this incident sometimes have been neglect by some party because of this case of accident is still minor, but once it's happen when people start to blame the authority and city council. So, the better way to avoiding this consequences from happening again and again is by changing the existing material of drain cover which is steel with the sawdust material which has less market value compared to the steel. Hence, it is a better way on how to handle the dumped waste more appropriately than being throw it as a rubbish. Moreover, the number of rubbish can be reduced plus can balance our lovely natural environment.

### **1.4 Objectives**

- To redesign a new concept of drain cover from the existing drain cover that can decrease the drain pollution.
- To optimize drain cover design using finite element analysis.
- To propose the best design and analysis of drain cover.

## 1.5 Scope of Project

This project describes the design and analysis of the drain cover. The purpose of this project is to improve and optimize the current design of drain cover. That means the current Drain cover will redesign. Before the redesign process the current product will be drawn by CAD software (SOLIDWORKS) and analyze the current design by using CAE software (NASTRAN PATRAN). In the design process, it consist conceptual design where more than three current designs will generate. After that all design will analyze by using CAE software. And then the result will differentiate between each other. And one of the design results will be taken as a guideline. After that from previous conceptual design, the new design will be generate and analyze. The redesign process will conducted until the best result and design created. The best result here means are the Drain cover design must be has smallest maximum displacement then the current design result. Beside that this project need some survey the mean numbers of citizens weight in the in this country and also the weight of the light duty vehicle such as bicycle or motorcycle. The other process is to identify the material used for drain cover and the properties of drain cover.

## **CHAPTER 2**

### **LITERATURE REVIEW**

#### **2.1 Introduction**

Literature review includes study and research of published material like journals, thesis, case studies, technical document, book and online library. Generally, the purpose of their view is to analyze critically a segment of a published body of knowledge through summary, classification, approach used in their project, and any technique that used in their study, review of literature and theoretical articles. This chapter will describe topics that related of Computer Aided Design (CAD), design, conceptual design, Optimization, Finite Element Analysis (FEA), Design Process and other relevant topic for this project. These chapters to carry out any approach that can use in drain cover frame design and analysis using Finite Element Analysis method and carry out current product design.

#### **2.2 What is Drain Cover?**

A fitting waste will spare your property from water harm by keeping it dry even in the heaviest of downpour storms. The way to a legitimate seepage framework is a useful waste setup utilizing the right kind of building materials that will help flow water far from your property and not endure water harm simultaneously.

A drain is the essential vessel for unnecessary water to be flow away to a more useful region yet for the most part of the waste water is flown out into a repository if not into the sewer. In few system, the drain used is for to release the waste fluids, for an example the channel in a sink in which the water is emptied when it is no more

required. In the last case, there is a conspicuous wellbeing issues, on the grounds that numerous individuals don't have experience more than the head of the water over the channel when touching a drain. For an example, in a previous case, a lifeguard went to the base of a pool to recover something at the bottom of the pool and his hand got stuck on account of the additional weight and extra pressure from the pump. At the point when there is a recirculating pump, the danger of the suction comprises of the head of the water, in addition to the suction of the pump. As a consequence of this suction capture or Duct Entanglement, there had an accident lead to fatalities have occurred around the drains. In these circumstances, a share of the body, hair, or apparel may get to be stuck against the channel will be bringing about suffocating and may get to be difficult to discharged away. When an allotment of the channel opening is blocked, the drain suction will increase rapidly by having two channels or a bigger channel inlet permits an interchange suction ways for the pump. It there has a rapid increase in the suction is detected, the safety devices installed in the swimming pool are accessible to consequently turn off an operating working pump. The children should be taught not to deliberately touch or attempt to block the components of a swimming pool recirculation system while the alarm may be in counterproductive state.



**Figure 2.1 :** Structural steel grating weight for tubular type outdoor drain cover (Source : [http://www.alibaba.com/product-detail/Structural-steel-grating-weight-for-tubular\\_136833162.html](http://www.alibaba.com/product-detail/Structural-steel-grating-weight-for-tubular_136833162.html))  
20/09/14)

### 2.2.1 Specifications of structural steel grating weight

This guideline were stated by one of the steel and gratings manufacturer manufacturers that established in 1993 by Tohoku Okajima.

1. Reasonable cost and have the Japanese quality.
2. Good rub resistance and corrosive resistance.
3. Strong heavy-loading ability.
4. Safety in use.

Numerous homes have an outside concrete, solid or like material deck adjoining the house. Normally, a screen walled in area is introduced above and around the deck to give an outside stimulation range that is protected from irritations, for an example mosquitoes, flies and etc. Regularly, the surface of the deck is higher than the encompassing the ground surface which is generally grass or earth. The edge of the structure of the screen incorporates a base rail or track which mounts to the top of the surface of the deck. Therefore, it surrounds the ground surface. The base rails of the screen fenced in the region frame structure is pretty nearly 1” to 1 1/2” in tallness and when mounted to the deck surfaces. The frames structures will raised the lip which keeps the water from flowing out of the deck surfaces and surrounded the ground surfaces.

In many cases, the decks are slanted to regulate the water towards the corners. The base rail will raised the lip and keeping the water from streaming off from the deck surface, causes the rain water, pool water, and so forth to gather in the corners. In a short time, the determined of the gathering of the standing water causes the buildup, mold, and staining of the deck.

Previously, attempts have been made to empty the water out from the enclosed decks by boring the gaps through the base rails of the screen fenced in an area frame structure. The waste technique is effective at first. Nonetheless, over the long times, the openings through the base rail get to be obstructed with leaves, and insects that obstruct the drainage.