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Safety Factor Analysis of Sports and Physical Therapy Equipment Parallel Bars using FEM

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***Abstract* - Parallel bars is a medical device that is made as a sporting tool and also as a physical therapy tool, in its use parallel bars are used to hold the weight of the user by holding both bars as support using the hands, for that reason a parallel bar design that can withstand the weight of the user and also safe to use is needed. The purpose of this analysis is to find out using Finite Element Method whether the parallel bars designed by the examiner has the strength and also the safety as required, the value sought in this test is the stress, strain, deformation, and safety factor of the parallel bars after tested by a force of 700 N.**

Keywords: FEM, Physical Therapy, Safety Factor.

I. INTRODUCTION

Parallel bars are medical devices commonly used in sports for exercising or for physical therapy. How to use it is to put your weight with the support of your hands on both sticks and then lift your weight with your hands so that your body's strength is focused on the strength of the hands.

Parallel bars when used as a sporting tool can be used to train the strength and flexibility of the muscles in the hands by trying to lift the weight of the body without using the help of legs and doing a gymnastic movements.

Parallel bars can also be used to undergo physical therapy, if someone has an accident or an injury that injures the lower back and / or legs it will be difficult for the person to be able to walk, it is necessary to do physical therapy after the person's condition begins to improve using parallel bars, where they can train their legs to walk again by focusing their weight with the hands on both bars so not to much weight is focused on their feet and makes it easier for walking.

By viewing from its use, parallel bars are always used to withstand loads, if we assume the weight being held is the average human body weight of 62 KG, then of course if parallel bars are not designed properly there will be damage, and if the damage occurs while in use an accident will occur which greatly impacts the user's safety.

In this study, researchers created a parallel bars design using Solid works which would then be analyzed using the Finite Element Method (FEM) to determine the safety factor in the designs created by researchers.

II. RESEARCH METHODOLOGY

2.1 Flow Chart

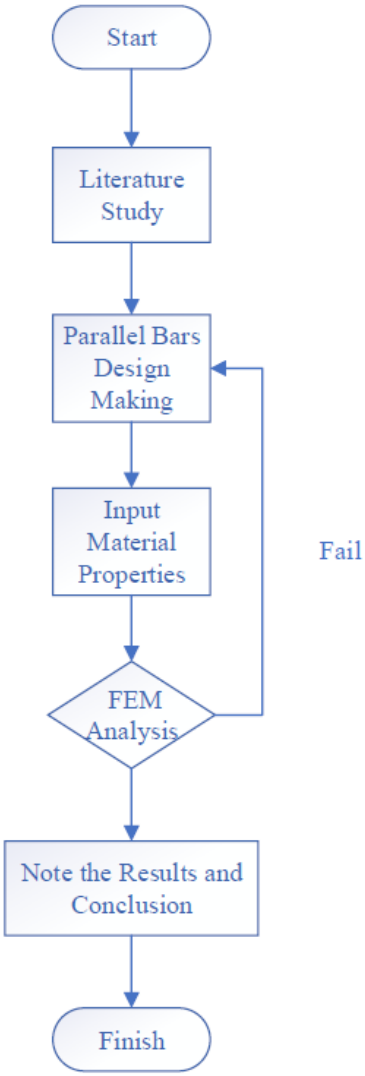

Figure 1: Flow Chart

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2.2 Parallel Bars Design Identification

The parallel bar design used in this study was made using the Solid works software, at each corner at the base of design has extra rod to prevent the tool from falling when holding a load on one side, and on each bar's supporting rod is given a pin hole can be attached a rope to prevent the bars from vibrating a lot.

Figure 2: Parallel Bars design

2.3 Material Identification

The material used as base material for the parallel bars is Structural Steel (ASTM A36) with the characteristics in table 1.

TABLE 1
ASTM A36 Specification

No	Characteristic	Value
1	Density	7850 kg/m^3
2	*Ultimate Tensile Strength*	400-550 MPa
3	Elasticity Modulus	200 GPa
4	Yield Strength	250 MPa

III. FEM ANALYSIS

The analysis in this experiment uses Finite Element Method (FEM) in Ansys software; the main purpose of this experiment is to determine the safety factor in the design of parallel bars that have been made using ASTM A36 material.

3.1 Analysis using Ansys

The analysis was carried out once to find the value of stress, strain, and deformation that occurred in parallel bars and also to find the value of safety factor, here are the results of FEM analysis.

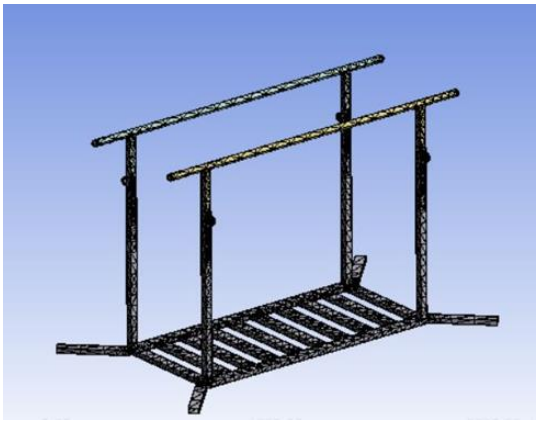

Figure 3: Meshing Result

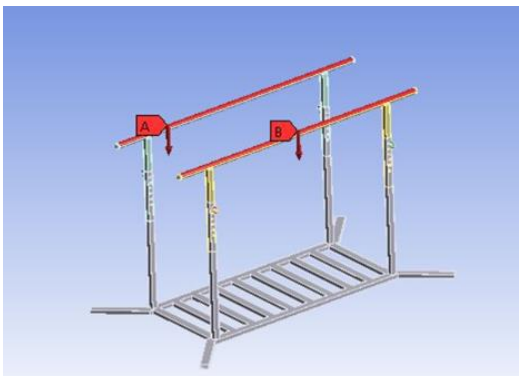

Figure 4: Force

As can be seen in Figure 4, in this analysis the simulation is done using a force of 700 N, the force is divided in half so that one bar / bar receives a force of 350 N.

3.3 Analysis Results

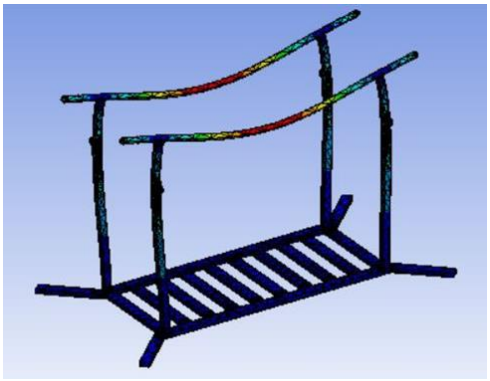

Figure 5: Deformation Analysis

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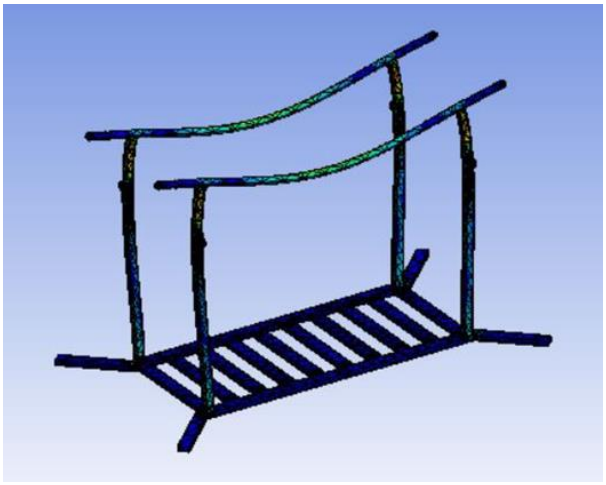

Figure 6: Strain Analysis

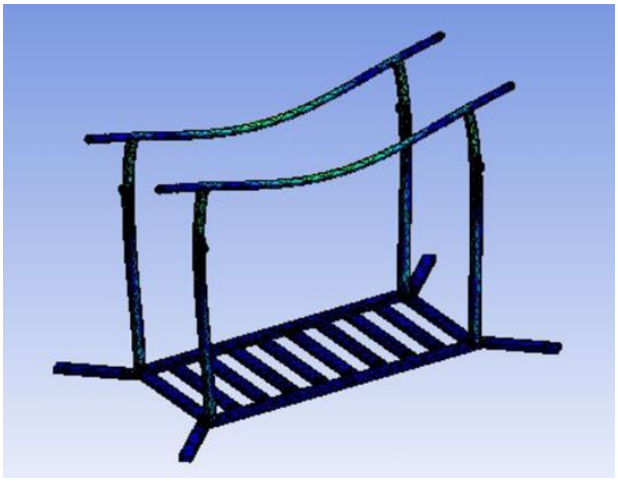

Figure 7: Stress Analysis

3.4 Analysis Results Data

TABLE 2
Analysis Results Data

Force	Parallel Bars Design	
	Min	**Max**
Equivalent (Von Mises) *stress* (Mpa)	1.215×10^{-11}	7.8983
Equivalent (Von Mises) *strain*	1.4305×10^{-16}	4.0308×10^{-5}
Deformation (mm)	0	0.11535

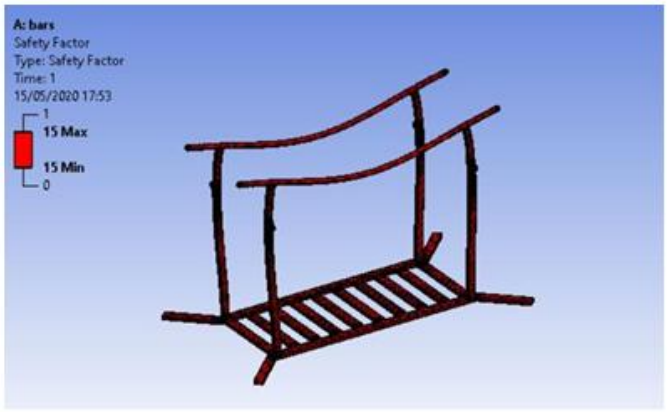

Figure 8: Safety Factor Analysis

The results of the analysis using FEM showed that the design of parallel bars that have been made and given ASTM A36 material, if given a force of 350 N in each bar with a total of 700 N has a safety factor of 15.

IV. CONCLUSION

Based on the design and discussion of parallel bars design analysis, the following conclusions are obtained:

1. The parallel bars design has a maximum stress of 7.8983 MPa after the force test
2. The parallel bars design has a maximum strain of 4.0308 x 10-5 after the force test
3. The parallel bars design has a maximum deformation of 0.11535 mm after the force test
4. Desai parallel bars have a safety factor of 15 after the force test

The results from analysis of the parallel bars design products shows the number of stress, strain, and deformation are small and also show that this design has a good safety factor value so that this design is feasible and safe to use.

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