DESIGN OF TESTING EQUIPMENT FOR FINDING FRICTION COEFFICIENT

MARLON JOAO VIERA

UNIVERSIDAD AUTÓNOMA DE OCCIDENTE
FACULTAD DE INGENIERÍA
DEPARTAMENTO DE AUTOMÁTICA Y ELECTRÓNICA
PROGRAMA DE INGENIERÍA MECATRÓNICA
SANTIAGO DE CALI

2006

DESIGN OF TESTING EQUIPMENT FOR FINDING FRICTION COEFFICIENT

MARLON JOAO VIERA

Pasantía para optar por el título de Ingeniero Mecatrónico

Director
ROBERT VOZENILEK
Mecanıc Engineer, MSC

UNIVERSIDAD AUTÓNOMA DE OCCIDENTE
FACULTAD DE INGENIERÍA
DEPARTAMENTO DE AUTOMÁTICA Y ELECTRÓNICA
PROGRAMA DE INGENIERÍA MECATRÓNICA
SANTIAGO DE CALI
2006

Acceptation Note:

Paper aproved by the degree committe in order to do the requirements proposed by the Universidad Autónoma de Occidente to obtain the title of Mechatronic Engineer.

JIMMY TOMBE ANDRADE

Jurado

Santiago de Calí, January 12th of 2006

This paper is dedicated to my parents for their support, dedication and effort. To my classmates for all the good times we shared, to God for stay to my side giving me light in dark moments and being my guide in every time of my life.

Marlon Joao Viera

SAY THANKS TO

Thanks professors for your wisdom, labour and dedication.

Thanks to Mr. Robert Vozenilek for his support and patience.

Thanks to Jimmy Tombe Andrade for his help and labour forming Engineers.

Thanks to Sandra Juliana Toro for makes my dreams true and help me with my international trainee.

Thanks to Universidad Autonoma de Occidente.

Thanks to Technical University of Liberec.

CONTENIDO

Pág.

IMAGES LIST

Pág.

TABLES LIST

ATTACHMENTS LIST

EXECUTIVE SUMMARY

This document shows the process for the design and the developed of a test platform, taking care of each parameter and making a complete documentation for futures improves. The first step is the creation of a mission statement which contains a description, assumptions and constraints and finally the stakeholders in the developed of the process.

The next step is an identification of necessities whit the aim to determinate a design to develop. This is one of the most important step of the design process because will determinate the metrics ant the specifications of the final product.

The main part of the design process is the simulation and the modelling using the CAD, CAE tools able to have an idea of the behaviour of the platform, efforts, constrains, measurements, dimensions, based in a profiles and documentation of the Technical University of Liberec.

INTRODUCTION

Automobile accidents are one of the most common causes of death. A great number of companies have destined efforts to avoid these fatal events. Researchers have developed many methods to improve the safety and protection for the passengers and most modern cars now come with a long list of standard safety equipment, and have been through a stringent process of crash-testing to find out how well they protect their occupants in the event of an impact. For example crush measurements from vehicles are routinely used and have been proven effective in determining the impact velocity in automobile accidents.

This paper has been done with the purpose to design a test platform for simulate a crush vehicle able to take some measurements that allow improving the security for the driver. The data obtained through this test platform will be useful to improve the security on the driver's feet for the Skoda cars.

The present work looks for a new test method emphasizing at the moment of the driver push the break pedal that will be able to contribute data to analyze and improve the security for the driver.

1. JUSTIFICATION

The tests on car crushes are developed with the aim of providing a definitive source of information on crash safety. This incorporates front impact, side impact and head protection tests. In the front-impact test, the car is driven head-on into a deformable barrier at 40 mph; in the side-impact test, a trolley with a deformable front is crashed into the driver's side of the car at 30 mph, and in the recently introduced head-protection test (also known as the pole test), a pole is accelerated sideways through the driver's side of the car at head level, at 18 mph.

There are many companies in United States and Europe working with the goals to provide safety information for a large number of vehicles and evaluate all this information for assigns rates of performance to the vehicles.

The present work looks for a new test method emphasizing at the moment of the driver push the break pedal that will be able to contribute data to analyze and improve the security for the driver.

2. OBJECTIVES

2.1 GENERAL OBJECTIVE

- Design and analyze a test platform for simulate the driver's feet at the time of restrain in a collision with the purpose to calculate the coefficient of friction between the carpet and the driver's feet.

2.2 SPECIFICS OBJECTIVES

- Design a mechanism for simulates the feet of a car driver able to apply a force using CAD, CAE tools.

- Design a platform for simulates a car crush scene using CAD, CAE tools.

- Assembling the mechanism and the platform using CAD, CAE tools.

- Analyze the assembly using FEM.

- To make the documentation of the design process for future improves and updates.

3. EXPOSITION OF THE PROBLEM

In many automobile accidents the feet of the driver are in high risk of suffer a lesson at the moment to push the break pedal. This considering the force that is applied for the driver and the force produced in the impact. An alternative solution to reduce this high percent of risk is to calculate the coefficient of friction between the driver's feet and the carpet. This data will be useful for improve the carpet material and to prevent possible fractures for the car driver.

3.1 MISSION STATEMENT

3.1.1 Description of the problem Test platform for simulates the driver's feet at the time of restrain in a collision.

3.1.2 Assumptions and constraints These are the assumptions and constrains to taking care at the time to design and development a mechatronic product.

- The platform must be safe to use.
- The final prototype must be robust and trustworthy to tests of continuous use.
- The platform must be affordable for the budget of the Transportation Machines Department.
- The final design prototype must be ready before September 30 of 2005.

3.1.3 Stakeholders

- Technical University of Liberec.
- Transportation Machine Department.
- Distributors of materials.
- Assistants of laboratory.

4. IDENTIFICATION OF NECESSITIES

The following classification was determinate from collected primary data by made personal interviews to educational of the university about the fundamental necessities for the design of this platform.

Table 1. Identification of Necessities

#	KIND	NECESSITIES	IMP
1	Structure	Its part should be easy to obtain at the country where it is going to be assembled	3
2	Structure	The assembly of the platform would be easy to do it	3
3	Functionality	The foot’s mechanism can change the angle for test different positions.	5
4	Functionality	The foot’s mechanism can change the applied load for simulate different breaking force.	5
5	Structure	The platform will be safe to use.	4
6	Trustworthiness	The assembly will be robust and trustworthy for multiple tests.	4
7	Trustworthiness	The obtained data will be reliable.	5
8	Structure	The assembly has to have as less as possible number of parts.	2
9	Trustworthiness	Each part must be resistant for the different loads to apply.	4
10	Structure	Its part should be of easy manufacture	2

4.1 TECHNICAL SPECIFICATIONS

Considering that does not exist any precedent about this kind of platform with similar purposes, the measures have been assumed on the basis of a previous test and calculus made by experts of the car crush test. As far as the measure of the parts these were determined considering the laboratory area available for the tests.

Table 2. Technical Specifications

#	MÉTRICS	UNITS	MARGINAL VALUES	OPTIMAL VALUES
1	Applied Load	N	5000	3000
2	Dimensions of the supports	cm	60	120
3	Length of the trolley lines	cm	100	150
4	Diameter of the trolley wheels	cm	15	25
5	Weight	Kg	60	40
6	Useful live	Years	2	5
7	Appearance	Subj	Bad	Excellent
8	Cost	USD$	5000	3500

8.2 NEEDS – METRICS MATRIX

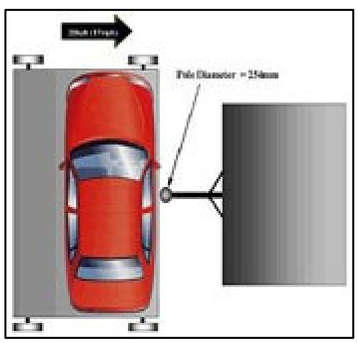
Table 3. Needs – metric matrix

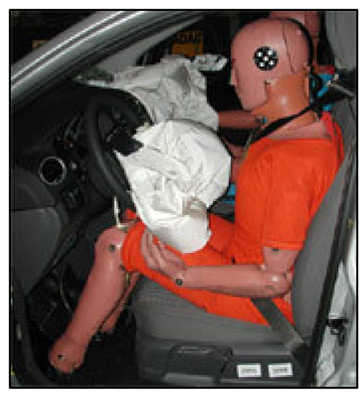
	THE NEEDS-METRICS MATRIX **HIGH = 9** **MEDIUM = 5** **LOW = 3**		Metric	Applied Load	Dimensions of the supports	Length of the trolley lines	Diameter of the trolley wheels	Weight	Useful live	Appearance	Cost	
No.	**NEED**	**Imp**	#	1	1	2	3	4	5	6	7	
1	Its part should be easy to obtain at the country where it is going to be assembled	3									5	
2	The assembly of the platform would be easy to do it	2			5	5	3	9		3		
3	The foot's mechanism can change the angle for test different positions.	4			5					3		
4	The foot's mechanism can change the applied load for simulate different breaking force.	5		5	5					3		
5	The platform will be safe to use.	5		3		3						
6	The assembly will be robust and trustworthy for multiple tests.	4						3	9		5	
7	The obtained data will be reliable.	4		3							3	
8	The assembly has to have as less as possible number of parts.	4			5	3		3		5	3	
9	Each part must be resistant for the different loads to apply.	5		5					3		3	
10	Its part should be of easy manufacture	5			3	3	3	5			5	
	MARGINALS VALUES		**Total**	77	90	60	21	67	51	53	99	518
			%	14.8	17.4	11.6	4	13	9.8	10.2	19.1	100

4.3 ANTECEDENTS

The first SID (side-impact dummy) was developed in the late 1970s at the University of Michigan under a contract with the National Highway Traffic Safety Administration. This dummy with an adapted thorax, is the official dummy used in government-required side-impact testing of new cars. These dummies primarily measure injury risk to the head, chest and pelvis. It is used for compliance testing of side-impact head airbags. BioSid (Figure 2) was later designed by General Motors' researchers, working with the Society of Automotive Engineers. This has more sensors and a more biofidelic (human-like) body than the first, which gives engineers a better assessment of the risk of injury to internal organs.

Image 1. View of side impact (left) and bioSid by GM (right)





These kind of test are common for many companies but represent a high inversion for them. The crash-test dummies used are rubber-skinned, with steel 'skeletons', and each one costs around £100,000 on account of the sensors they incorporate to provide the data.

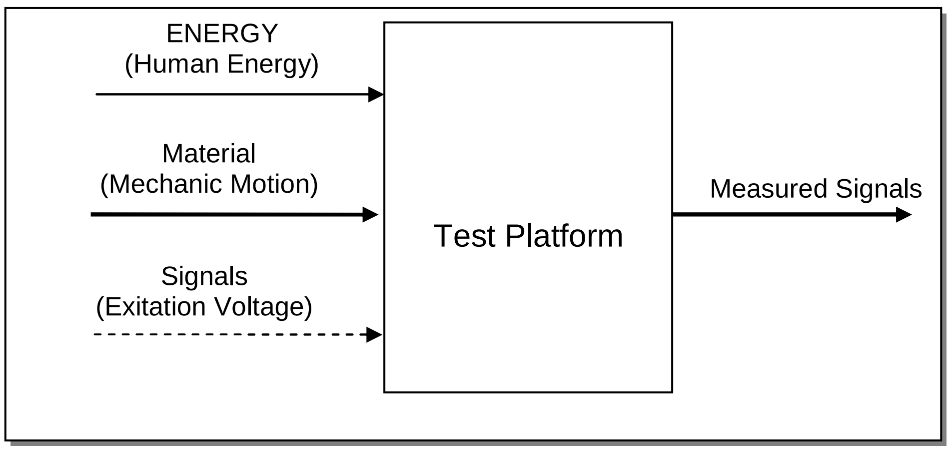
Day by day companies are improving their testing tools and creating more sophisticate elements with more exactitude data. All the existent platforms emphasize in the reaction of some part of the body but neither thinks about the reaction of the driver’s feet.

5 GENERATION AND SELECTION OF CONCEPT TO DEVELOP

For the generation of the concepts have been used the methodology of Five step concept generation.

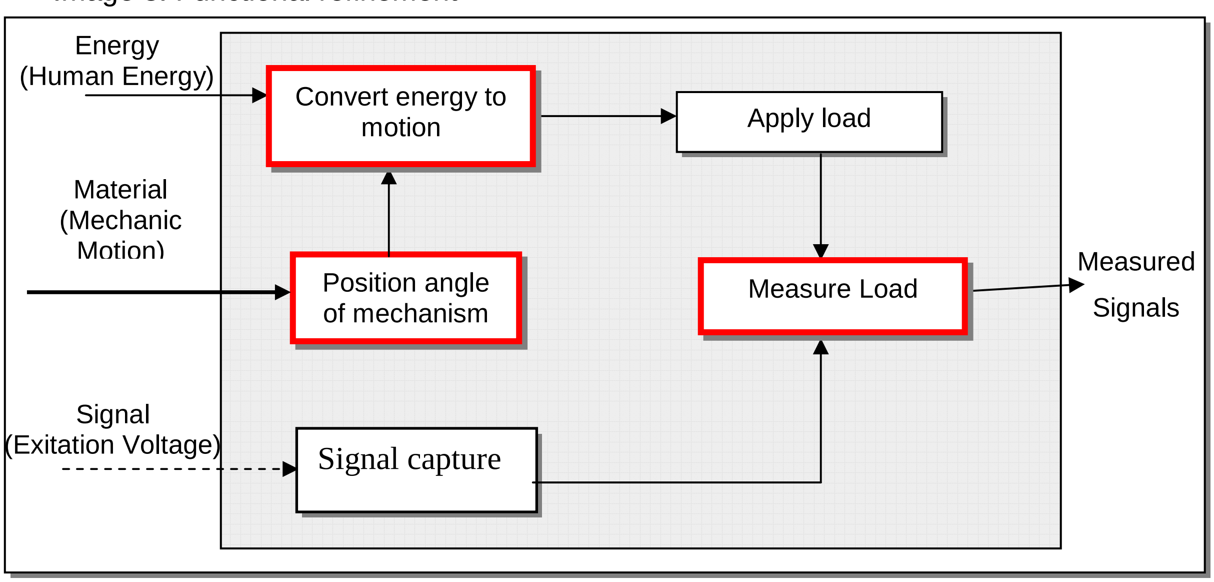
5.1 BLACK BOX DIAGRAM

Image 2. Black box diagram



5.2 REFINEMENT SHOWING SUB-FUNCTIONS

Image 3. Functional refinement



5.3 DECOMPOSITION OF THE CRITICAL WAY

The following sub function has been determined like the more critics considering that its functionality is complex and it is determinate for the physic design of the structure and the data measurement.

The external research was made based on source provided by the internet, nevertheless since it has been mention before does not exist any precedent of this kind of tests. There are more common the tests using dummies which provide of multiple information but this is not useful for the problem to figure out. For this same reason the competitive benchmarking won't be fundamental for obtain a possible solution for the identified problems.

The internal research provides greater and better information. The brainstorming was the base of this internal research and was decisive for the generation of multiple ideas. These ideas will be gathered with the purpose to obtain the best solution for the identified problems.

5.3.1 Convert Energy to Motion This block refers to how is going to be converted the physical motion of a human operator in a mechanic motion able to apply a load.

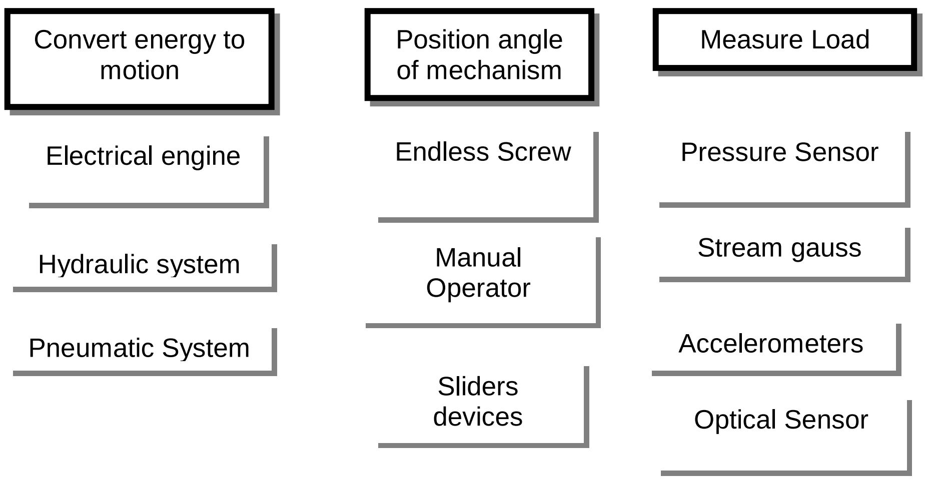
5.3.2 Position Angle of Mechanism This block refers to how will be able the mechanism to change the angle position for simulate different position of the driver's foot. This block is one of the most critics considering that it will determine the final design of the main structure.

5.3.3 Measure Load This block refers to how is going to be taken the measures of the loads applied in order to guarantee reliable data.

5.4 CONCEPT COMBINATION

In the systematic exploration it has been obtained a possible variety of solution for each one of the most critics functions mentioned before with the purpose to generate concepts basing of the combinations of these solutions.

Image 4. Concept combination

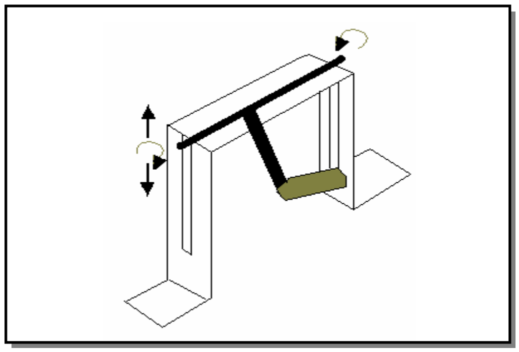


The result of the all possible combination for this concept was around 36, However some of this concepts will be discarded based on their high cost of implementation and they might complicate the develop of the design.

5.5 CONCEPT GENERATION

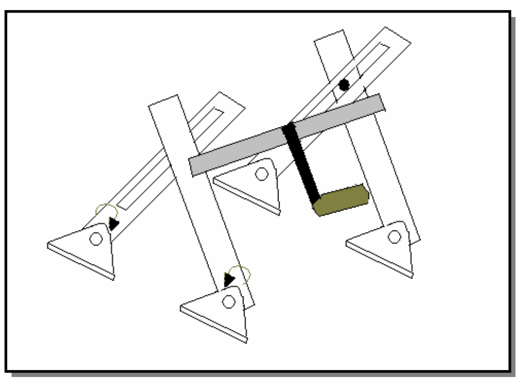
Based on the last diagram it had been chosen three concepts according to the Assumptions and constrains found at the mission statement.

Image 5. Mechanism A



This mechanism is basically a support weld to a platform on the floor. It has lines in the vertical supports and a horizontal bar that can be sliced through these arms. The position of the bar is changed for a human operator.

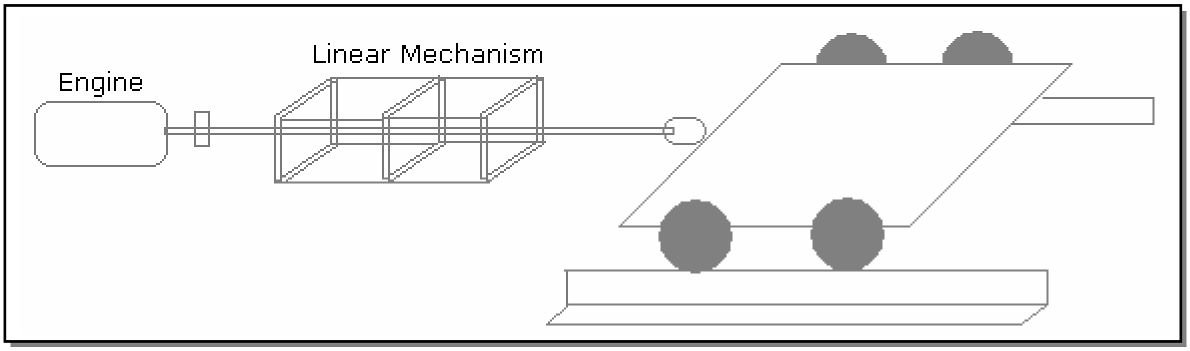
Image 6. Mechanism B



This structure is a set of arms articulated in an axe in the supports. The arms can be rotated in both directions controlling the angle and the high. The positions of the supports can be changed moving these supports through the guide lines.

5.5.1 Concept A Electric Engine – mechanism able to produce a linear motion – (The mechanism for the position of the angle can be any of the showed before) – Any Sensor.

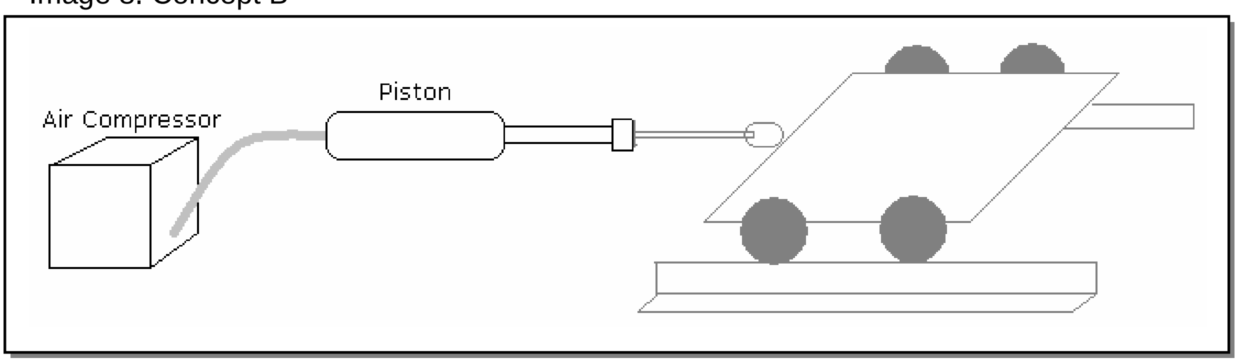
Image 7. Concept A



This concept is an electric motor connected to a linear mechanism able to generate the motion of the trolley. This mechanism can be a bit complex but if is chosen this will be taken from an old printer.

5.5.2 Concept B Pneumatic System – (The mechanism for the position of the angle can be any of the showed before) – Any Sensor.

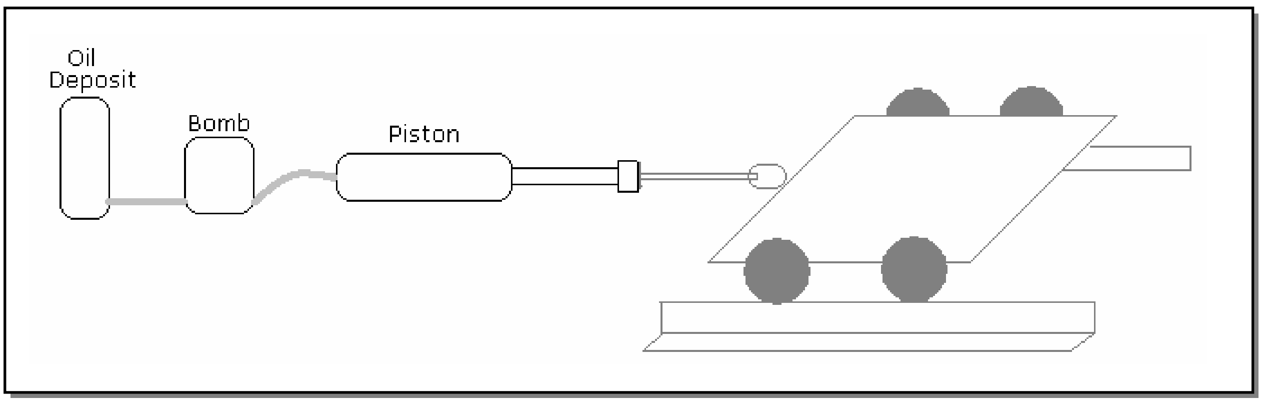
Image 8. Concept B



This concept is basically a pneumatic system able to generate a linear motion for the trolley. This concept can be ideal for the application based on the main features for the pneumatic systems (Ideals for applications of ending and starting position). The main disadvantage is the air compressor required.

5.5.3 Concept C Hydraulic System – (The mechanism for the position of the angle can be any of the showed before) – Any Sensor.

Image 9. Concept 6

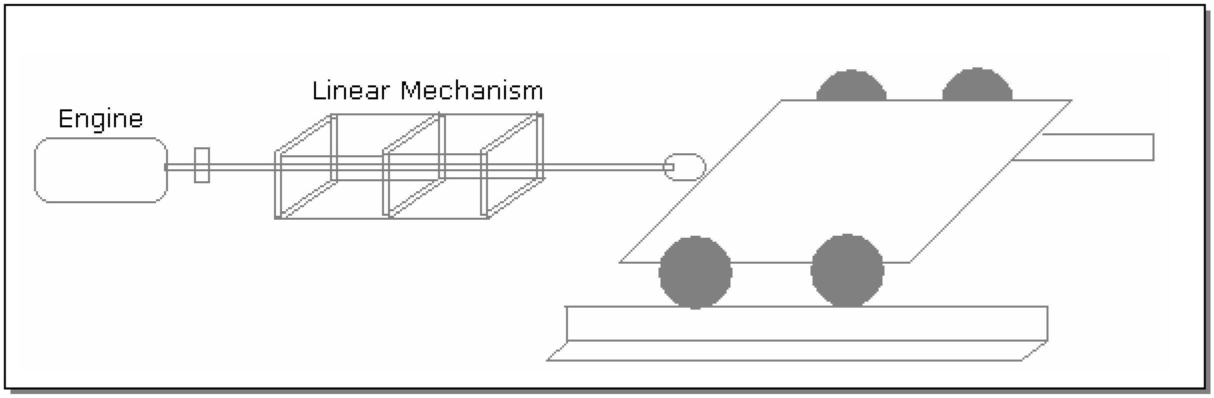


This concept is basically a hydraulic system able to generate a linear motion for the trolley. This concept is not as ideal as it looks because the hydraulic systems are used for application that is required the control of middle positions.

5.6 CONCEPT SELECTION

As a final decision the concept A will be chosen as the device to convert energy in motion. The hydraulic and pneumatic systems require an extra device such as an air compressor or a hydraulic bomb, these devices will increase the final price of the platform and will difficult some aspects of the design.

Image 10. Final Concept



For the angle position of the mechanism will be develop a device of fixed parallel bars. The angle will be changed by a human operator moving the bars in any direction. And the load will be applied turning an endless screw until generate the load required.

A pressure sensor will be used to measure the load applied. The main reason to choose this sensor is based that the Technical University of Liberec has already one of this sort of sensor. And the other one will by bought and will be useful for others applications.

5.6.1 Conceptual valuation Based on the selection of the concept A and the improve for the angle position device there is no reason to make a valuation to identify the sensibility of the concept.

5.6.2 Final product specifications

Table 4. Final Specification

#	MÉTRICS	UNITS	FINAL VALUES
1	Applied Load	N	3000
2	Dimensions of the supports	cm	120
3	Length of the trolley lines	cm	150
4	Diameter of the trolley wheels	cm	25
5	Weight	Kg	40
6	Useful live	Years	4
7	Appearance	Subj	Excellent
8	Cost	USD$	3500

6. DEVELOPMENT OF THE PRODUCT ARCHITECTURE

6.1 GEOMETRIC SCHEME OF THE PRODUCT

Image 11. Virtual prototype back side

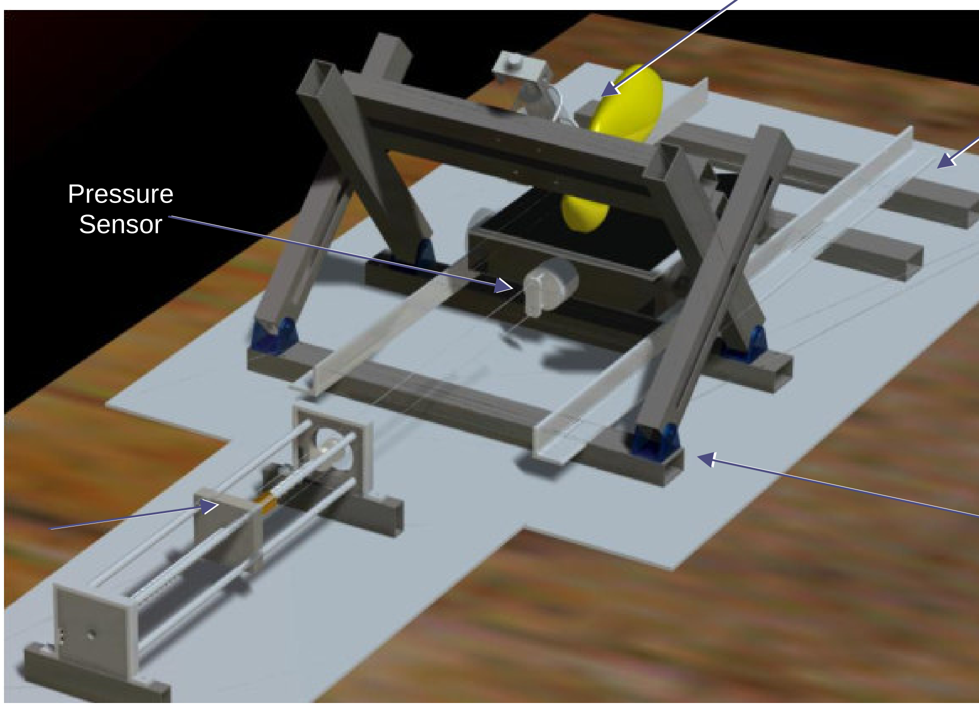
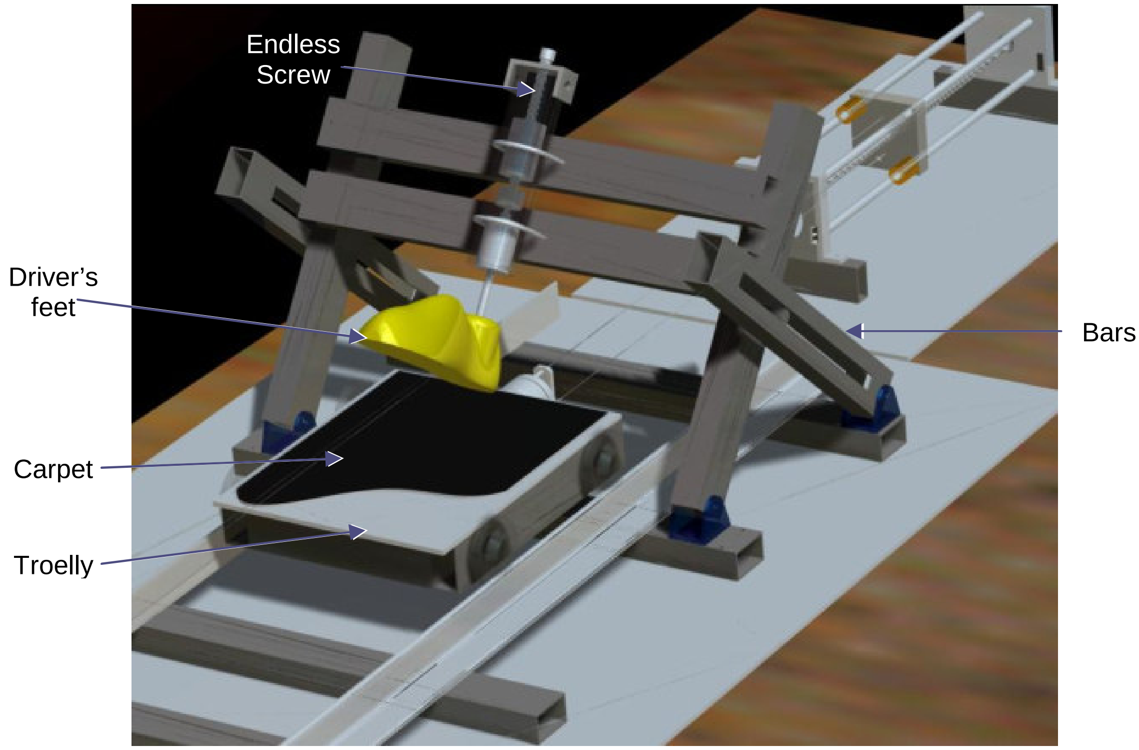


Image 12. Virtual prototype front side



7. INDUSTRIAL DESIGN

7.1 INDUSTRIAL DESIGN VALUATION

The main feature of the platform to develop is that must be functional and provide reliable data, however each step of the design is analyzed with the aim to develop a product with higher valuation. The aesthetic and ergonomics are very important features for the industrial design.

7.1.1 Ergonomics The ergonomics is as not important as other aspects such as functionality and reliability. However the persons who are going to use the platform are not only teachers for the Technical University of Liberec but also researchers of the Skoda Company. Consider this, the handle of the platform should be easy and fit to any person interesting in its manipulation.

7.2.2 Aesthetics The aesthetic considerations are very important considering the product will be installed in one of the Technical University of Liberec laboratories, due to this the platform must looks acceptable and reliable. The member of the university should feel pride of possession for the platform.

7.1.3. Industrial valuation frame

Image 13. Industrial valuation frame

Ergonomics	Easy to use	
	Easy for maintenance	
	Quantity of interactions	
	Interaction newness.	
	Security.	
Aesthetics	Product differentiation.	
	Possession pride, Image or fashion.	
	Group motivation.	

7.2 INDUSTRIAL DESIGN VALUATION AND IMPACT

Analyzing the result obtained from the last chart is possible determinate that the product could be dominated by the users. The main aspect for tha last decision taken is the handle of the product must be relited by intuition.

Image 14. Classification of the product

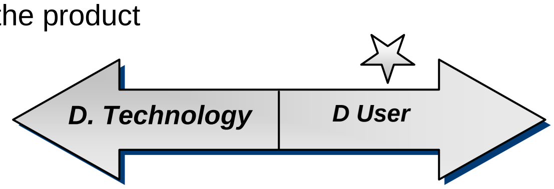


Image 15. Positional Bar

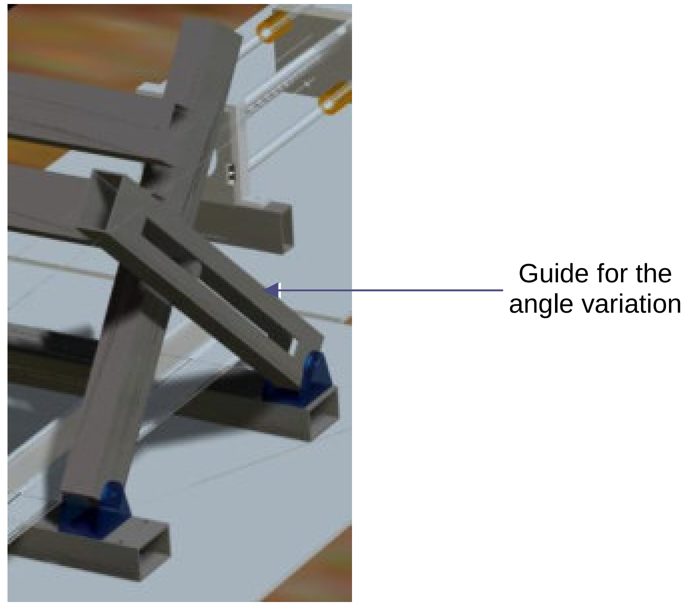
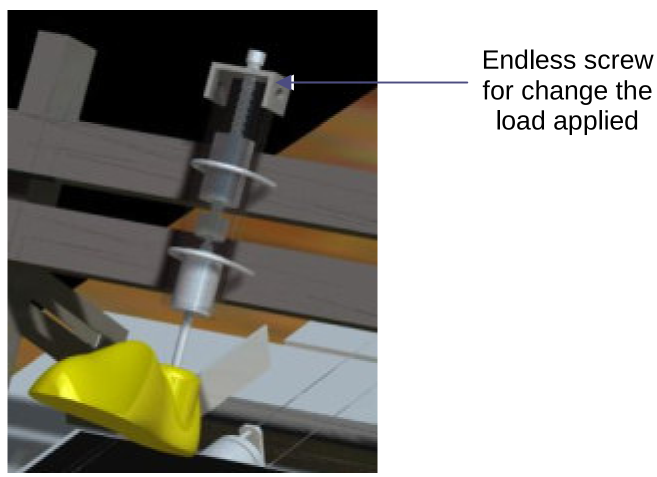


Image 16. Driver's Feet simulation



7.2.1 Interface quality Considering that the platform is a group of mechanism that must be assembled of the correct way without any mistake the interface quality must be high. In addition the data obtained in the experiment will be reliable if there is a good interface between the different mechanisms.

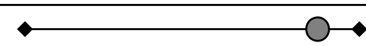
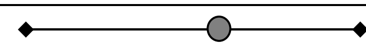
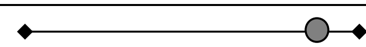
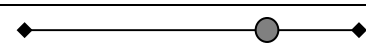
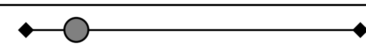
7.2.2 Emotional requirements This is not as important aspect to considering as others mentioned before. However the platform will be installed in some of the Technical University of Liberec laboratories, due to this would be interesting that every member of the university fell pride of possession for the platform.

7.2.3 Easy for maintenance Since the platform is going to have a continuous use and test and considering the long useful live specified in the final metrics, the platform should be easy for maintenance.

7.2.4 Appropriated use of the materials The material of the product must be trustworthiness considering the loads that will interact on the platform. For this reason the material must be chosen of appropriated way taking care for no increasing the manufacture cost.

7.2.5 Product differentiation Due to the specification of the product there is no comparison point with other product. For this reason there is no product differentiation.

Table 5. Valuation of the industrial design

VALUATION OF THE INDUSTRIAL DESIGN	
Interface quality.	
Emotional requirements.	
Easy for maintenance.	
Appropriated use of the materials.	
Product differentiation.	

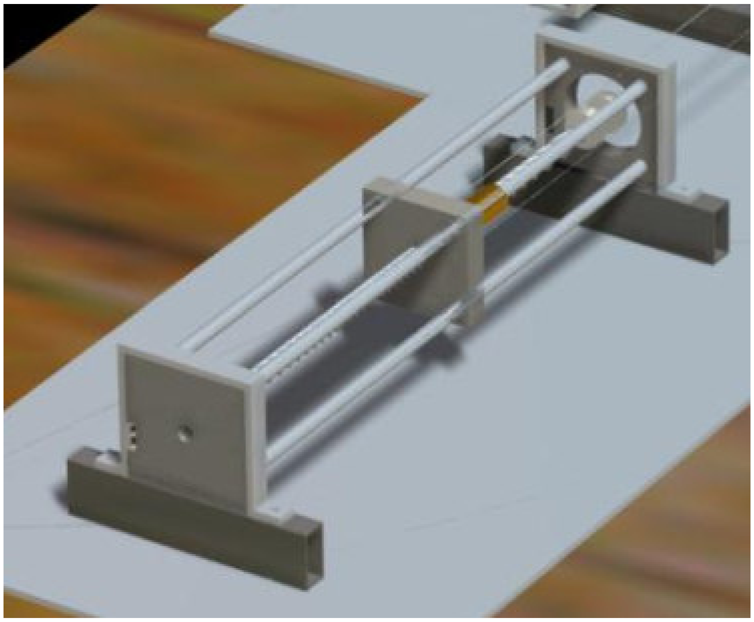
8. DESIGN FOR MANUFACTURE & ASSEMBLY

8.1 DESIGN FOR MANUFACTURE ANALYSIS.

For the complexity of the platform there is no relevant part such as a chassis or something. The platform is an assembly of many mechanisms and parts that must have the correct measurements. For this reason each part has to be manufacture. The advantage is the easy way to find any part and these can be also designed to fit at the laboratories of the Technical University of Liberec.

Since there is a mechanism that have been taken for an old printer machine, this part and its component won't be mention in the design for assembly analysis.

Image 17. Printer Machine Mechanism



8.2 DESIGN FOR ASSEMBLY ANALYSIS

As was mentioned before, each part will be manufacture taking care of the measurements defined in the design. The assembly will be easy and fast since there is some welding join and other that will be done with screws.

Number of parts considered = 32.   Considered time of assembly = 40 min
Considered time for assembly = handling time x fit time = 100 x 24 = 2400 s

$$DFA\ index = \frac{\#Parts\ \min * 3s}{Considered\ time\ of\ assembly}$$

$$DFAindex = \frac{32 * 3s}{40 * 60s} = 0.04$$

8.3 COST STRUCTURE ANALYSIS

The cost for the parts of the main structures are cheap since will be bought in quantity and then will be cut and treated for obtain the required part. For example for the trolley lines will be bought six meter of angle bar and then will be cut in two bars of three centimeter each one. The same will be done for the supports of the platform. The sensor will be the more expensive devices.

The next chart shows the approximation of cost due to parts.

Table 6. Components list

COMPONENT	QUANTITY	ESTIMATED COST
Pipe Square 4 * 2 cm	10m	USD$ 60
L Angle Bar	6m	USD$ 20
Pipe (Bearing)	1m	USD$8
Pressure Sensor	2	USD$3000

Wheels (diameter 20cm)	4	USD$ 22
Bearings	4	USD$30
Screws	8	USD$1
Supports	4	USD$ 15
Endless Screw	1	USD$ 2
Embracers	2	USD$ 1
Iron Bar (diameter 1cm)	20cm	USD$ 2
Feet model in wood	1	USD$ 5
Passers Screws	2	USD$ 1
Butterfly Screw	2	USD$ 1
TOTAL	**Relative**	USD$ 3168

9. PROTOTYPES

With the aim to determinate the right election of the concept to develop it has been realized prototypes. This will be useful to determinate possible improves or change before the final design.

9.1 ANALYTIC PROTOTYPES

This analytic prototype was made with the aim to determinate the mathematic model of the system to design. At the end was obtained an equation that will be useful to determinate the coefficient of friction between the carpet and the drivers' feet. The prototype was determinate as is showed in the next figure:

Image 18. Sketch of the analytic prototype

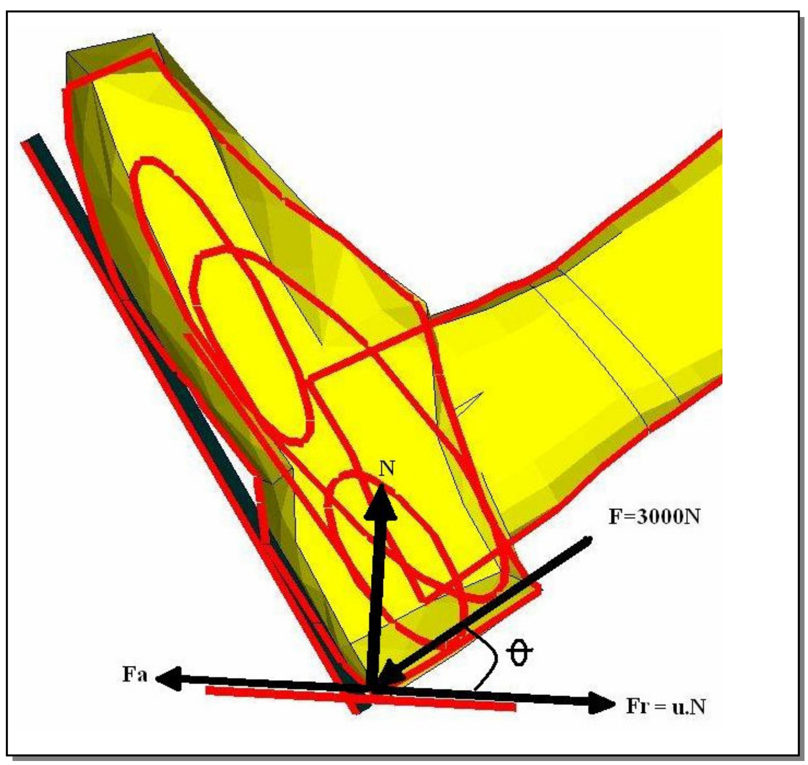
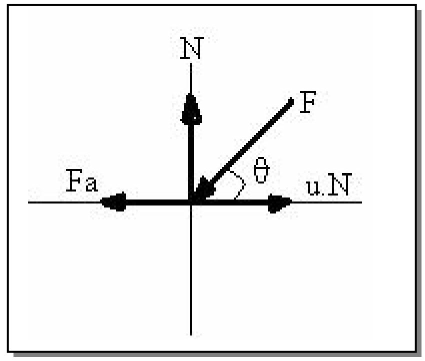


Image 19. Forces Diagram



$$N - F * \sin\theta = 0 \Rightarrow N = F * \sin\theta$$

$$Fa + F * \cos\theta - \mu * N = 0 \Rightarrow Fa + F * \cos\theta = \sin\theta$$

$$\mu = \frac{Fa}{F * \sin\theta} + \frac{\cos\theta}{\sin\theta}$$

10. CONCLUSIONS

- The design and analyze of the test platform for simulate the driver's feet at the time of restrain in a collision with the purpose to calculate the coefficient of friction between the carpet and the driver's feet was designed in the time specified.

- The product developed will be able to calculate reliable data used to determinate the coefficient of friction between the carpet and the driver's feet at the time of restrain in a collision.

- The product developed has reached the goals proposed at the beginning of the paper.

- All the necessities that were determinate at the beginning of this paper have been satisfied.

- Were made simulation and modeling of the platform using the CAD, CAE tools and this were useful to give an idea of the behavior of the platform, efforts, constrains, measurements and dimensions,.

- The present work was a new test method emphasizing at the moment of the driver push the break pedal that will be able to contribute data to analyze and improve the security for the drive.

11. RECOMMENDATIONS

- Since the weight of the platform will depend on the base will be better have the platform fixed to the floor in determinate area.

- For safety reasons will be better retired the sensors when the platform does not be used.

- Each part of the platform must have the required maintenance.

- The applied load must not overload the measure specified in the metrical specifications.

BIBLIOGRAPHY

Crash test and Analysis [on line]. Paris, France: Safetimes and automobile test corporation, 2000. [visited 10th of September, 2005]. Available on Internet
http://www.crash-test.org/

General Motors Company [on line]. New York, USA: General Motor Company, 1996. [visited 2nd of September, 2005]. Available on Internet
http://www.gm.com/company

HISTAND, Michael B. y ALCIATORE, David G. Introduction to Mechatronics and Measurement Systems. New York: McGraw Hill, 1999. 400 p.

NORTON, Robert L. Diseño de Máquinas. México: Prentice Hall, 1999. 1048 p.

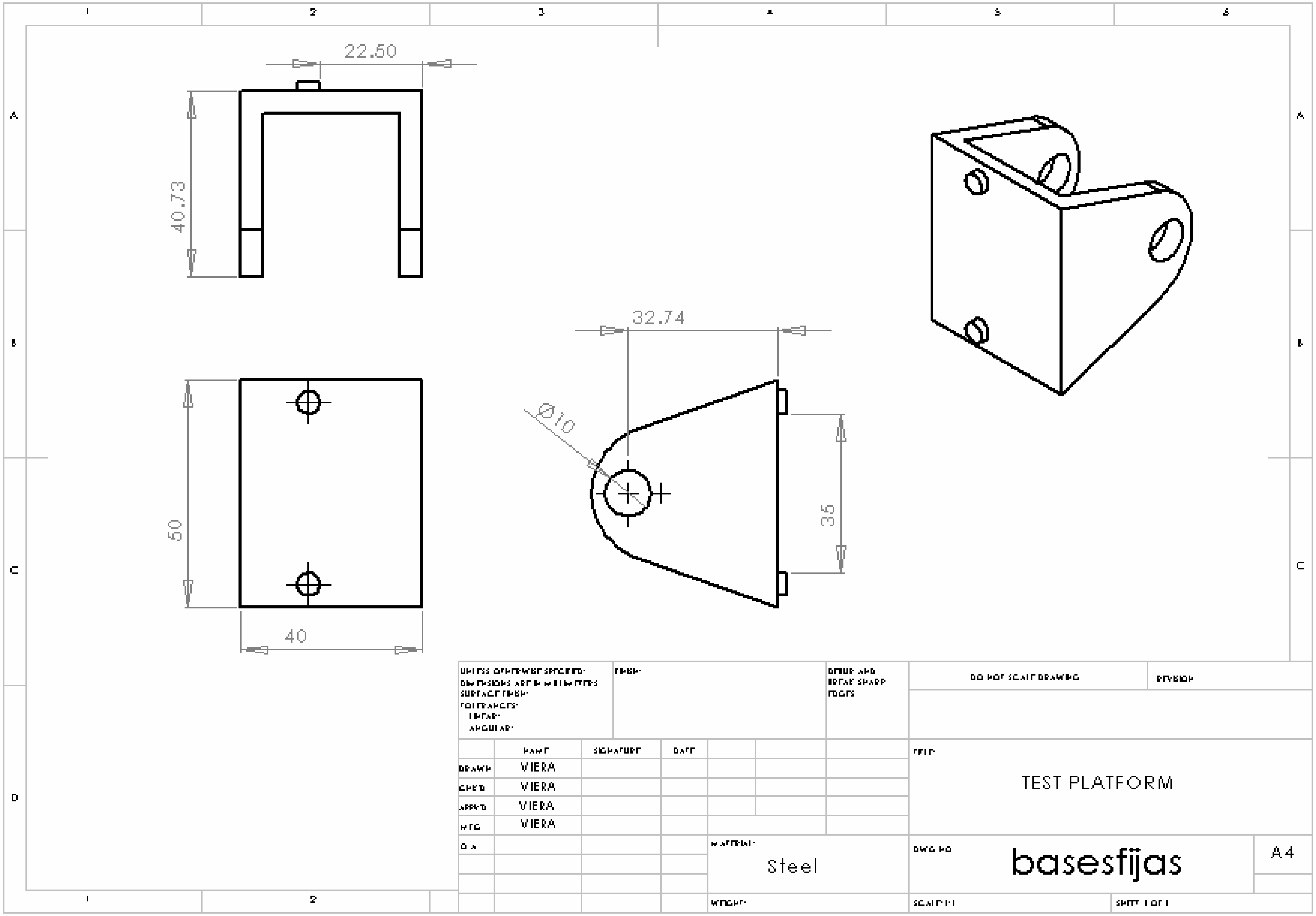
OTTO, K. ET.AL. Products Designs - Techniques in Reverse Engineering and New Product Development. 3 ed. Chicago, USA: Prentice Hall, 2001. 585 p.

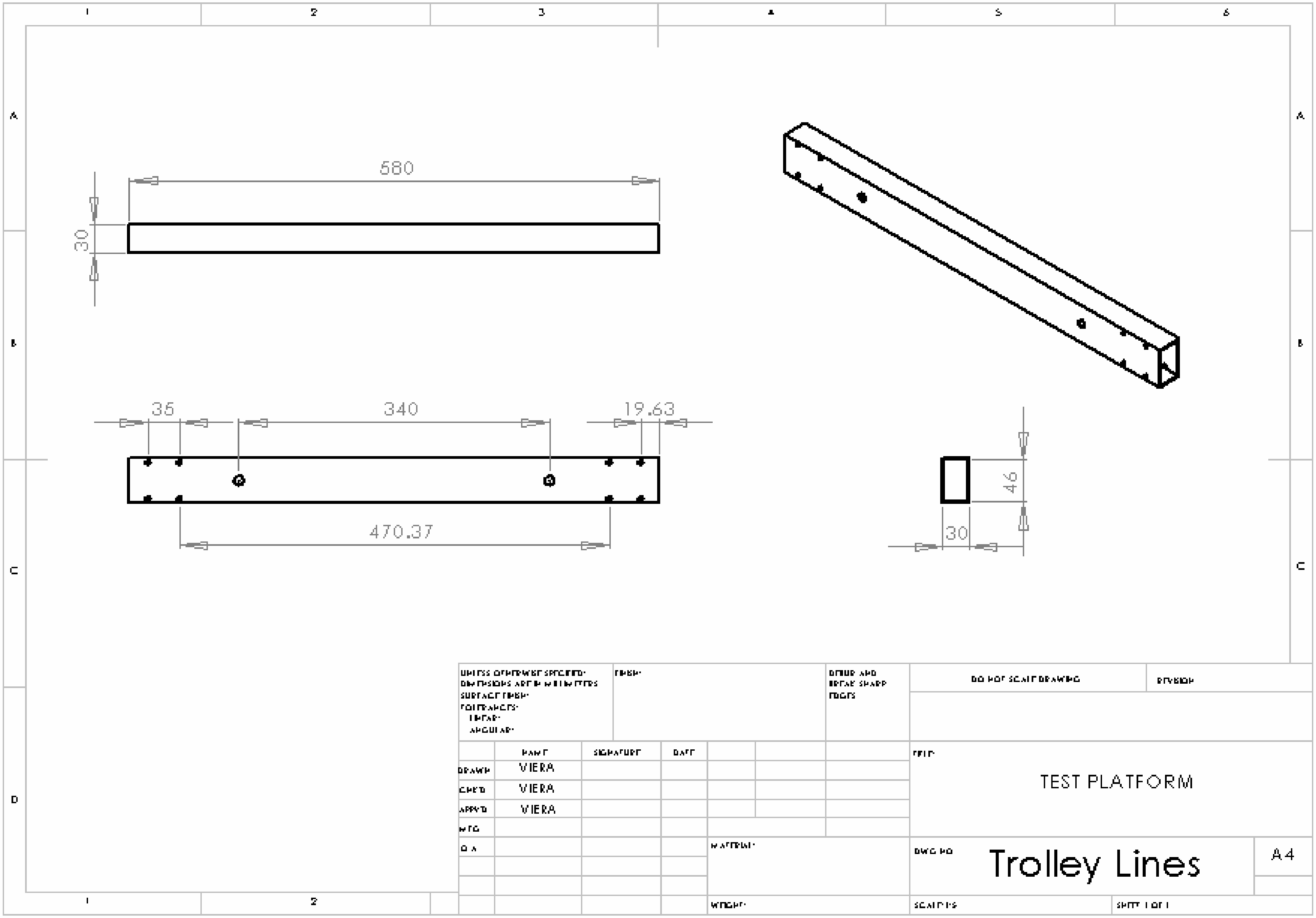
Test and vehicle performance [on line]. Brigthon, UK: Channel 4 Company, 2002. [visited 28th of august, 2005]. Available on Internet
http://www.channel4.com/4car/buying-guide/advice/crashsafety-542

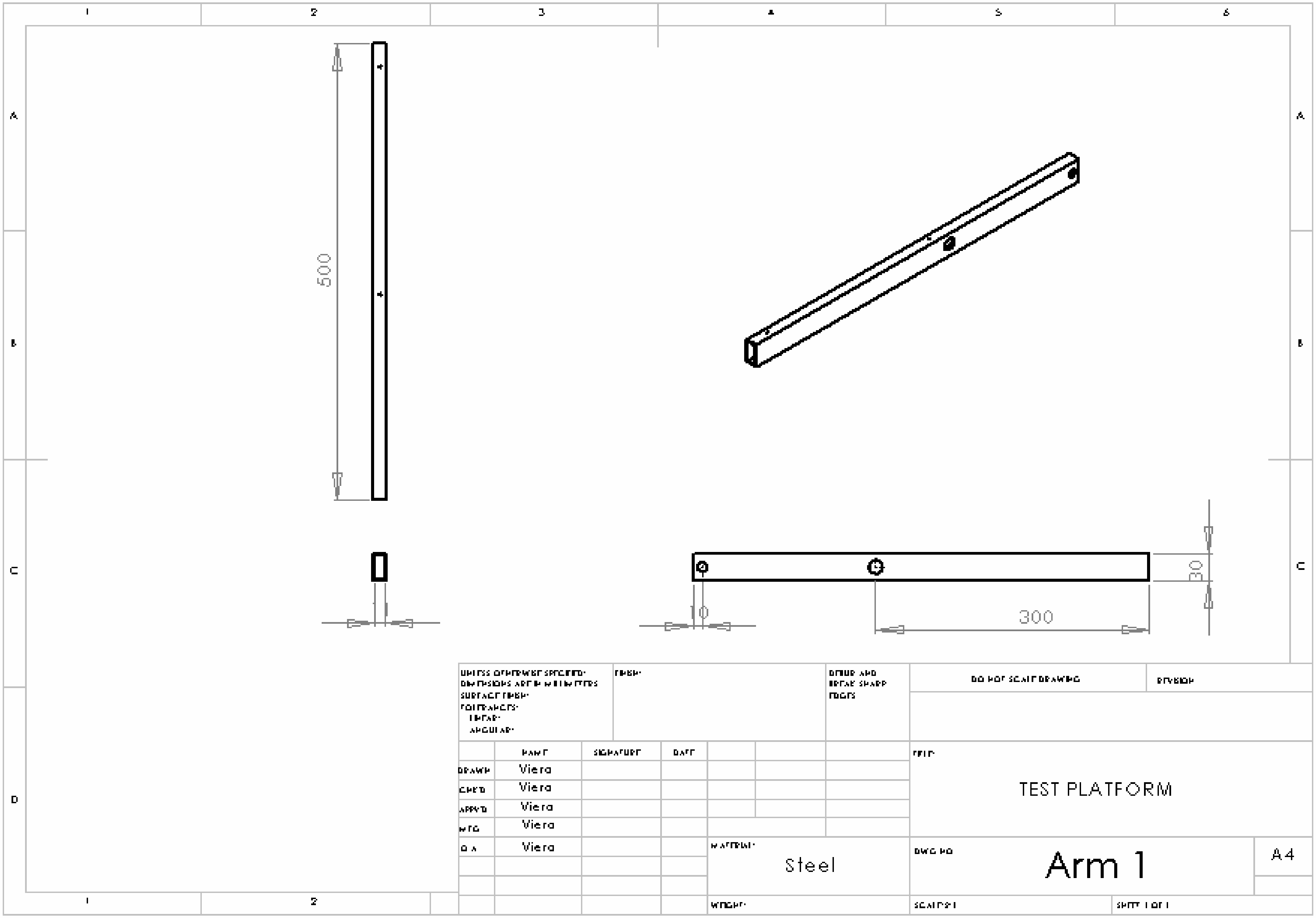
ULRICH, Kart T. Y EPPINGER, Steven D. Product Design and Development. 2 ed. Boston, USA: McGraw Hill, 2000. 358 p.

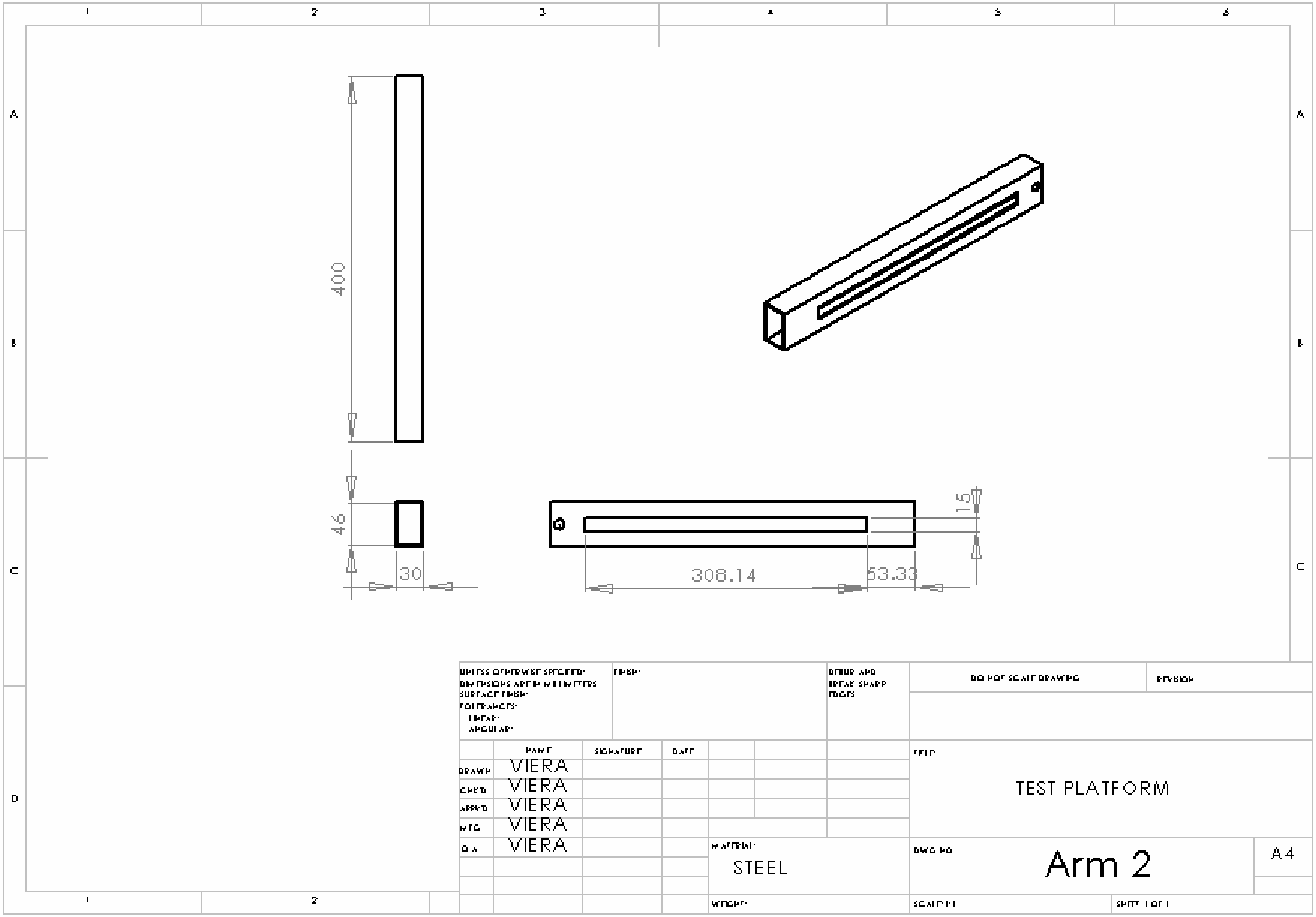
ATTACHMENTS

Attachment A. Peaces Plans

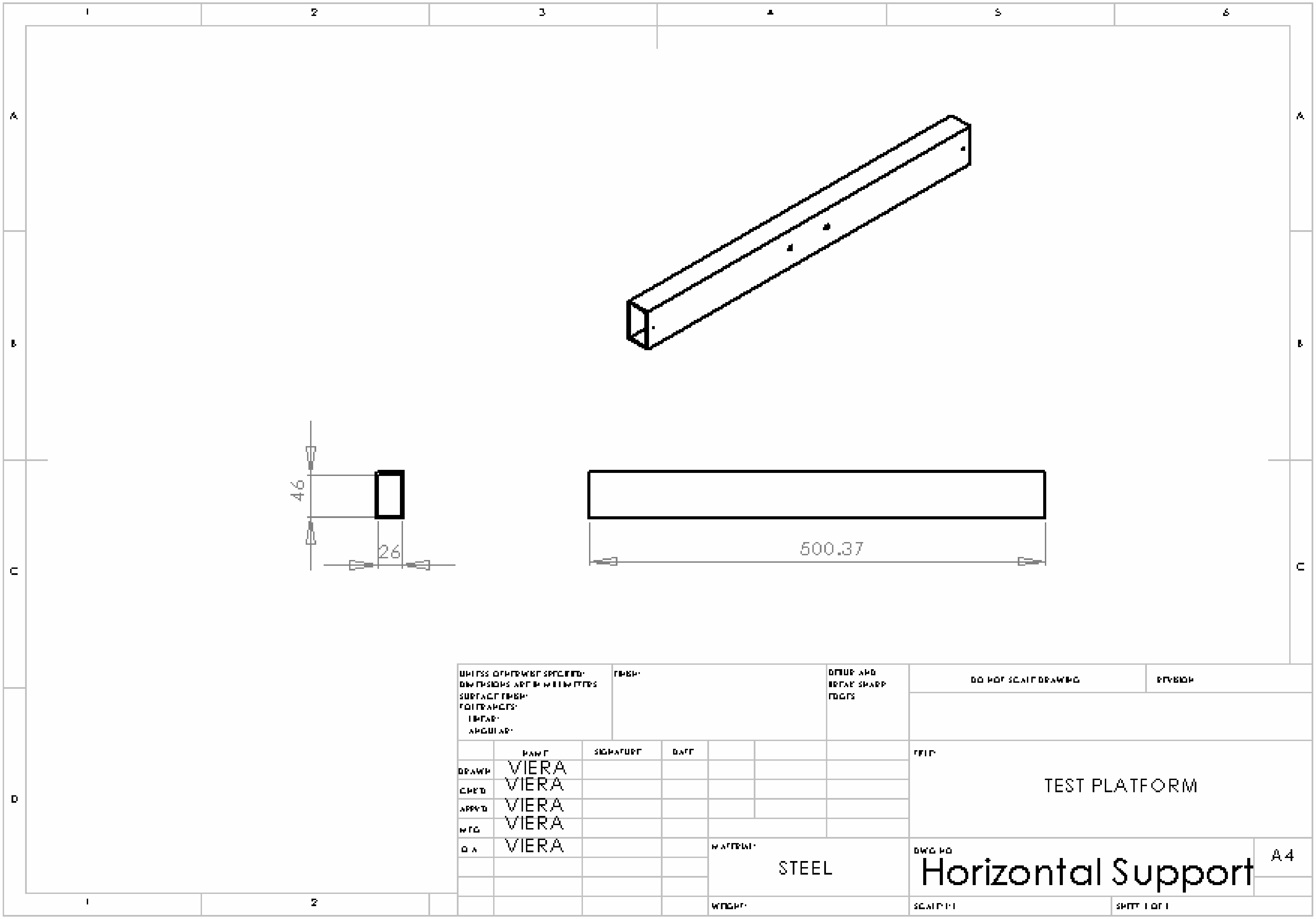

22.50
40.73
50
40
32.74
Ø10
35
UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN MILLIMETERS
SURFACE FINISH:
TOLERANCES:
LINEAR:
ANGULAR:
FINISH:
DEBUR AND BREAK SHARP EDGES
DO NOT SCALE DRAWING
REVISION
NAME
SIGNATURE
DATE
DRAWN VIERA
CHK'D VIERA
APPV'D VIERA
MFG VIERA
Q.A
TITLE:
TEST PLATFORM
MATERIAL:
Steel
DWG NO.
basesfijas
A4
WEIGHT:
SCALE:1:1
SHEET 1 OF 1

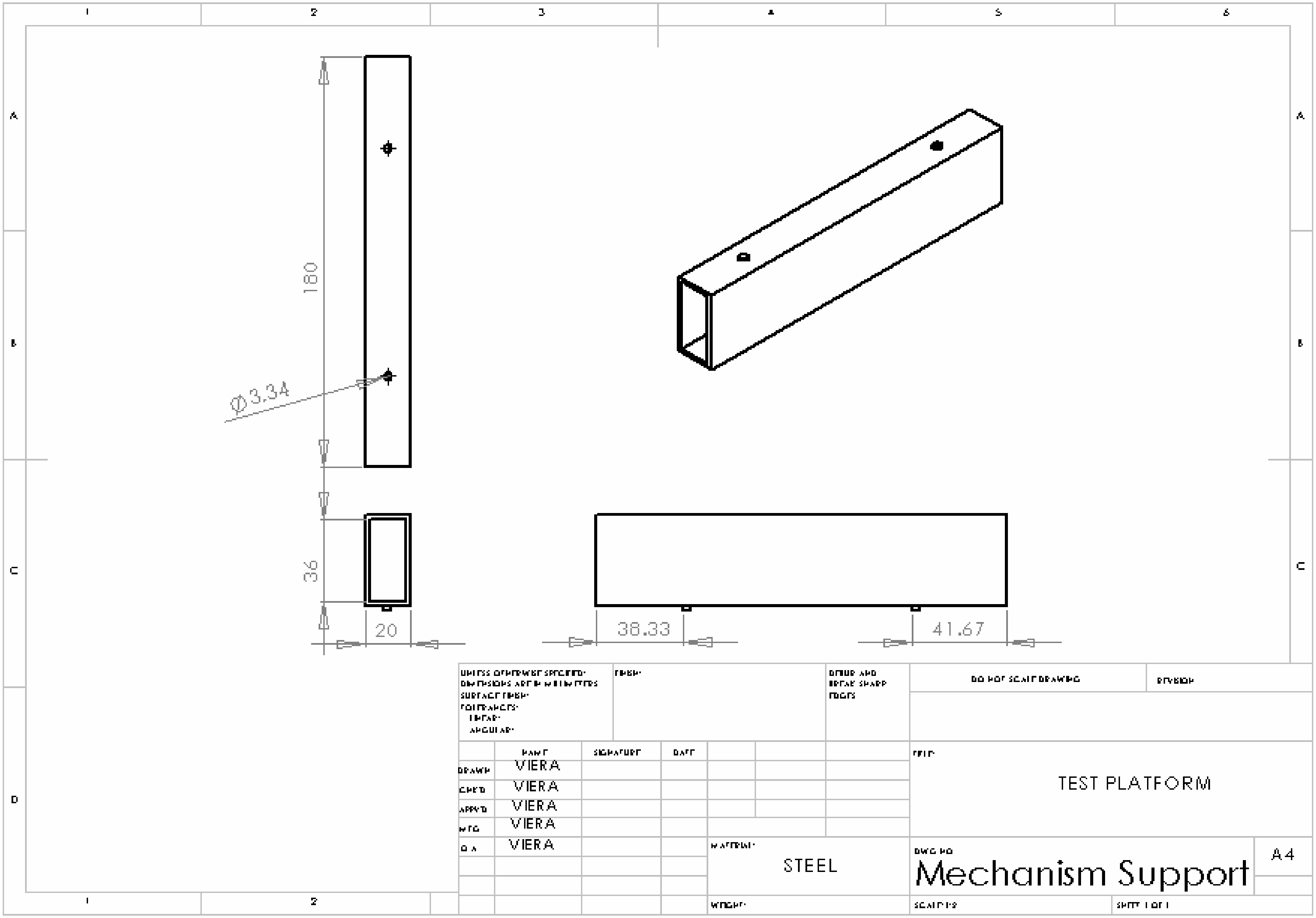

580
30
35
340
19.63
470.37
46
30
UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN MILLIMETERS
SURFACE FINISH:
TOLERANCES:
LINEAR:
ANGULAR:
FINISH:
DEBUR AND BREAK SHARP EDGES
DO NOT SCALE DRAWING
REVISION
NAME
SIGNATURE
DATE
DRAWN
VIERA
CHK'D
VIERA
APPV'D
VIERA
MFG
Q.A
MATERIAL:
WEIGHT:
TITLE:
TEST PLATFORM
DWG NO.
Trolley Lines
A4
SCALE:1:5
SHEET 1 OF 1

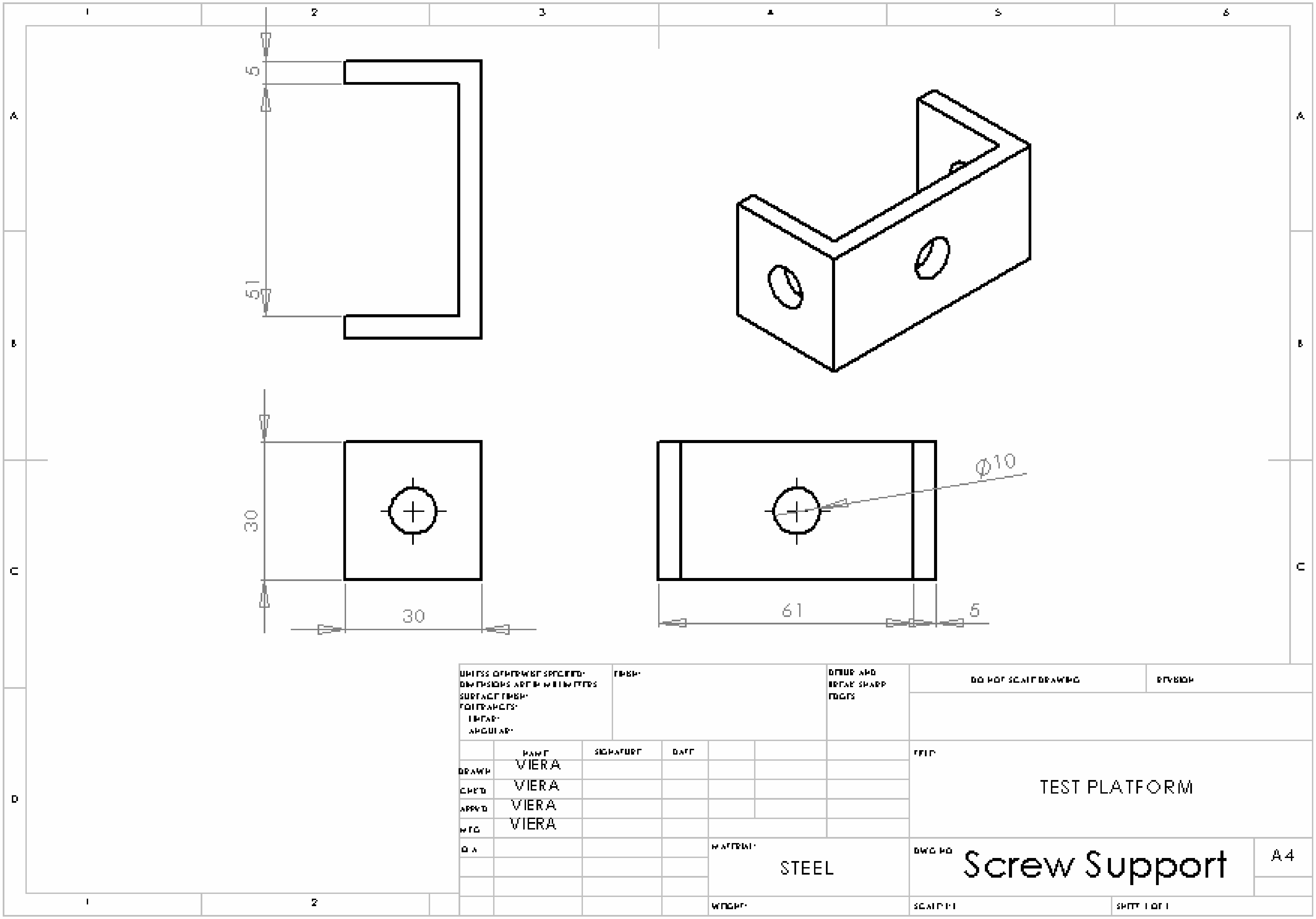

500
300
30
10
DO NOT SCALE DRAWING
REVISION
Viera
Viera
Viera
Viera
Viera
TEST PLATFORM
Steel
Arm 1
A4

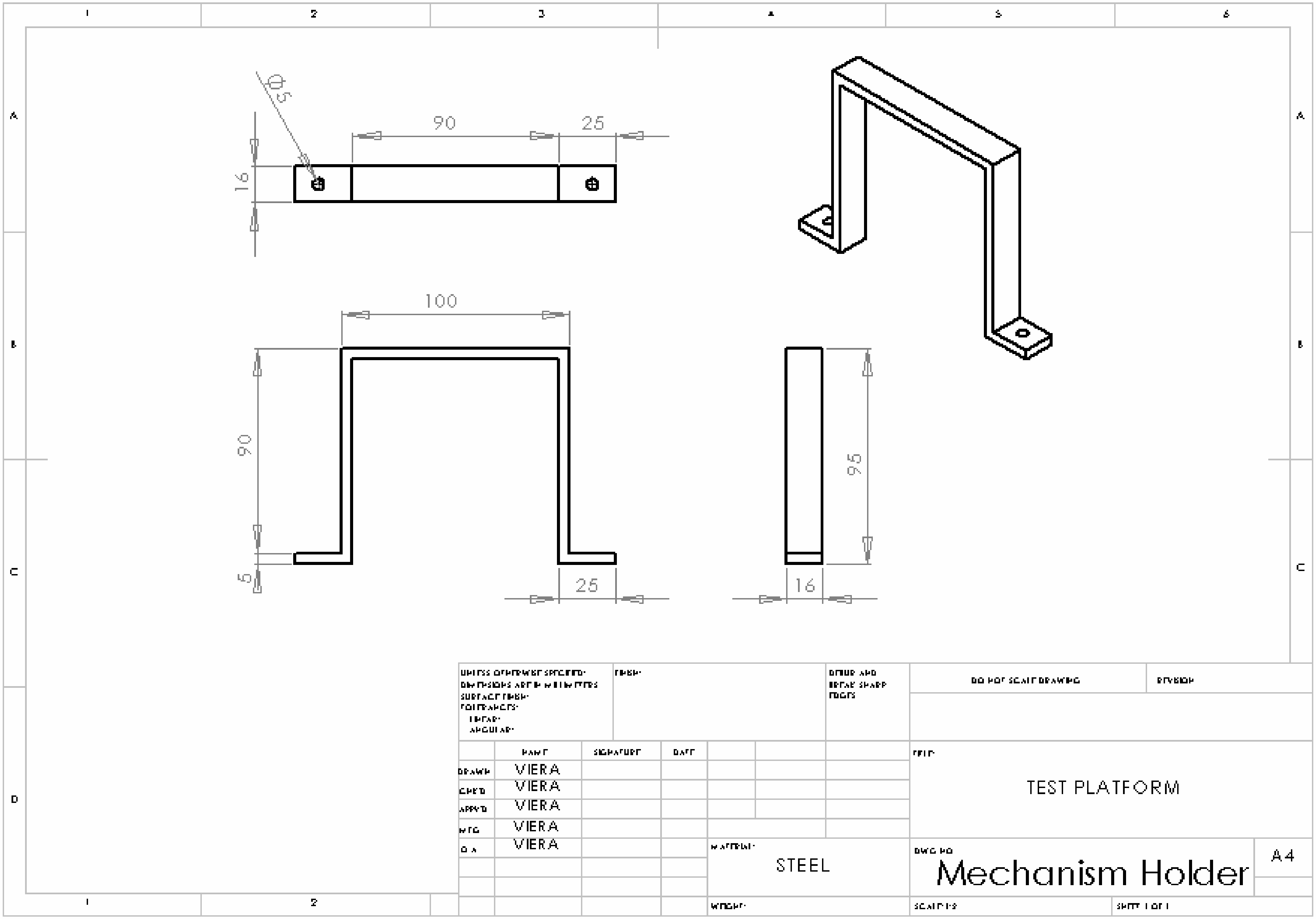


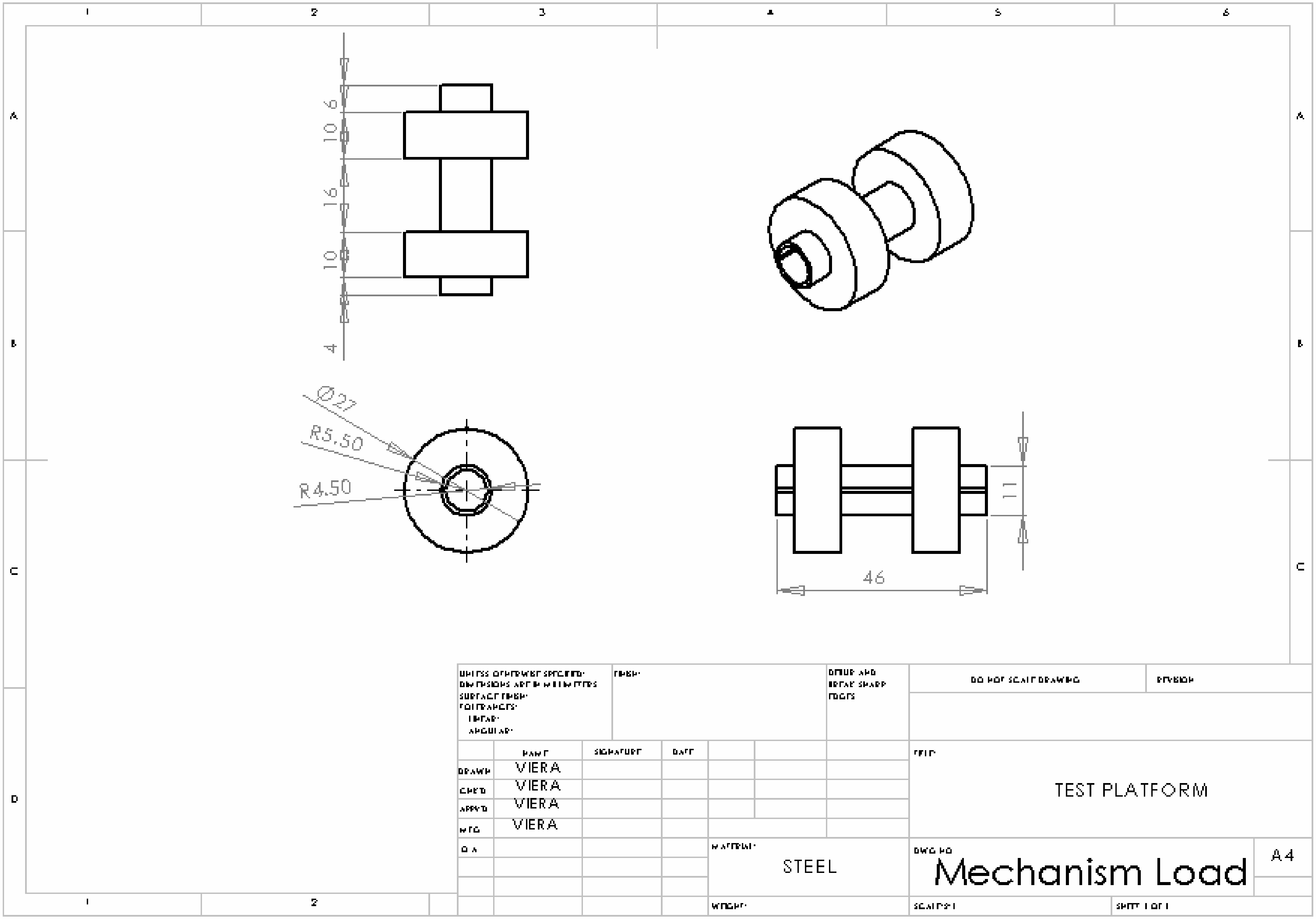
400
46
30
308.14
53.33
15
UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN MILLIMETERS
SURFACE FINISH:
TOLERANCES:
LINEAR:
ANGULAR:
FINISH:
DEBUR AND BREAK SHARP EDGES
DO NOT SCALE DRAWING
REVISION
NAME
SIGNATURE
DATE
DRAWN VIERA
CHK'D VIERA
APPV'D VIERA
MFG VIERA
Q.A VIERA
MATERIAL:
STEEL
WEIGHT:
TITLE:
TEST PLATFORM
DWG NO.
Arm 2
A4
SCALE:1:1
SHEET 1 OF 1

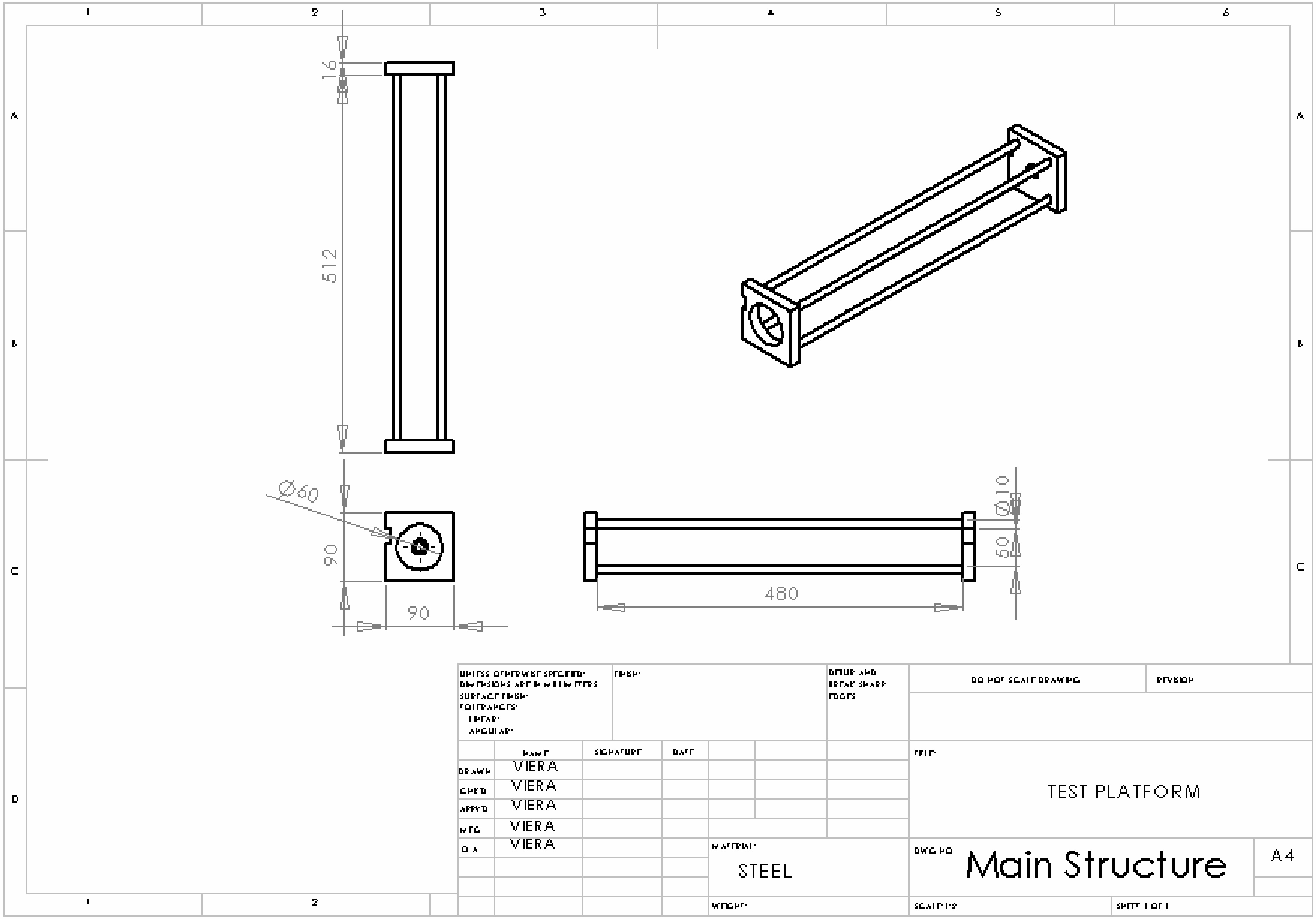

46
26
500.37
DRAWN VIERA
CHK'D VIERA
APPV'D VIERA
MFG VIERA
Q.A VIERA
MATERIAL: STEEL
TITLE: TEST PLATFORM
DWG NO. Horizontal Support
A4

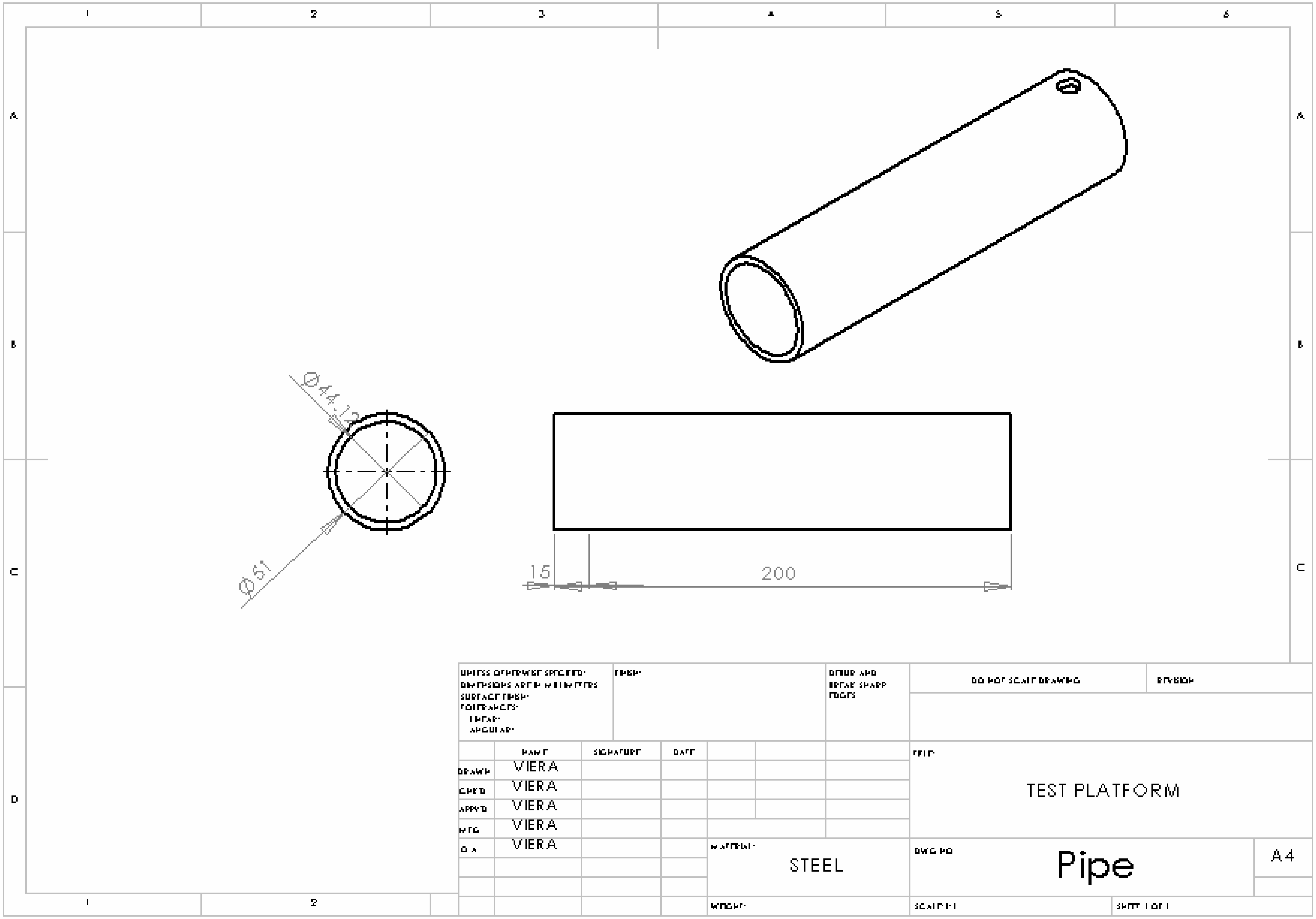

180
Φ3.34
36
20
38.33
41.67
UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN MILLIMETERS
SURFACE FINISH:
TOLERANCES:
LINEAR:
ANGULAR:
FINISH:
DEBUR AND BREAK SHARP EDGES
DO NOT SCALE DRAWING
REVISION
NAME
SIGNATURE
DATE
DRAWN VIERA
CHK'D VIERA
APPV'D VIERA
MFG VIERA
Q.A VIERA
TITLE:
TEST PLATFORM
MATERIAL:
STEEL
DWG NO.
Mechanism Support
A4
WEIGHT:
SCALE:1:2
SHEET 1 OF 1

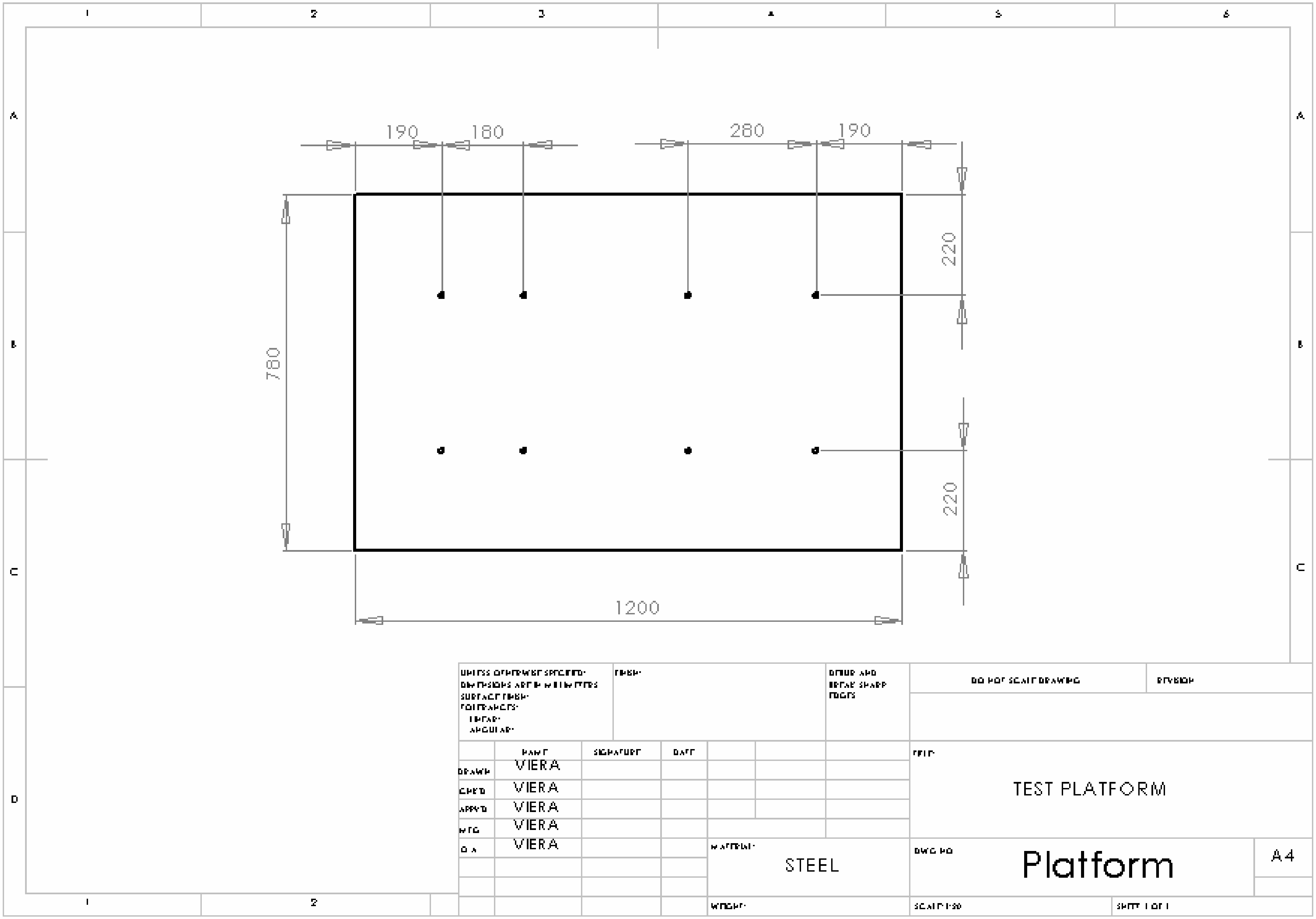

5
51
30
30
61
5
Ø10
UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN MILLIMETERS
SURFACE FINISH:
TOLERANCES:
LINEAR:
ANGULAR:
FINISH:
DEBUR AND BREAK SHARP EDGES
DO NOT SCALE DRAWING
REVISION
NAME
SIGNATURE
DATE
DRAWN
VIERA
CHK'D
VIERA
APPV'D
VIERA
MFG
VIERA
Q.A
TITLE:
TEST PLATFORM
MATERIAL:
STEEL
DWG NO.
Screw Support
A4
WEIGHT:
SCALE:1:1
SHEET 1 OF 1

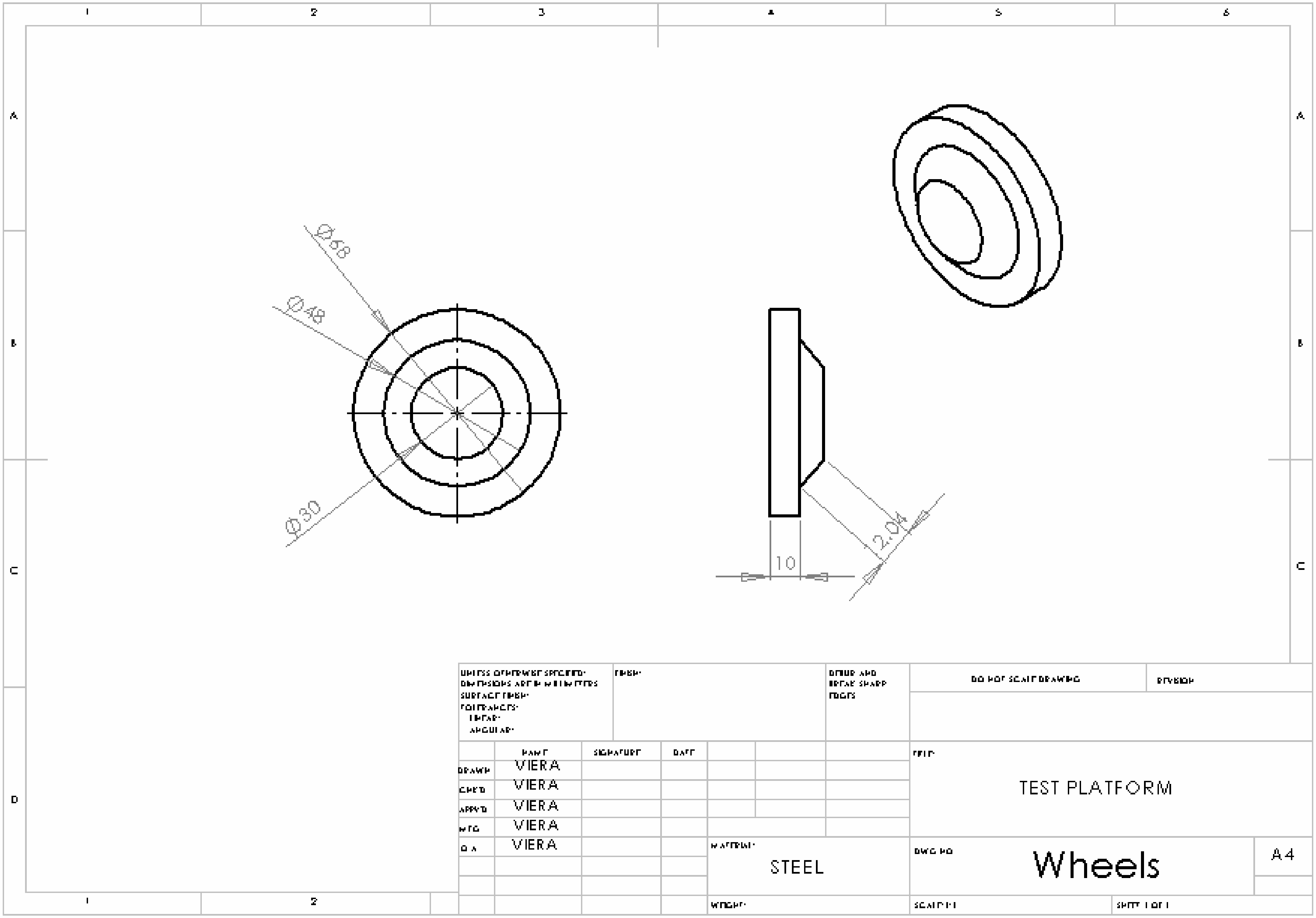

Ø5
90
25
16
100
90
5
25
95
16
UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN MILLIMETERS
SURFACE FINISH:
TOLERANCES:
LINEAR:
ANGULAR:
FINISH:
DEBUR AND BREAK SHARP EDGES
DO NOT SCALE DRAWING
REVISION
NAME
SIGNATURE
DATE
DRAWN
VIERA
CHK'D
VIERA
APPV'D
VIERA
MFG
VIERA
Q.A
VIERA
TITLE:
TEST PLATFORM
MATERIAL:
STEEL
DWG NO.
Mechanism Holder
A4
WEIGHT:
SCALE:1:2
SHEET 1 OF 1

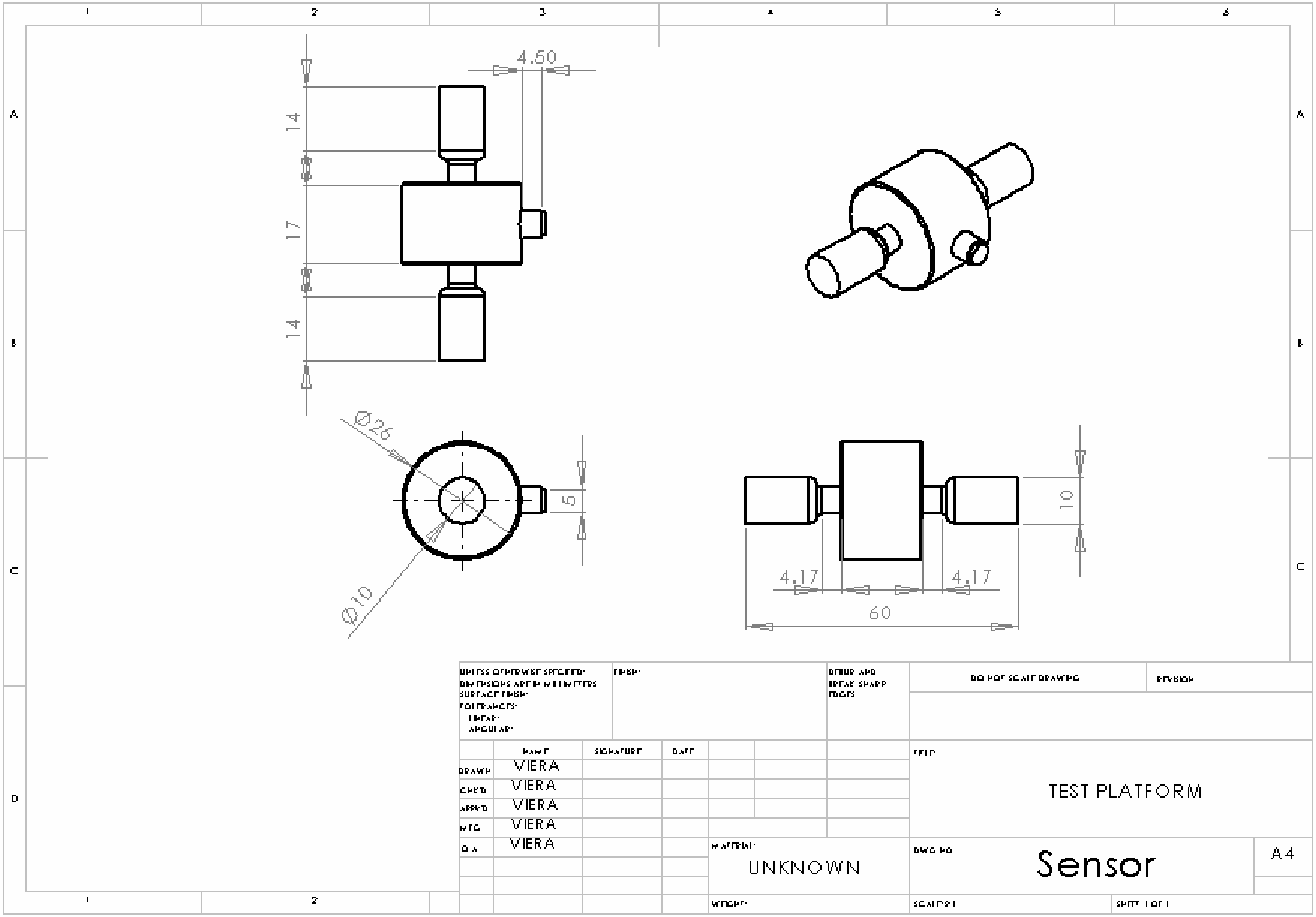

10
6
10
16
10
4
Ø27
R5.50
R4.50
11
46
UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN MILLIMETERS
SURFACE FINISH:
TOLERANCES:
LINEAR:
ANGULAR:
FINISH:
DEBUR AND
BREAK SHARP
EDGES
DO NOT SCALE DRAWING
REVISION
NAME
SIGNATURE
DATE
DRAWN
VIERA
CHK'D
VIERA
APPV'D
VIERA
MFG
VIERA
Q.A
TITLE:
TEST PLATFORM
MATERIAL:
STEEL
DWG NO.
Mechanism Load
A4
WEIGHT:
SCALE:2:1
SHEET 1 OF 1

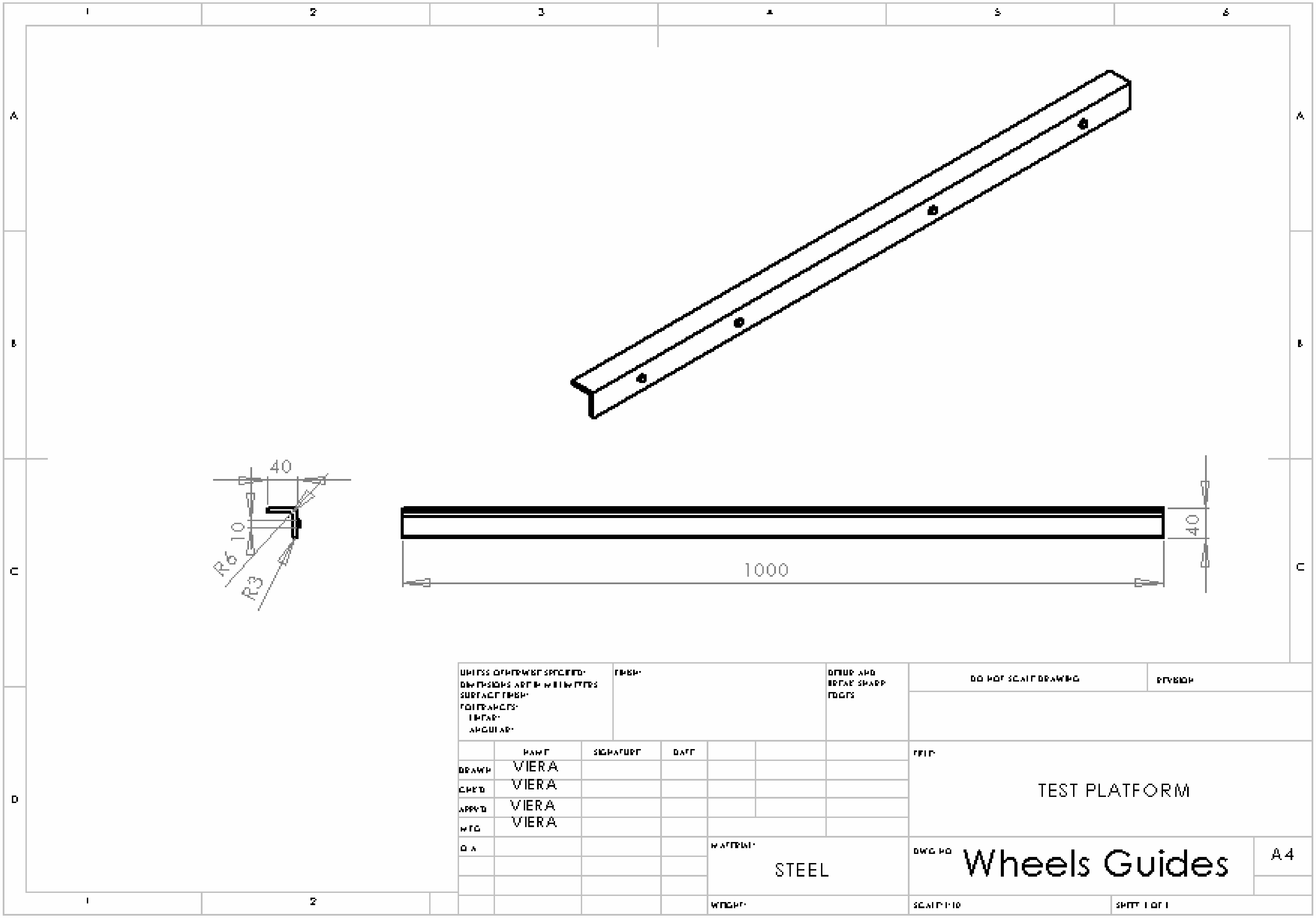

16
512
Ø60
90
90
480
Ø10
50
UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN MILLIMETERS
SURFACE FINISH:
TOLERANCES:
LINEAR:
ANGULAR:
FINISH:
DEBUR AND BREAK SHARP EDGES
DO NOT SCALE DRAWING
REVISION
NAME
SIGNATURE
DATE
DRAWN VIERA
CHK'D VIERA
APPV'D VIERA
MFG VIERA
Q.A VIERA
TITLE:
TEST PLATFORM
MATERIAL:
STEEL
DWG NO.
Main Structure
A4
WEIGHT:
SCALE:1:9
SHEET 1 OF 1

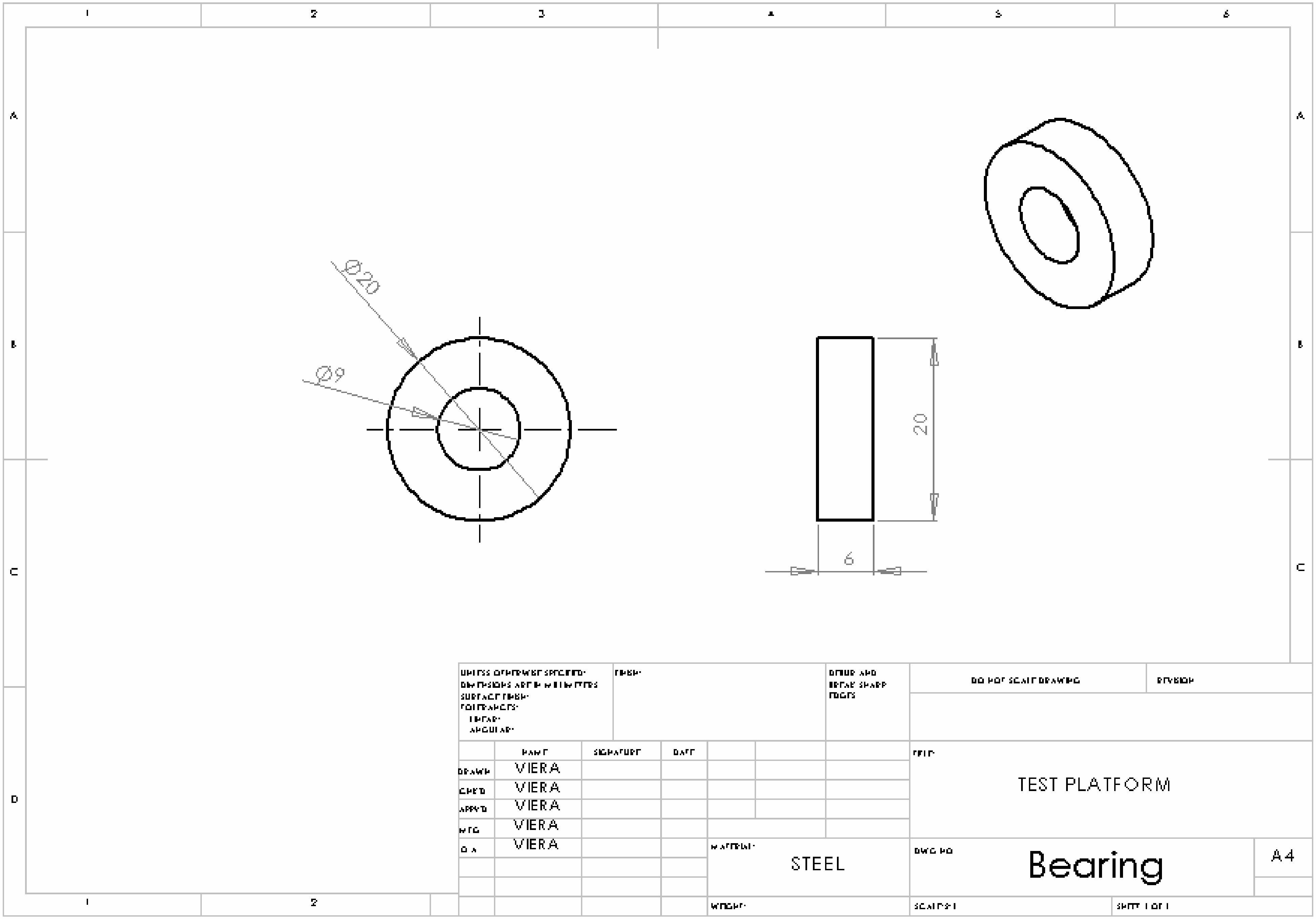

Ø44.12
Ø51
15
200
UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN MILLIMETERS
SURFACE FINISH:
TOLERANCES:
LINEAR:
ANGULAR:
FINISH:
DEBUR AND BREAK SHARP EDGES
DO NOT SCALE DRAWING
REVISION
NAME
SIGNATURE
DATE
DRAWN VIERA
CHK'D VIERA
APPV'D VIERA
MFG VIERA
Q.A VIERA
TITLE:
TEST PLATFORM
MATERIAL:
STEEL
DWG NO.
Pipe
A4
WEIGHT:
SCALE:1:1
SHEET 1 OF 1

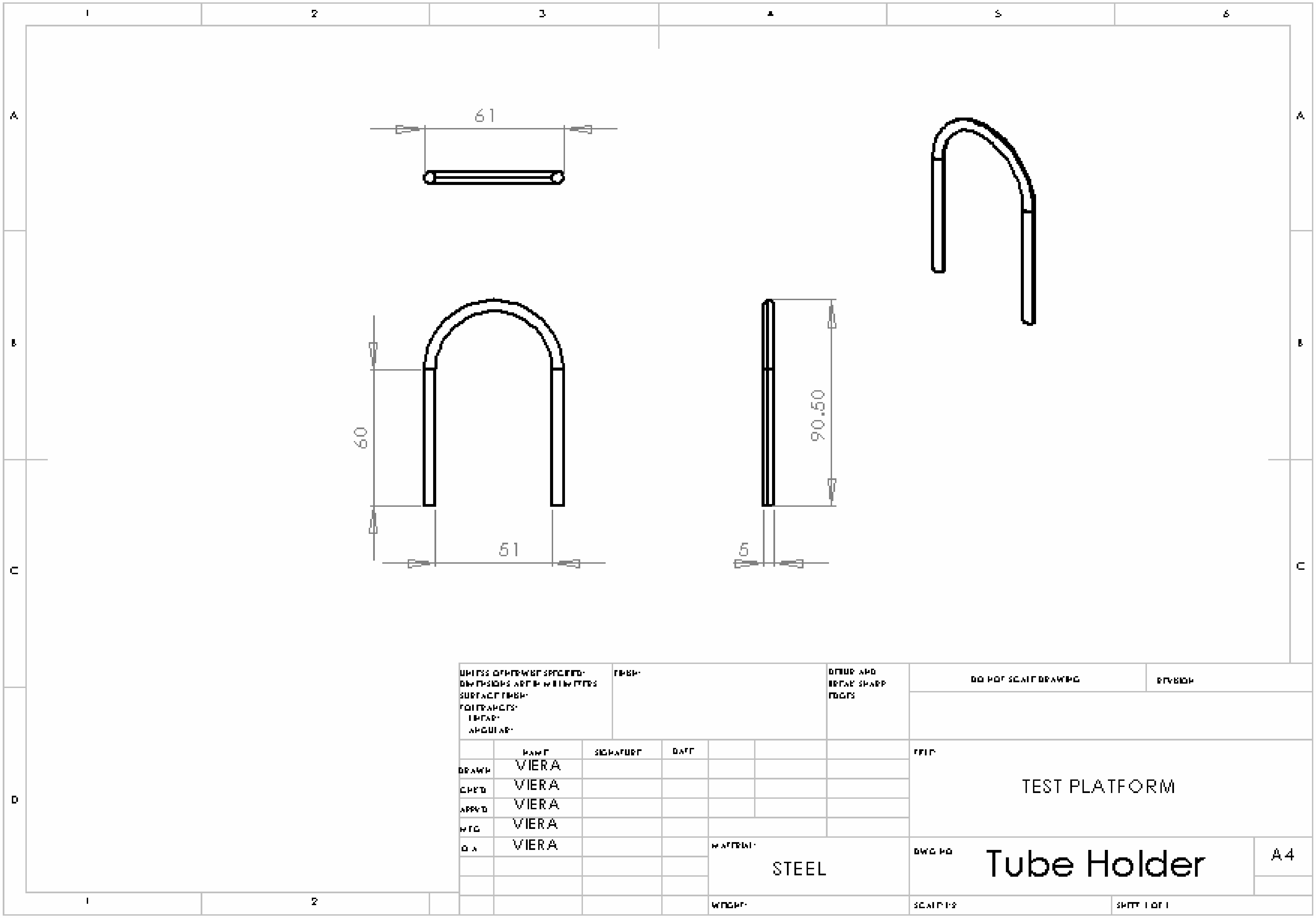

190
180
280
190
220
780
220
1200
UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN MILLIMETERS
SURFACE FINISH:
TOLERANCES:
LINEAR:
ANGULAR:
FINISH:
DEBUR AND BREAK SHARP EDGES
DO NOT SCALE DRAWING
REVISION
NAME
SIGNATURE
DATE
DRAWN VIERA
CHK'D VIERA
APPV'D VIERA
MFG VIERA
Q.A VIERA
TITLE:
TEST PLATFORM
MATERIAL:
STEEL
DWG NO.
Platform
A4
WEIGHT:
SCALE:1:20
SHEET 1 OF 1


Ø68
Ø48
Ø30
10
2.04
UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN MILLIMETERS
SURFACE FINISH:
TOLERANCES:
LINEAR:
ANGULAR:
FINISH:
DEBUR AND BREAK SHARP EDGES
DO NOT SCALE DRAWING
REVISION
NAME
SIGNATURE
DATE
DRAWN VIERA
CHK'D VIERA
APPV'D VIERA
MFG VIERA
Q.A VIERA
TITLE:
TEST PLATFORM
MATERIAL:
STEEL
DWG NO.
Wheels
A4
WEIGHT:
SCALE:1:1
SHEET 1 OF 1


4.50
14
17
14
Ø26
Ø10
5
10
4.17
4.17
60
VIERA
VIERA
VIERA
VIERA
VIERA
UNKNOWN
TEST PLATFORM
Sensor
A4


40
10
R6
R3
1000
40
UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN MILLIMETERS
SURFACE FINISH:
TOLERANCES:
LINEAR:
ANGULAR:
FINISH:
DEBUR AND BREAK SHARP EDGES
DO NOT SCALE DRAWING
REVISION
NAME
SIGNATURE
DATE
DRAWN VIERA
CHK'D VIERA
APPV'D VIERA
MFG VIERA
Q.A
MATERIAL:
STEEL
WEIGHT:
TITLE:
TEST PLATFORM
DWG NO.
Wheels Guides
A4
SCALE:1:10
SHEET 1 OF 1


Ø20
Ø9
20
6
VIERA
VIERA
VIERA
VIERA
VIERA
STEEL
TEST PLATFORM
Bearing
A4


61
60
51
90.50
5
VIERA
VIERA
VIERA
VIERA
VIERA
STEEL
TEST PLATFORM
Tube Holder
A4