JMM: Journal of Mechanical and Manufactur e-ISSN:2829-4424
Vol. 4 No 2, April 2025 , pp. 43-50
DOI: https://doi.org/10.31949/jmm.v4i2.13684

ANALYSIS OF GIRDER ON OVER HEAD CRANE WITH 4 TON CAPACITY USING INVENTOR

Dimas Maulana[1], Rizal Hanifi[2] , Aa Santosa[3]
Universitas Singaperbangsa Karawang[1,2]
[1] 1810631150017@student.unsika.ac.id, rizal.hanifi@ft.unsika.ac.id,[2]. aa.santosa@ft.unsika.ac.id [3]

ABSTRACT

In the field of overhead crane construction, a girder is a beam that is positioned between two supports that can be pillars or abutments. The shape of the girder beam varies, ranging from square, trapezoidal, letter U, letter I to letter T. The I-girder type is an I-shaped beam made of composite or non-composite materials. This type of girder is most often used in bridge construction in Indonesia. It is natural that all manufacturers must provide and accept custom manufacturing. The research conducted in this report focuses on girders for overhead cranes to withstand a load of 4 tons. The research was conducted by comparing the results of the manual calculation process with the simulation process using Inventor software. . Steel Girder Material ST 37 Standard JIS 3101 SS400 profile I beam size 350 x 175 x 7 x 11 mm.
The results obtained are Normal Stress on the beam of $59\ {}^{N}/_{mm^2}$ Shear Stress 1.96 N / mm^2 Deflection that occurs in the I-section beam 1.2 mm. Where E is the modulus of elasticity of Steel of 200,000 Mpa.

Keywords: Girder, Crane, Steel, Stress, Modulus elasticity

Submitted: 2025-01-29	Revised: 2025-03-17	Accepted: 2025-04-25

Introduction

The transportation system at present is a very important need. In the process of moving goods, especially those with very heavy loads, a lifting tool is needed that is capable and has sufficient strength so that accidents do not occur. Currently, lifting equipment is widely used in container terminals, such as Overhead Cranes which function to move containers by hanging the containers. One type of overhead crane is a single girder overhead crane with a capacity that is still considered standard with a span of 6 meters. One of the components of an overhead crane is the girder used according to the needs of the crane. Girders with a bar frame construction are currently rarely used in overhead use, the most widely used are in the form of beams or boxes which are considered more practical both in terms of construction and shape.
In lifting equipment, the safety and work safety factors of the equipment itself and the operator who uses it need to be considered. In planning the construction of the girder, it depends on the requirements that must be met for its needs. This is intended to obtain efficient conditions for effective equipment. Research that has been conducted by several authors on girders such as Manalip, 2018 conducted research on Planning Girder Profile I, Then Sujiati, 2021 conducted research on Design Analysis of PC I Girder on Section Overpass STA 52 + 174 Balikpapan-Samarinda Toll Road Project. From several previous studies, the author here will conduct research on girders with a span of 6 meters by conducting a stress-strain and displacement analysis on beams with profile I as the material for the Girder.

The purpose of this study is as follows
1. Conducting the Girder Design Process, conducting simulations with inventors to become non-standard design guidelines.
2. Applying Cad Inventor to the design conditions and girder analysis in real conditions in the field

3. Knowing the changes in position due to the loading process on the girder with a maximum load of 4 tons

Overhead Crane

Overhead Crane is a combination of a separate lifting mechanism with a frame to lift and move loads that can be hung freely or attached to the crane itself.

In addition to functioning as a lifting tool, overhead traveling cranes also function as a means of moving goods, although the goods being moved are limited to a relatively small environment (indoors). However, overhead traveling cranes are very effective because their movements can move forward and backward and left and right.

Many girders are used according to the needs of the crane. Overhead traveling cranes can be made single girder or double girder. Girder with a bar frame construction is currently rarely used in overhead traveling cranes, the most widely used is a girder with a beam or box shape, which is considered more practical both in terms of construction and shape. In terms of technology, the design and manufacture of this overhead traveling crane does not require too high technology as in the manufacture of vehicles (automotive).

In lifting equipment, what needs to be considered is the safety and security factors of the equipment itself and the operator who uses it.

In planning the construction of this overhead traveling crane girder, it depends on the requirements that must be met for its needs. This is intended to obtain efficient conditions and effective equipment.

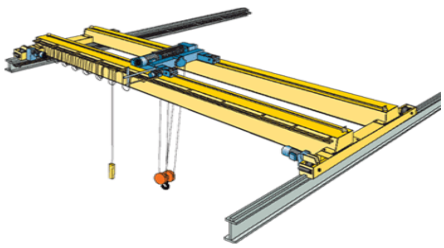


Figure OverHead Crane

Working principle of overhead crane

The working principle of this lifting machine is to lift, lower and move heavy equipment or objects in the workshop when repairs or maintenance are carried out on heavy equipment.

In its operation, the object to be lifted must be free from all obstacles so that it can be easily placed according to its position.

In the operation of this lifting machine there are 2 types:

1. Manually: Which is done by humans
2. Automatically: Which is equipped with a driving motor (gasoline, steam, electric motor and so on).

Most lifting machines move loads or loads over short distances. In practice, it is usually achieved, limited between 10 meters to
100 meters.

There are three types of crane movements on overhead cranes, including;

1. Hoist Movement (Up/Down).

This movement is the movement of the load that has been installed on the hook lifted or lowered using a drum, in this case the drum rotation is adjusted to the planned drum. The drum is driven by an electric motor and the drum movement is stopped by a brake so that the load will not rise or fall after the specified position is as planned.

2. Transverse Movement.

This movement is moving in a transverse direction. For this movement, a trolley motor is needed, where the trolley motor will move on the main girder. The distance of the material transfer can be

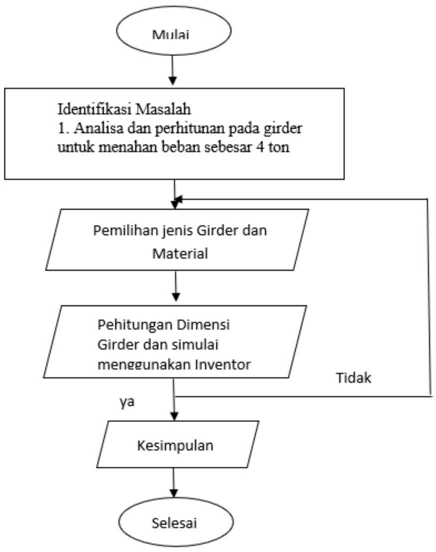
adjusted as desired. The control brake is mounted on the motor shaft and works according to the electromagnetic principle.
3. Longitudinal Movement.
This movement is a longitudinal movement along the rail located at the location where the portal crane is located. This movement is obtained by using a motor to the road wheels.

Main Types of Cranes

Of the lifting equipment, the crane group is the most frequently encountered. The types of cranes can be grouped again as follows:
Stationary rotating cranes
Generally a fixed crane with a mast that rotates on a vertical axis.
Cranes that move on rails
Generally consist of cantilever cranes and monorails (both rotating and non-rotating) that move straight on a special track.
Trackless crane
This crane mainly consists of a mast crane mounted on a truck, car or tractor so that it can move on chalky, rocky and paved roads.

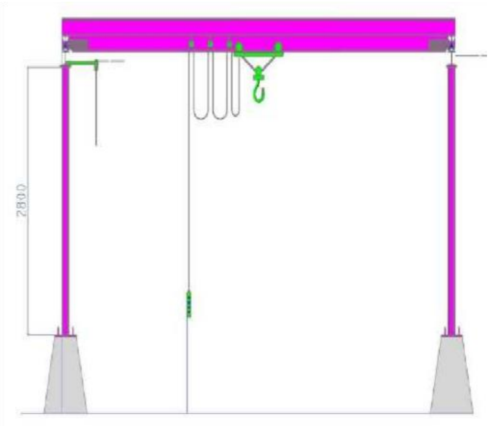
METHODOLOGY

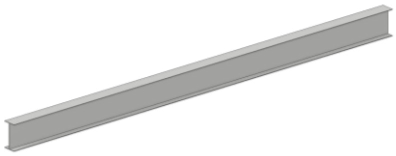
The Mechanical Engineering Workshop of Singaperbangsa Kaawang University which is used for practicum has 2 rooms located on the 1st and 2nd floors. Due to the limited space for this practicum and the addition of certain rooms that use one of the practicum rooms, the machines and practicum materials must be moved. To move these items, a goods moving tool is needed that is capable of moving heavy items in a limited space. Therefore, an Overhead Crane with a Single Girder type with a capacity of 4 tons is the right tool to support activities in the workshop.
3.1 Research Flowchart
This research begins with problem identification, namely looking at the existing problems so that an analysis is carried out on the overhead crane girder.



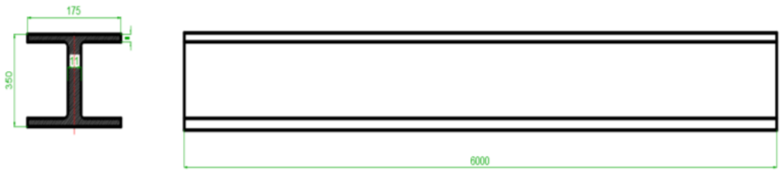
3.2 Research Method
The method used in this study is the analysis method, which is a method used to predict a component or design by analyzing the design with the required analysis methods. In this case, the simulation uses Inventor
3.2.3 Research Procedure

The research procedures that will be carried out in this study are as follows:
a. Making engineering drawings
Engineering drawings are needed to visualize the product to be made.
b. Girder Design
c. Analysis and simulation
The analysis is carried out to see the response of the girder when given a load of 4 tons

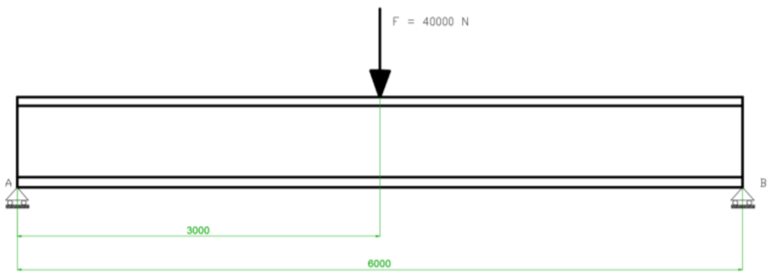




ANALYSIS AND DISCUSSION
Calculation of Stress on Girder due to Load
The size of the WF Steel beam that will be used to make the girder has the following dimensions. Steel Girder Material ST 37 Standard JIS 3101 SS400 profile I beam size 350 x 175 x 7 x 11 mm



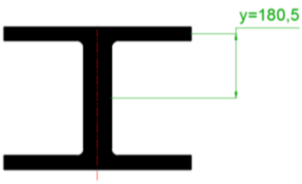
The girder receives a load of 4 tons (40000 N）.



$$\Sigma MA = 0$$

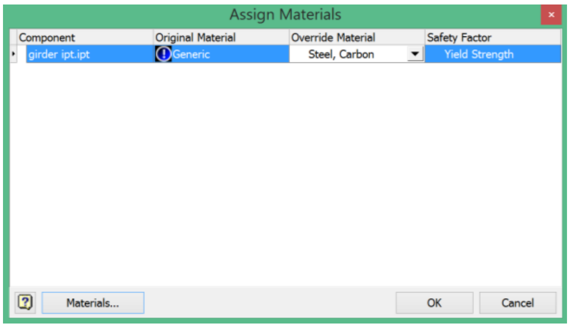
$$F.3000 - RBY.6000 = 0$$

$$RBY = \frac{40000N.3000mm}{6000\ mm}$$
$$= 20000N$$
$$\Sigma Fy = 0$$
$$RAy - F - RBY = 0$$
$$RAY = F - RBY$$
$$= 40000\ N - 20000\ N$$
$$= 20000\ N$$
$$\Sigma MA = 12.10^6\ \text{N.mm}$$
$$I_P = \frac{1}{12}[(bh^3 + hb^3) - (b-w)(h-2t)^3 + (h-2t)(b-w)^3]$$
$$= \frac{1}{12}[(350.175 + (17.350^3) - (175-11)(350-2.7)^3 + (350-2.7)(175-11)^3)]$$
$$= 201316{,}4\ mm^4$$

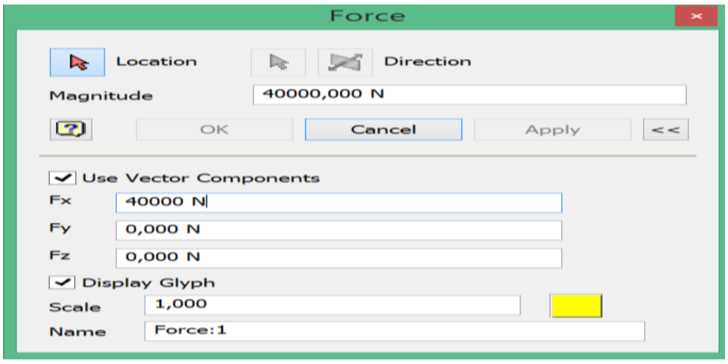


Normal stress on the beam is $\sigma = \frac{M.y}{I}$
$$= \frac{12.10^6}{201316{,}4}$$
$$= 59 \frac{N}{mm^2}$$
Shear stress on the beam is $\tau = \frac{3.p}{b.h}$
$$= \frac{3.40000}{350.175}$$
$$= 1{,}96\ \frac{N}{mm^2}$$
Deflection that occurs in the cross-section beam I ,
$$\Delta = \frac{5.ML^2}{48.E.I}$$
Where E is the modulus of elasticity of steel of 200.000 Mpa
$$= \frac{5.120000.6000^2}{48.200.10^3.201316{,}4}$$
$$= 1{,}2\ mm$$

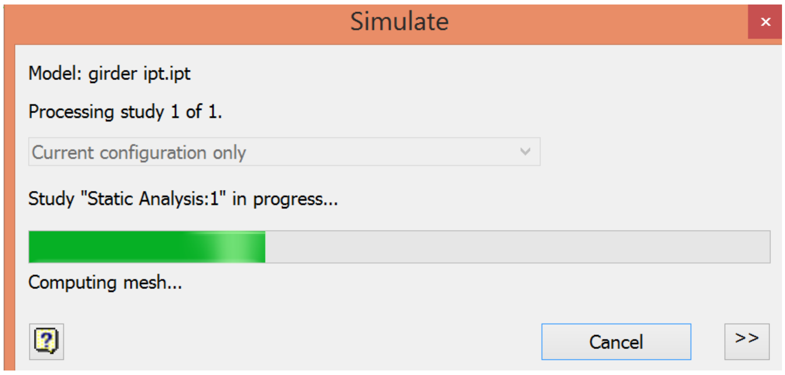
Simulation Calculation using Inventor
1. The first step is to determine the material to be used on the Girder, then an image will appear.



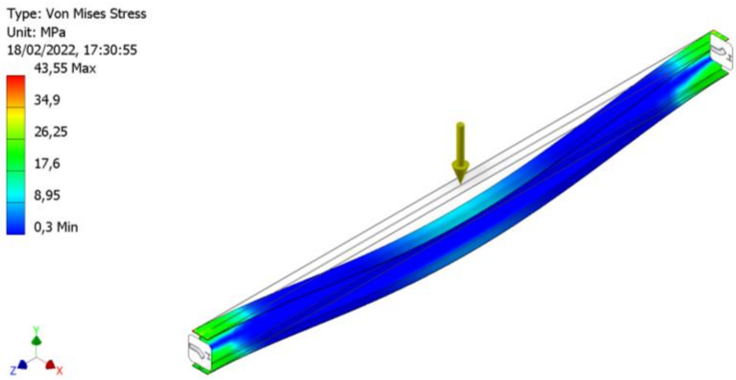
In the Override Material section, select the type of material according to the initial design, then select the material Steel, Carbon, then OK.
2. The second step is to determine the location and magnitude of the force on the girder.



1. The third step is to simulate the design results.
2.

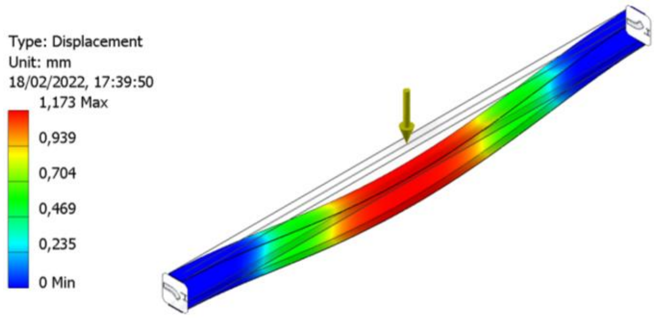


4. The fourth step is the result of the simulation
a. Von Misses Stress

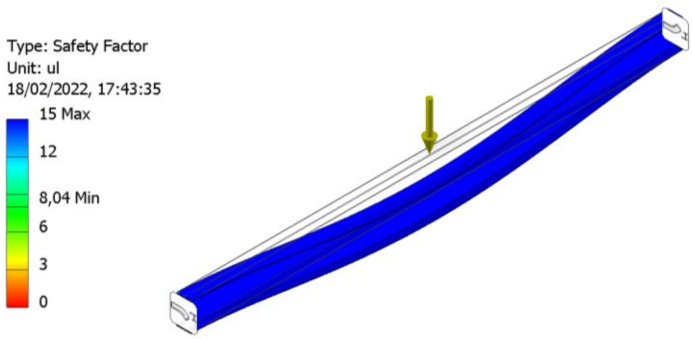


From the results of the girder simulation against a load of 40,000 N, the stress that occurs is 17.6 Mpa at the support section and 0.3 Mpa at the rod section. Overall, these figures can be seen from the colors shown.

b. Displacement



C. Safety Factor



From the simulation results to determine the safety factor, it was found that the girder obtained an Sf value of 12, meaning that the girder is very strong enough to withstand a load of 4000 N.

Comparison of calculated values with simulations

After the simulation is completed, the values of the results of the process between the simulation and the calculation can be compared to determine the difference in value.

Table Comparison of calculated values with simulation results

Komponen yang dianalisa	Hasil Simulasi	Hasil Perhitunan	Selisih
Tegangan	0,3 Mpa	0,000059 Mpa	0,29 Mpa
Tegangan Geser	0,198 Mpa	0,000000198 Mpa	0,19 Mpa
Defleksi	0,939 mm	1,2 mm	0,26
Safety Factor	12		

CONCLUSION

Girder is a Beam type structure, which is experiencing a compressive force that produces a moment, the force on the design on the girder is 40000 N. The resulting moment is 12,106 N.mm, the cross-sectional shape of the girder is I with a Cross-sectional Inertia of 201316.4 〖mm〗^4. The material used in designing this girder is ST 37 Steel Standard JIS 3101 SS400 profile I beam size 350 x 175 x 7 x 11 mm

The Design and simulation process uses Inventor software which is an application of the Cad and Engineering Database course.

From the comparison results, there is a difference below the value of 1, so the calculation results and simulation results have similarities in value, so they are usually used as a comparison.

Girder is part of the transportation equipment, many forms are used such as I-section steel, hollow section steel. In the future, it is recommended that there be a comparison between different cross-section shapes so that the best cross-section shape is produced and can be referenced for material selection.

Reference

Manalip, 2018. Perencanaan Balok Girder Profil I pada Jembatan dengan variasi Bentang, Jurnal Sipil Statik, Vol 6 No.2

Sujiati, 2021, Analisa Desain PC I Girder Pada Section Overpass STA 52+174 Proyek Jalan

Tol Balikpapan-Samarinda. Jurnal Inersia Vol 13 No 1 Pliteknik Negeri Samarinda.

Khurmi RS, Gupta JK, 2005, Machine Design, Eurasia Publishing House, New Delhi.

Rudenko, N,1996, *Mesin Pengangkat*, Erlangga, Jakarta.

Stolk Jack, 1994, *Elemen Konstruksi Bangunan Mesin* , Erlangga, Jakarta.

Sularso, 1997, *Dasar Perencanaan dan Pemilihan Elemen Mesin*, Praditya Paramitha, Jakarta.