ENGINEERING ANALYSIS ON SPREADER BEAM BY USING MANUAL CALCULATION AND SOLIDWORKS SIMULATION SOFTWARE

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

by

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SESI PENGAJIAN: 2012/13 Semester 2

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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 (Process) (Hons.). The member of the supervisory is as follow:

……

(Dr. Md Nizam Bin Abd Rahman)

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ABSTRAK

Laporan ini berkaitan dengan projek industri yang menerangkan satu analisa kejuruteraan mengenai *spreader beam* yang digunakan di Syarikat M. Spreader beam adalah digunakan untuk mambantu proses mengangkat barangan khususnya untuk barangan yang panjang. Walau bagaimanapun, *safe working load* (SWL) bagi *spreader beam* ini tidak ketahui. Analisis matematik dan *Finite element analysis* (FEA) menggunakan SolidWorks 2011 perisian simulasi digunakan untuk mengenalpasti kebolehan untuk menahan beban berdasarkan reka bentuk spreader beam. Di dalam analisis ini, 1.5 Ton digunakan sebagai beban kerja. Beban ini adalah beban maksima bagi *spreader beam* yang telah dipilih. Berdasarkan pengiraan matematik tekanan maksima adalah 88.53 MPa manakala daripada FEA analisis tekanan maksima adalah 92.52 MPa. Terdapat 4.3% perbezaan antara kedua-dua keputusan ini. Had SWL adalah 95 MPa berdasarkan *factor of safety* lima. Kedua-dua keputusan ini tidak melebihi had SWL. Ini bermaksud, *spreader beam* ini selamat untuk mengangkat beban maksima yang digunakan oleh Syarikat M seberat 1.5 ton. Reka bentuk Lifting lug telah dicadangkan bagi meningkatkan prestasi *spreader beam* yang bersesuaian dengan penggunaannya di Syarikat M.

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ABSTRACT

This project is industrial related project that focused on engineering analysis of spreader beam used in Company M. The spreader beam was used in hoisting process usually for the long objects. However, safe working load (SWL) of the spreader beam was unknown. The mathematical analysis and Finite Element Analysis (FEA) using SolidWorks 2011 simulation software were used to identify the loading capacity of spreader beam design. In the analysis, 1.5 ton load was used as the working load. This load is the maximum load to be hoisted based on Company M for selected spreader beam. Based on mathematical calculation the maximum stress obtained is 88.53 MPa while from FEA simulation maximum stress is 92.52 MPa. There is 4.3% difference between these two results. The SWL limit is determined as 95 MPa based on factor safety of five. Both of the results did not exceed the SWL limit. That mean, spreader beam is safe to lift the maximum load specifed by Company M which is 1.5 ton. New Lifting lug design was purposed to improve spreader beam performance suited to its application in Company M.

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DEDICATION

To my beloved parents

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ACKNOWLEDGEMENT

First and foremost, I would like to express my appreciation to my final year project supervisor, Dr. Md Nizam Bin Abd Rahman and Production Manager Company M, Mr. Cheong Yew Leong for his guidance and support during completing this project.

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LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

A	-	Area I-beam (mm^2)
AISC	-	American institute of steel construction
ASME	-	The American society of mechanical engineers
ASTM	-	American Society for Testing and Materials
a	-	Least plate width at side of holes (mm)
CAE	-	Computer aided engineering
e	-	Distance edge of hole to edge of plate parallel to load (mm)
E	-	Young's modulus ($\frac{N}{mm^2}$)
F	-	Design load (N)
FEA	-	Finite element analysis
FEM	-	Finite element method
FOS	-	Factor of safety
F_u	-	Allowable ultimate tensile strength ($\frac{N}{mm^2}$)
F_b	-	Bending force ($\frac{N}{mm^2}$)
F_y	-	Yield strength ($\frac{N}{mm^2}$)
I	-	Moment of inertia (mm^4)
L	-	Length (mm)
N	-	Newton
SWL	-	Safe working load
T	-	Plate thickness (mm)
V	-	Allowable shear force (N)
Y	-	Perpendicular distance from neutral axis (mm)
σ	-	Stress
ƍ	-	Deflection

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CHAPTER 1
INTRODUCTION

This chapter explains the background of this research, company background, problem statement, objective, scope and introduction of spreader beam. This project has been carried out based on the industrial requirement from Company M.

1.1 Background

The background of this research is divided with two parts which is company background and project background.

1.1.1 Company background

Company M manufactures a comprehensive range of overhead travelling crane, hoist, warehouse truck and wide variety of industrial products such as gondolas, dock levellers, monorail systems and automated car parking system. Company M was established in 1972 and operates within a close knit regional network in Singapore (headquarters), Indonesia, Vietnam, Thailand and Taiwan. Company M is supported by eight facilities, over 35 companies, and sales offices.

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1.1.2 Project background

The primary aim of all design is to ensure that the structure performs well during their function and design. The design of the structure must capable of carrying the loads safely. This require of the designer to make realistic estimates of the strength of the materials composing the structure and the loading to which it may be subject during a basic design (Chanakya, 1994). This project is to perform mathematical analysis and simulation analysis to determine safe working load (SWL) of the spreader beam based on the working environment and the use of spreader beam at the Company M factory. The mathematical analysis and simulation analysis of the structure is considered in static condition. This project is using SolidWorks 2011 Simulation software to create drawing and simulation analysis according on company requirements.

1.2 Problem statement

In the Company M factory, overhead crane and lifting equipment including spreader beam extensively utilized. A spreader beam function is used to assist in the hoisting process usually for the long objects. However, load capacity of the spreader beam is unknown. The spreader beam product is not available in this region. Due to cost consideration Company M make their spreader beams with their own fabrication facility. Due to lack of engineering analysis the safe working load of this spreader beams has not been specified. The factory have several spreader beams of different sizes and unknown loading capacity. This project focuses only on a single spreader beam design that is shown in Figure 1.1. Due to that, the aim of this project is to determine the safe working load of the spreader beam based on calculation and SolidWorks 2011 Simulation method.

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Figure 1.1: Spreader beam (Company M factory)

1.3 Objectives

The objectives of this project are:

(a) To determine the capacity of an existing spreader beam of unknown potential using mathematical analysis and SolidWorks 2011 simulation software analysis.

(b) To identify the safe working load (SWL) value for the spreader beam.

(c) To improve the spreader beam design.

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1.4 Scope

This project focuses on the method to determine of load capacity for spreader beam in Company M factory. This project focuses only single spreader beam as shown in Figure 1.2 that is being used in Company M. The calculation and simulation analysis of the structure considered in static condition. Two methods that used to determine the load capacity of the spreader beam are mathematical calculation and FEA simulation using the SolidWorks 2011 design software.

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CHAPTER 2
LITERATURE REVIEW

This chapter explains in detail about literature related in this project. The subjects that are covered are introduced of the spreader beam, current design of spreader beam, spreader beam design, mathematical analysis, SolidWorks 2011 Simulation software, factor of safety and safe working load.

2.1 Introduction of spreader beam

Spreader beams is below-the-hook lifting device that lift loads with single or multiple attachment points. A spreader beam usually works with overhead crane used to assist in the hoisting process for the long or complex object. The basic spreader beam is shown in Figure 2.1. This arrangement provides two places of attachment to the object being lifted, thus avoiding the possibility of overstressing. This also allows for a straight pull on the object rather an oblique pull. This is sometimes important to minimize unwanted erection stresses or to prevent reversal of stress in certain portion of the lifted object. Spreader beam can also be used to provide multiple lifting points on a relatively flexible object. Figure 2.2 shows the spreader beam with two upper lifting lugs that prevent the objects from tilting. Another element commonly associated with spreader beams are hooks, shackles and slings. The shackle is used to connect the lines to the spreader beams that come in various pattern, size and load capacities that are shown in Figure 2.3. Figure 2.4 shows slings and oblong that used to suspend the spreader beams from the main hook (David, 2003).

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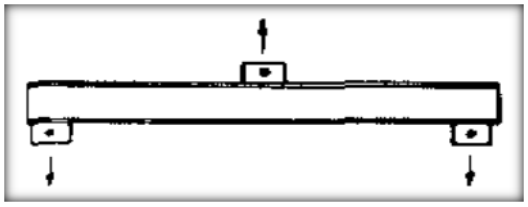

Figure 2.1: Basic spreader beam (David, 2003)

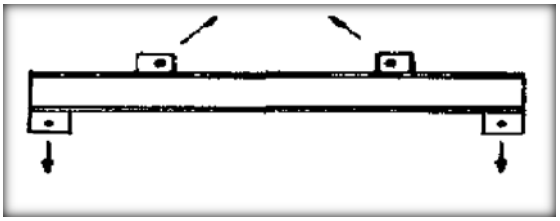

Figure 2.2: Spreader beam with two upper lifting lugs (David, 2003)

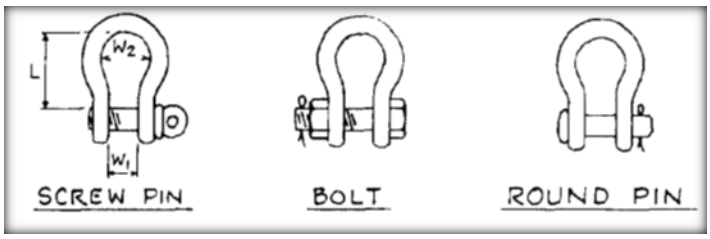

Figure 2.3: Shackles (David, 2003)

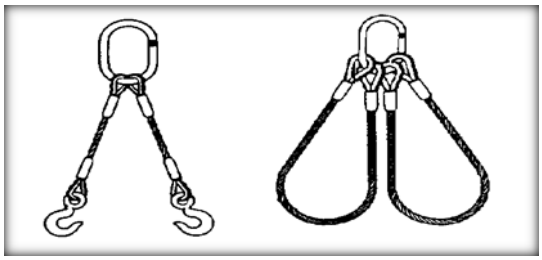

Figure 2.4: Oblong, sling and hook (David, 2003)

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2.2 Current design of spreader beam

The spreader beams offer the broadest range of Modular Spreader System component to give the material handling crane operator flexibility to meet lifting requirement according to the size, shape and weight of an object. Modulift products are designed following ASME B30.20 Standard that manufactured by Modulift. There are several types of the Modular Spreader System (Modulift, 2010).

2.2.1 Modular spreader beam

Modular spreader beam is shown in Figure 2.5 system provides the ultimate in flexibility. Modular spreader beam consists of three parts strut, drop link and end unit to assemble is is according the size object. (Modulift, 2010)

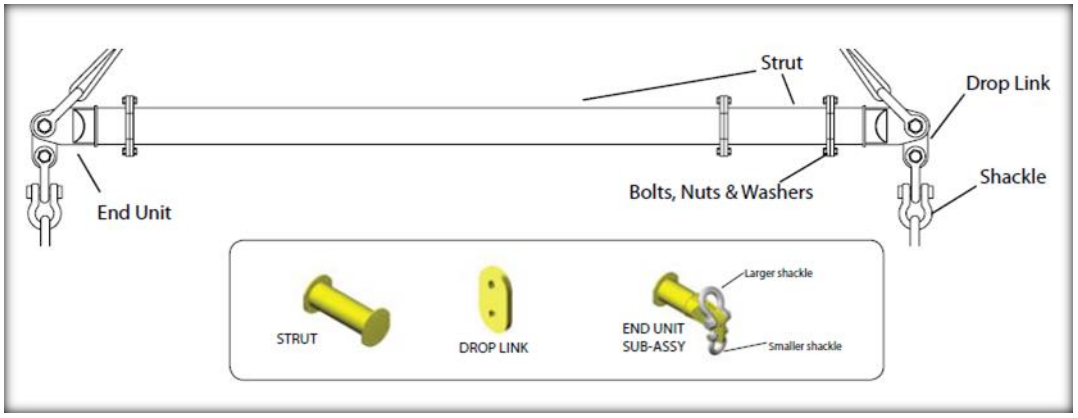

Figure 2.5: Modular spreader beam (Modulift, 2010).

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2.2.2 Fixed spreader beam

Fixed spreader beam is shown in Figure 2.6 is the basic design of spreader beam. This design of spreader beam cannot be adjusted (Modulift, 2010).

Figure 2.6: Fixed spreader beam (Modulift, 2010)

2.2.3 Castellated spreader beam

Castellated spreader beam is shown in Figure 2.7 is a fixed beam with variable lifting points, which can be easily adjust suitable with an object to be lifted (Modulift, 2010).

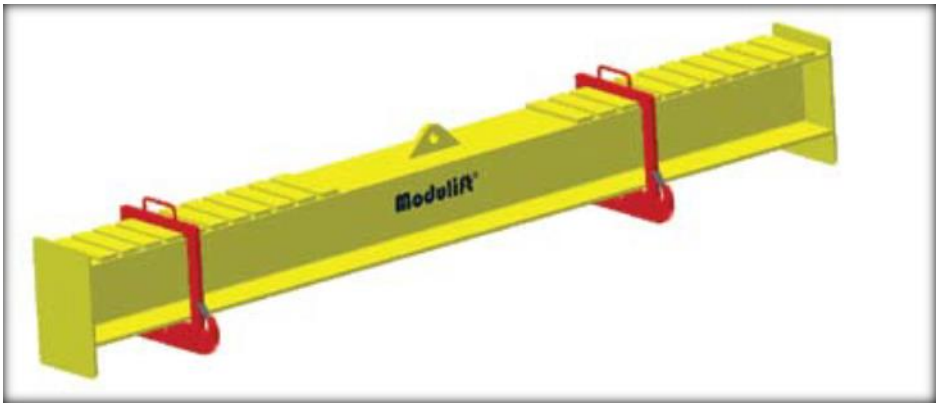

Figure 2.7: Castellated spreader beam (Modulift, 2010)

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