FAILURE ANALYSIS ON THE DRILLPIPE DUE TO THE TWIST-OFF

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SUPERVISOR'S DECLARATION

We hereby declare that we have checked this project report and in our opinion this project is satisfactory in terms of scope and quality for the award of the degree of Bachelor of Mechanical Engineering with "specialization".

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STUDENT'S DECLARATION

I hereby declare that the work in this report is my own except for quotations and summaries which have been duly acknowledged. The report has not been accepted for any degree and is not concurently submitted for award of other degree.

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To my beloved mother, father and family, the love of my life

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ABSTRACT

This thesis reports on the design and analysis for failure at three different drill pipes. When drilling boreholes, for example in the Oil & Gas industry, a hole is drilled into the ground which can be several kilometers long. One of main type of problem that can occur while drilling is the torque on the drill pipe can cause it to break (called twist-off). This problem results in drilling delays. Twist-offs also usually results in loss of expensive equipment. Therefore, ALGOR software has been use as the FEA tool to do the analysis to reduce this problem. Six different values of torque range from 2000 N.m to 3000 N.m is applied to the end of the pipe stand which is consist of three assembly of pipes. The materials of the pipe have been chosen are AISI 1010, ASTM A36 and AISI 4150 steels that have different mechanical properties the see the differences. The test results show that AISI 4150 is the most suitable material to use which gives 2800 N.m torque value before it starts to fail. Meanwhile, a constant pattern of failure has determined for these three pipes at the same location of the second engaged thread of the pipe assembly, between the male and female thread at the joint. For improvement, to see the differences from another point of view, the analysis for this drill pipe design is suggested to do with different thickness and length in order to analyze how much the maximum allowable torque value can be applied to the pipe before it starts to fail.

ABSTRAK

Tesis ini melaporkan tentang rekabentuk dan analisis kegagalan pada tiga jenis paip gerudi. Apabila proses gerudi dijalankan, sebagai contoh di industry minyak & gas, permukaan tanak digerudi dengan menggunakan paip untuk membuat lubang sejauh melebihi berkilo-kilo meter. Salah satu masalah yang dihadapi ketika proses menggerudi ialah pemintalan paip gerudi yang menyebabkan paip itu patah. Masalah ini menyebabkan penangguhan proses menggerudi. Pemintalan kebiasaannya akan menyebabkan kerosakan peralatan – peralatan yang berkos tinggi. Oleh itu, software ALGOR digunakan sebagai salah satu unsur FEA untuk menganalis kegagalan yang berlaku pada paip gerudi untuk mengurangkan masalah ini. Enam nilai tenaga putaran yang berbeza bernilai dari 2000 N.m ke 3000 N.m telah dikenakan kepada hujung paip yang terdiri daripada tiga sambungan batang paip. Antara bahan aloi yang dipilih adalah AISI 1010, ASTM A36 dan AISI 4150 yang mempunyai sifat mekanikal yang berlainan antara satu sama lain. Berdasarkan analysis, AISI 4125 adalah bahan yang paling sesuai untuk digunakan kerana nilai tenaga putaran maksima yang boleh dikenakan adalah yang tertinggi iaitu 2800 N.m sebelum ia gagal. Sementara itu, corak kegagalan yang sejajar dikenalpasti pada ketiga-tiga jenis paip ini yang berlaku pada sambungan kedua paip. Untuk penambahbaikkan, analisis ini dicadangkan untuk menggunakan ketebalan dan panjang paip yang berbeza untuk melihat perbezaan nilai tenaga putaran maksima yang boleh dikenakan kepada paip gerudi sebelum ia gagal.

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T	-	Motor torque
P	-	Pressure
C_1	-	Inner radius of the drill pipe
C_2	-	Outer radius of the pipe
J	-	Moment of inertia
τ	-	Shearing stress
t_1	-	Pipe thickness
d_1	-	Inner diameter of the drill pipe
d_2	-	Outer diameter of the drill pipe

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CHAPTER 1

INTRODUCTION

1.1 PROJECT OVERVIEW

Drilling engineering is a subset of petroleum engineering. It is primarily involved in the design and drilling of production and injection wells. The drilling engineer has the responsibility for the efficient penetration of the earth by a well bore, and for cementing of the steel casing from the surface to a depth usually just about the target reservoir. The Oil & Gas industry is involved in the global processes of exploration, extraction, refining, transporting (often with oil tankers and pipelines), and marketing petroleum products. The largest volume products of the industry are fuel oil and gasoline (petrol). Petroleum is also the raw material for many chemical products, including pharmaceuticals, solvents, fertilizers, pesticides, and plastics. Petroleum is vital to many industries, and is of importance to the maintenance of industrialized civilization itself, and thus is critical concern to many nations.

The usual problem in petroleum drilling is failure due to fatigue. Failure due to fatigue is a very costly problem in oil and gas industry. Drillstring failure occurs on 14-percent of all rigs and the resulting downtime costs roughly $106 000 per event. A survey of all drilling problems reported worldwide over a 15-month period shows that 36-percent were due to stuck pipe. Stuck pipe cost estimates for the worldwide drilling industry range as high as $250 million for this period. The threaded connection of the type used in hydrocarbon exploration is a critical component of the drillstring that is highly susceptible to fatigue damage. Fatigue crack growth can either lead to a catastrophic failure of the connection, known as a twist-off, or can be a non-critical failure, known as a wash-out.

Failure in most cases is restricted to either the drill pipe located at the upset regions or at the threaded connections. External damage arising from poor pipe handling practices can occasionally lead to failure at random locations along the length of the drillpipe. The range of commonly encountered primary damage mechanisms covers ductile fracture, brittle fracture, fatigue and stress corrosion cracking. Various simple and complex combinations can also occur. A consistent feature where twist-off has occurred is that post-separation damage to fracture surfaces can often be very severe, obliterating much of the detail of the fracture morphology required to aid identification of the failure mode. This is due to the failure remaining undetected at the surface and consequently both weight-on-bit and rotation continues. In addition, the large pressure differential drives flow of the mud from pipe bore to annulus should a leak path become available, resulting in wash-out damage.

1.2 PROJECT PROBLEM STATEMENT

When drilling boreholes, for example in the Oil & Gas industry, a hole is drilled into the ground which can be several kilometers long. One of main type of problem that can occur whilst drilling is the torque on the drill pipe can cause it to break (called twist-off). This problem results in drilling delays. Twist-offs also usually results in loss of expensive equipment.

1.3 PROJECT OBJECTIVES

The project is conducted to achieve the following objectives:-

i) To do the failure analysis on the drillpipe for directional borehole drilling.
ii) To find the desirable maximum allowable torque can be applied to the drillstring to reduce its failure.

1.4 PROJECT SCOPES

The project scopes are:-

i) The borehole drilling only consider for directional borehole drilling.
ii) The focus on problem is only for and 'twist-off'- (the torque on the drill pipe can cause it to break).
iii) Drill pipes are manufactured to different lengths and diameters. This investigation focuses on NQ drill pipes, which are mainly used for directional exploration drilling.
iv) The ALGOR Software will be used as the tool of Finite Element Analysis .

1.5 PROJECT ORGANIZATION REPORT

The rest of the report is organized as follows:-

There are 4 more chapters to be discussed which are Chapter 2, 3, 4 and 5. The literature review of this research will be explained further in chapter 2. In this chapter, the overview and explanation for failure analysis will be discussed. The description of step of method will be briefed detail in chapter 3. This chapter is more to the method that use in conducting this research. In chapter 4, the process performance on the failure analysis will be discussed. Discussion will be included in this chapter. Finally in chapter

5, all the results will be concluded in this chapter. Recommendation to improve the petroleum borehole drilling process performance also will be suggested.

1.6 PROJECT PLANNING

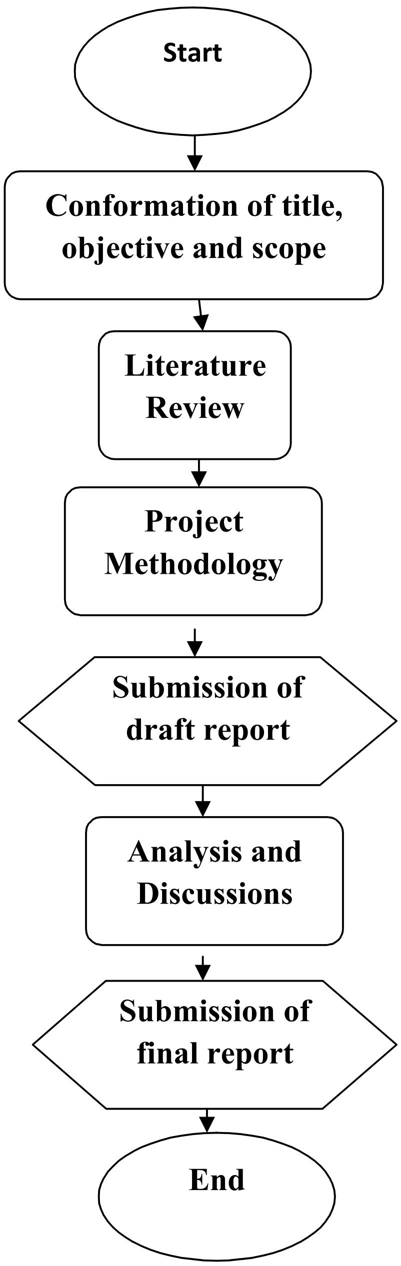

Figure 1.1 : Project Planning for both Final Year Project 1 and 2.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

The main purpose of this literature review is to get information about the project from the reference books, magazines, journal, technical papers and web sites. In this chapter the discussion will be made base on all the sources.

2.2 PETROLEUM DRILLING

The crew sets up the rig and starts the drilling operations. First, from the starter hole, they drill a surface hole down to a pre-set depth, which is somewhere above where they think the oil trap is located. There are five basic steps to drilling the surface hole:

1. Place the drill bit, collar and drill pipe in the hole.
2. Attach the kelly and turntable and begin drilling.
3. As drilling progresses, circulate mud through the pipe and out of the bit to float the rock cuttings out of the hole.
4. Add new sections (joints) of drill pipes as the hole gets deeper.
5. Remove (trip out) the drill pipe, collar and bit when the pre-set depth (anywhere from a few hundred to a couple-thousand feet) is reached.

Once they reach the pre-set depth, they must run and cement the casing which is place casing-pipe sections into the hole to prevent it from collapsing in on itself. The casing pipe has spacers around the outside to keep it centered in the hole. The casing crew puts the casing pipe in the hole. The cement crew pumps cement down the casing pipe using a bottom plug, a cement slurry, a top plug and drill mud. The pressure from the drill mud causes the cement slurry to move through the casing and fill the space between the outside of the casing and the hole. Finally, the cement is allowed to harden and then tested for such properties as hardness, alignment and a proper seal.

2.2.1 Borehole Drilling

Borehole is the hole drilled by the bit(wellbore). This term also is define by a circular hole made by boring, especially a deep hole of small diameter such as oil & gas or water well. Borehole drilling is the extraction of minerals in liquid or gaseous state from the Earth's crust by mean of boreholes and suction pumps. Boreholes are used for mining petroleum and for the extraction of liquid solution of salts, sulfur.

2.2.2 Drill String

A drill string on an oil rig is a column, or string, of drill pipe that transmits drilling fluid (via the mud pumps) and rotational power (via the kelly drive or top drive) to the drill bit. The term is loosely applied as the assembled collection of the drill pipe, drill collars, tools and drill bit. The drill string is hollow so that Drilling fluid can be pumped down through it and circulated back up the annulus (void between the drill string and the formation).

2.2.3 Drill Pipe

Drill pipe makes up the majority of a drill string. A drill string is typically about 15,000 feet in length for an oil or gas well vertically drilled onshore in the United States and may extend to over 30,000 feet for an offshore deviated well.