

# Drawbridge Project



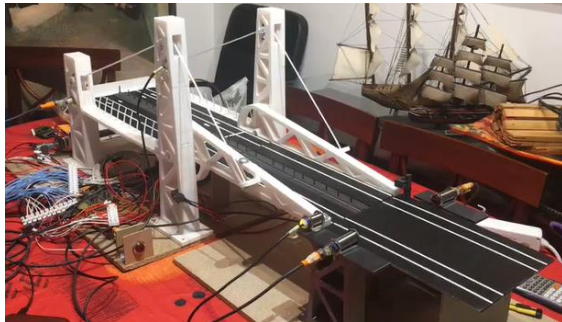
**Industrial engineering 2<sup>nd</sup> year**

**Students: David Hernandez, Victor Laloyau, Carlos Rodriguez & Armando Perez**

## Description

This course's main project was to design and bring to life a fully functioning drawbridge. This project involves the classes of mechanisms and automatism meaning that it was a full year project. The requirements were the following:

- Minimum size: 25cm wide, 40cm long and 15cm tall
- At least one lane in each direction
- Must open to allow the navigation in one direction
- Needs traffic lights to regulate the traffic of both cars and boats



Our drawbridge achieves all the minimum requirements and adds some additional features. With all the knowledge of what we learned in both mechanisms and automatism classes, we could complete the task.

Almost the whole structure of the bridge is 3D Printed and the rest is made out of wood and electrical parts

such as a PLC and different types of sensors. The main movement is actioned by a dc motor which turns a roller that pulls the paracords and opens the bridge. The initial design was to build a two side bridge but because of the costs of 3D printing, we decided to build the model onesided. The PLC, the sensors, and almost all the electrical components were provided by the parent of one of us who kindly borrowed the parts.

The additional feature we added was a system in which the PLC knows if a car is in the middle of the opening section of the bridge. We considered this was very important because this way it would avoid accidents in case the bridge would open when a car was still in the middle of it. This is done using counters and optical sensors for each lane. It sums 1 when a car enters the bridge and subtracts 1 when it passes throughout the next sensor. The bridge only opens if the counter for both lanes is at 0.

The total cost of the project was around 90 euros adding the PLA (3D printing material), electrical parts (cables and others), wood, and other objects we used to build the whole project. If we had to buy all the sensors and electrical components it would have been much more expensive.

It took us around 6 months (not subsequent but throughout the year) of work to design, print, program and put everything together.

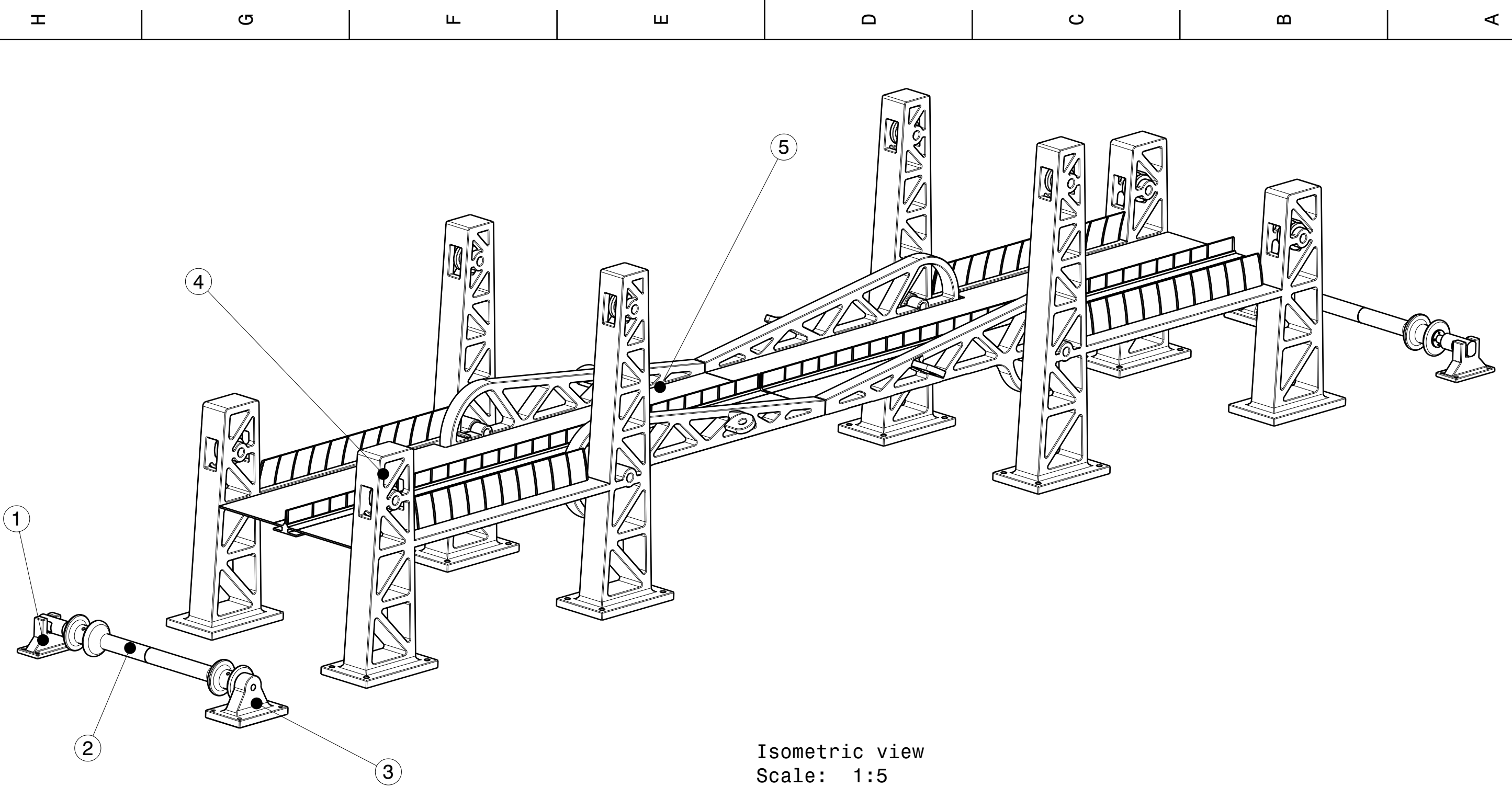
We as a team conclude that this project has taught us and showed us how we can make use of everything we learned this year from both subjects. The mechanism calculus and design and also the programming and setting of a PLC is much more interesting and appealing when we are dealing with a real project and not only with random exercises from class. We really enjoyed the time spent building this drawbridge.

## Annex

### Budget:

Materials	Cost in €
PLA	70
E. Parts	10
Wood & tools	10
<b>Total</b>	<b>90</b>

### Design & Program:



Part N.	Quantity	Part Name
1	2	Motor_holder
2	2	Roller
3	2	Roller_holder
4	2	Static_bridge
5	2	Rotatorys_bridge

		<b>Drawbridge</b>			
		DRAWING TITLE			
DRAWN BY <b>David Hdez</b>		DATE 5/02/2020		<b>Ensemble</b>	
		SIZE <b>A3</b>			
		SCALE 1:5		SHEET 1/6	

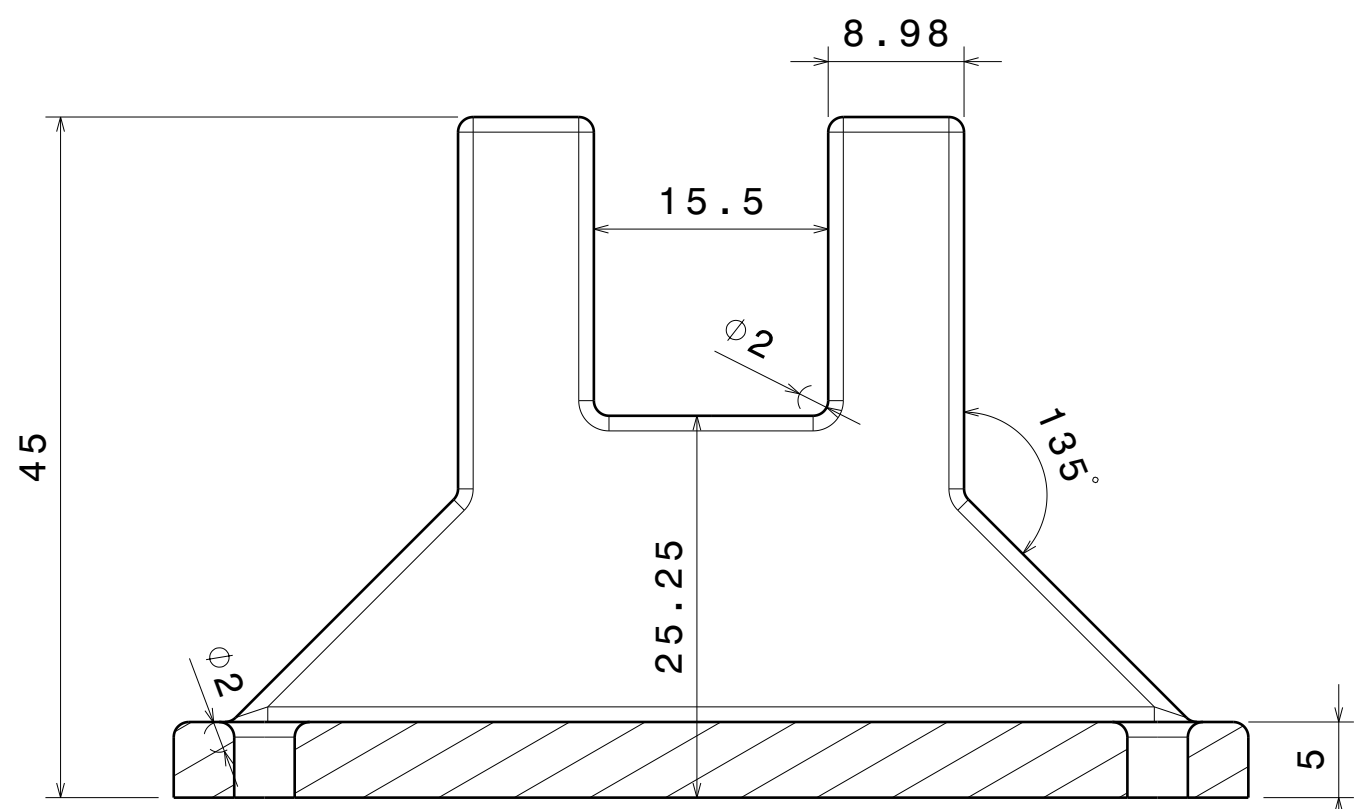
H G F E D C B A

4

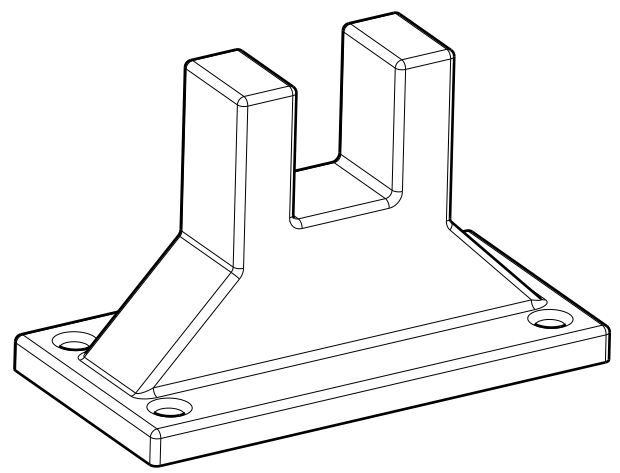
3

4

3



Section view A-A  
Scale: 2:1



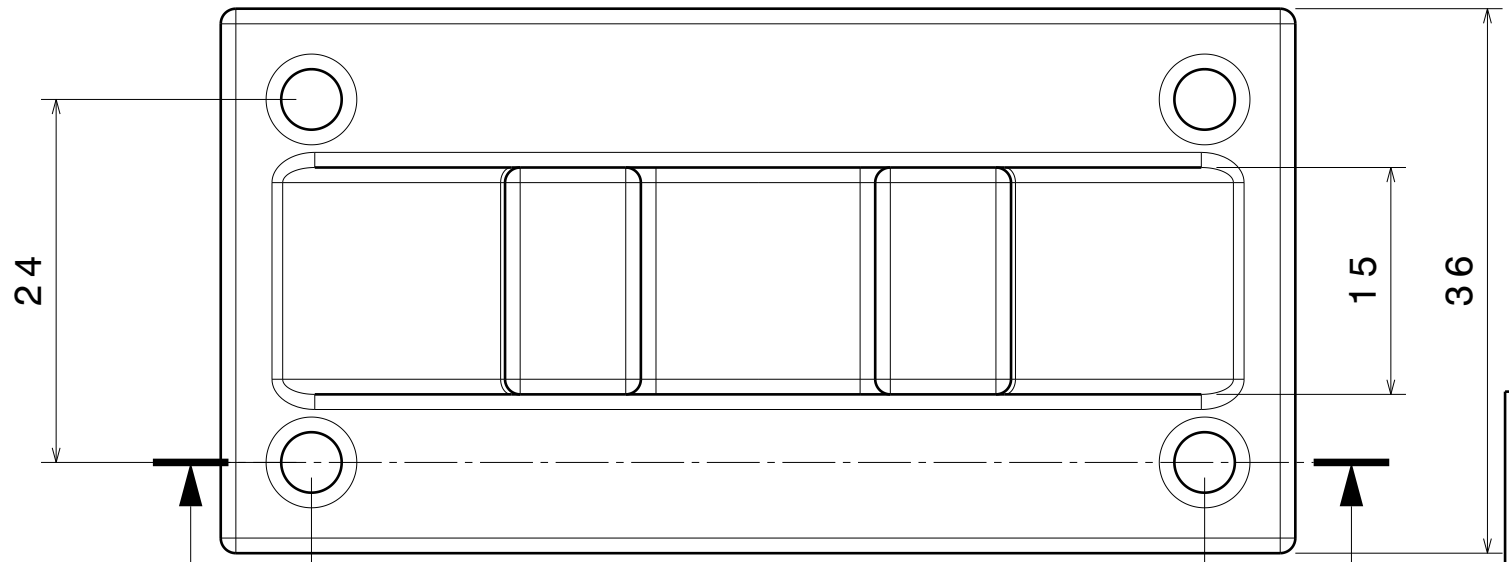
Isometric view  
Scale: 1:1

2

1

2

1



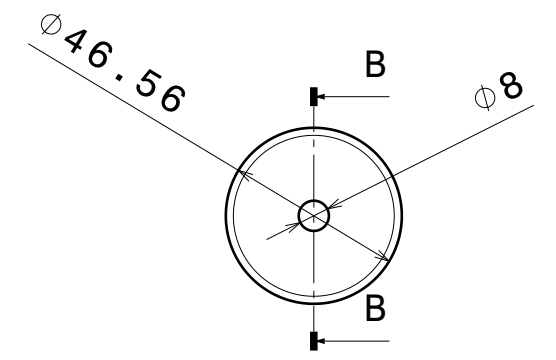
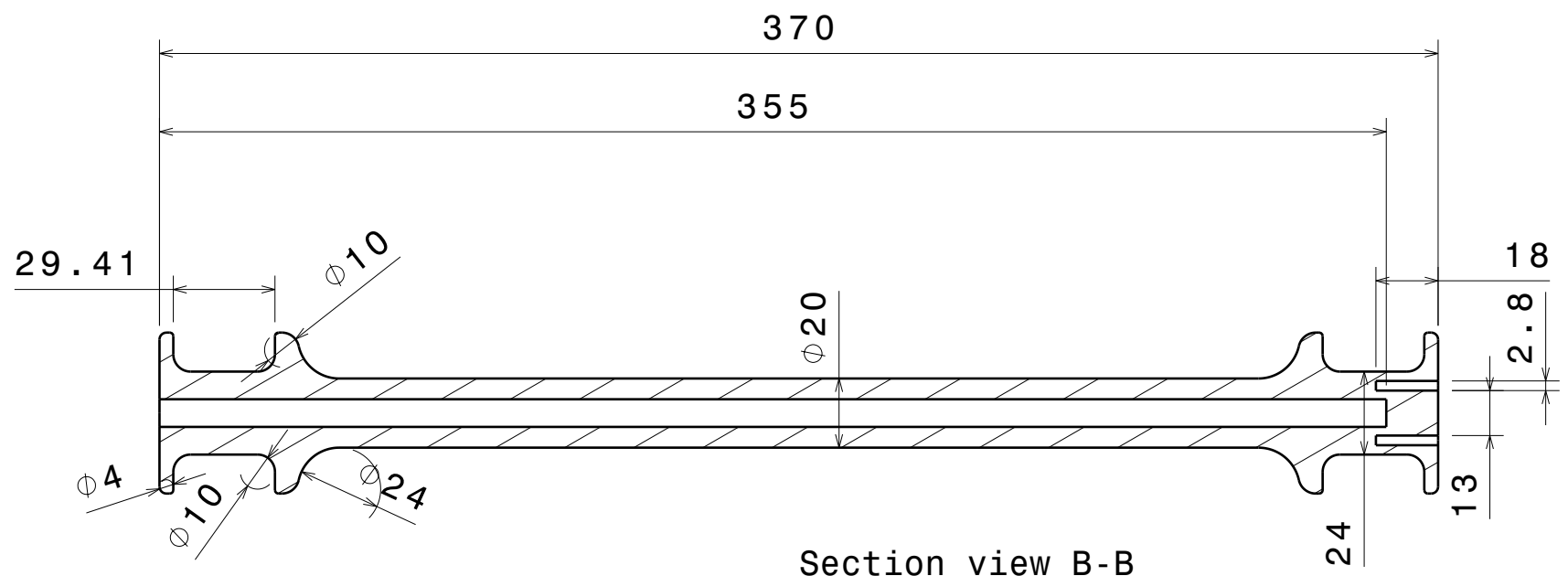
Front view  
Scale: 2:1

		<b>Drawbridge</b>			
		DRAWING TITLE			
DRAWN BY <b>David Hdez</b>		DATE 5/02/2020		<b>Motor holder</b>	
		DRAWING NUMBER			
		<b>A3</b>		<b>1</b>	
		SCALE <b>2:1</b>		SHEET <b>2/6</b>	

H G B A

H G F E D C B A

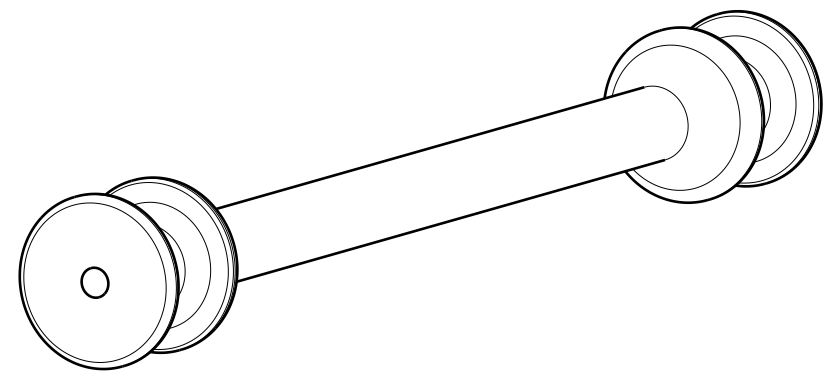
4



3

4

3



2

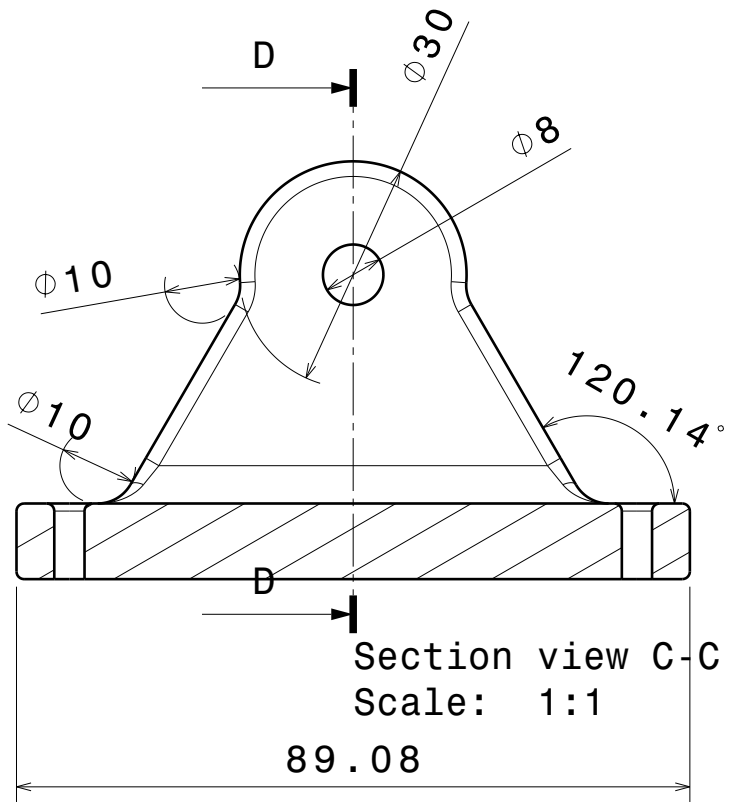
2

1

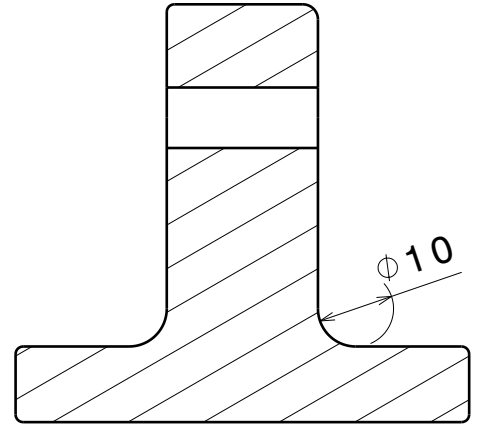
1

H G B A

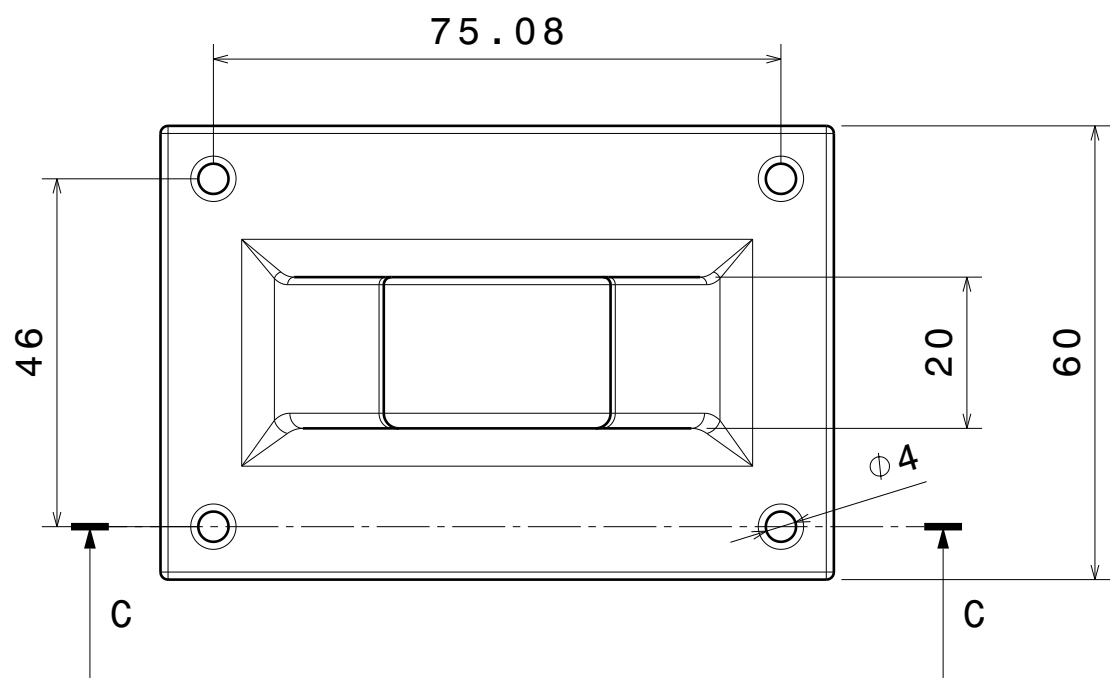
		Drawbridge			
DRAWN BY David Hdez		DATE 5/02/2020	DRAWING TITLE Roller		
		SIZE A3	DRAWING NUMBER 2		
		SCALE 1:2			SHEET 3/6



Section view C-C  
Scale: 1:1

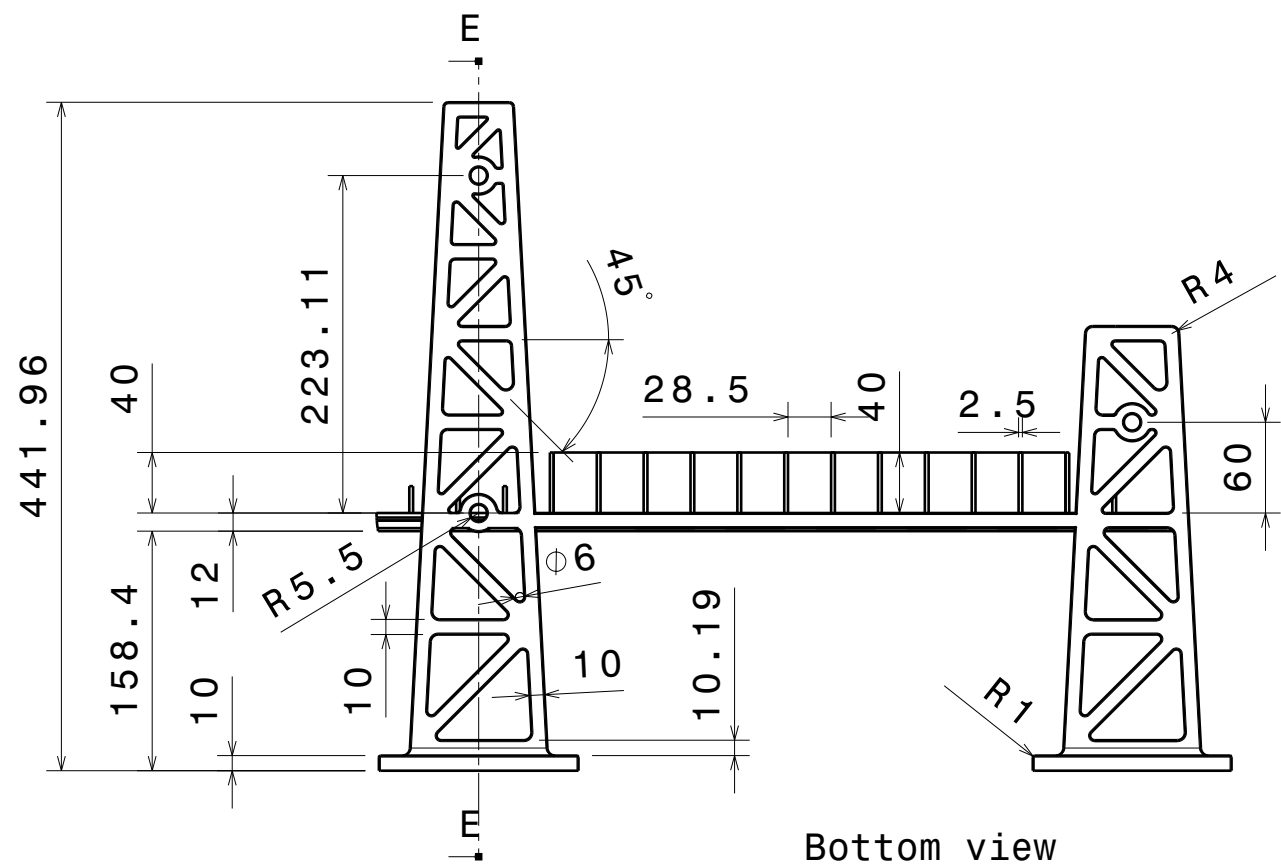


Section view D-D  
Scale: 1:1

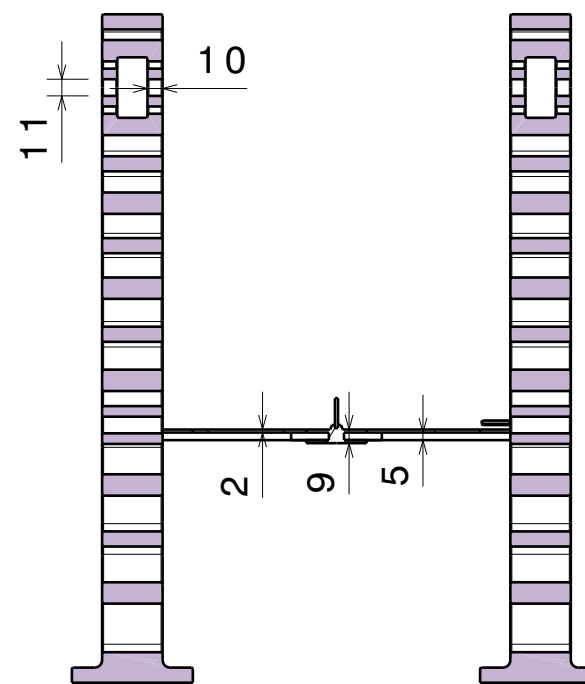


Front view  
Scale: 1:1

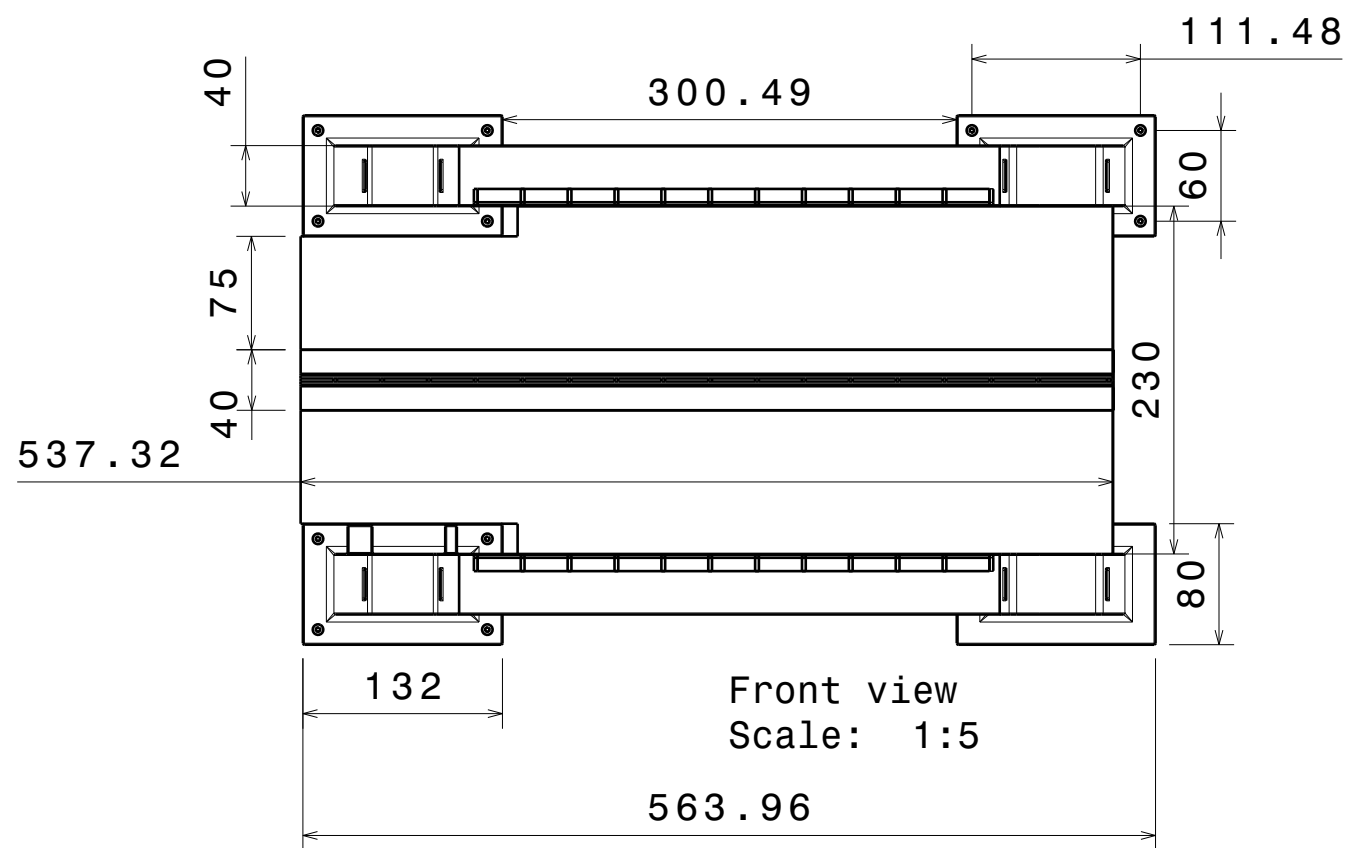
		DRAWING TITLE		
DRAWN BY David Hdez		DATE 5/02/2020	Drawbridge Roller holder	
		SIZE A3	DRAWING NUMBER 3	
		SCALE 1:1		SHEET



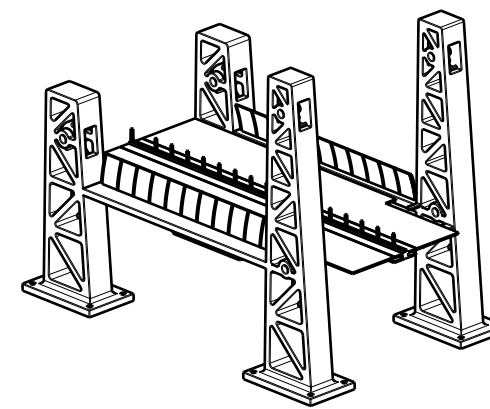
Bottom view  
Scale: 1:5



Section view E-E  
Scale: 1:5



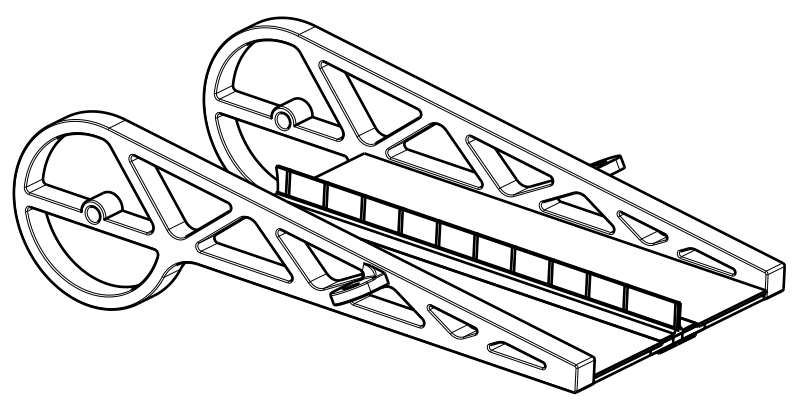
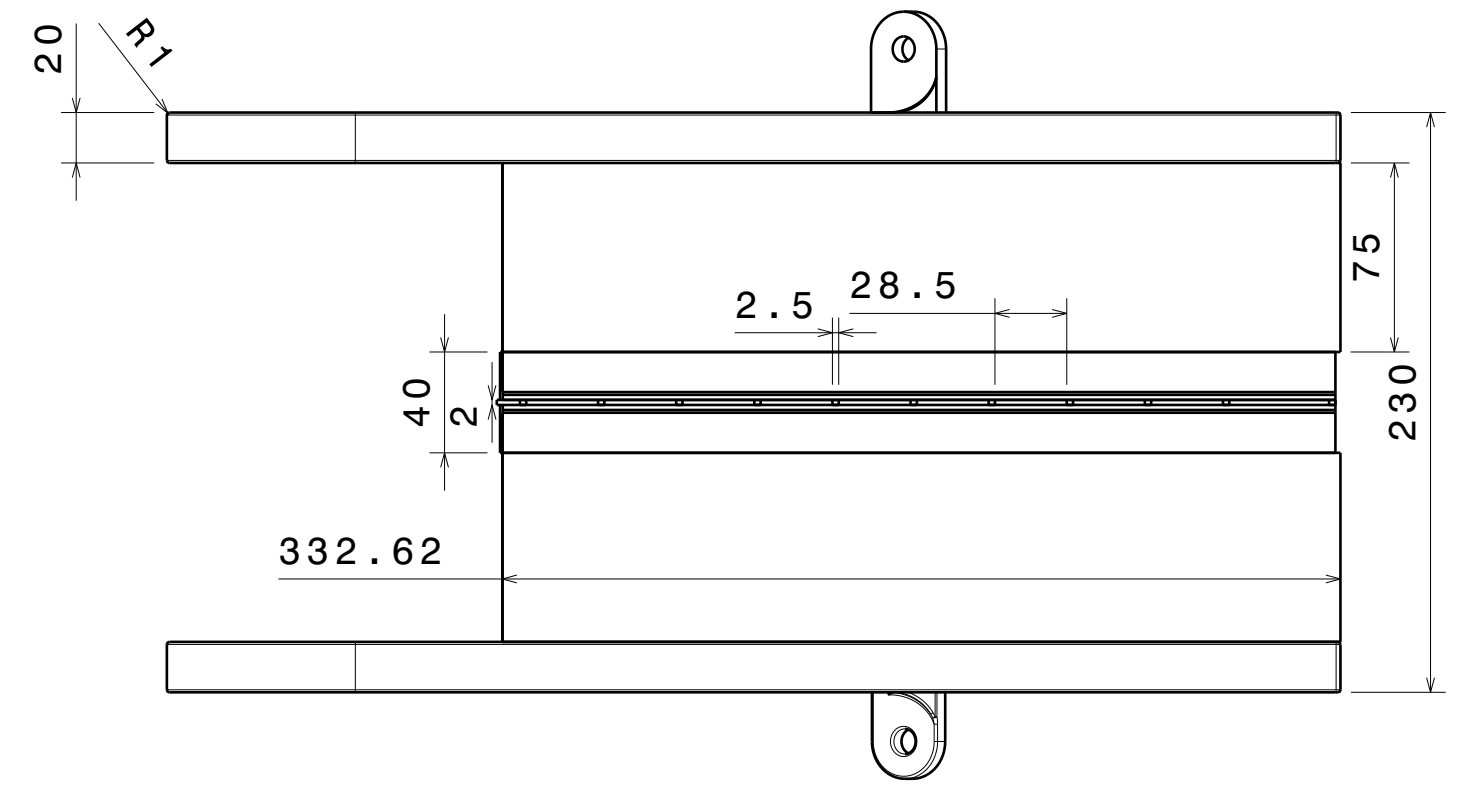
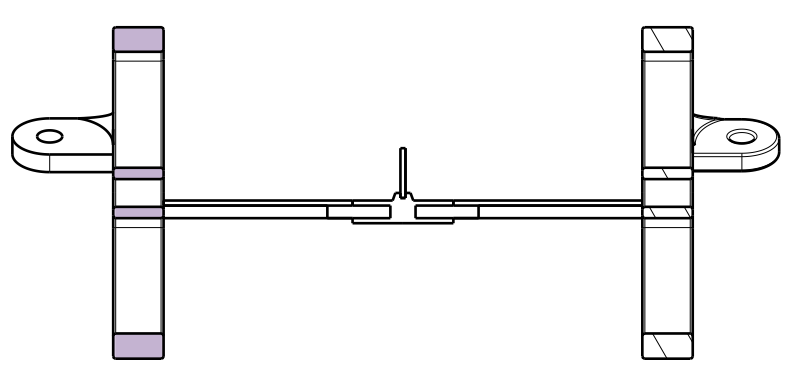
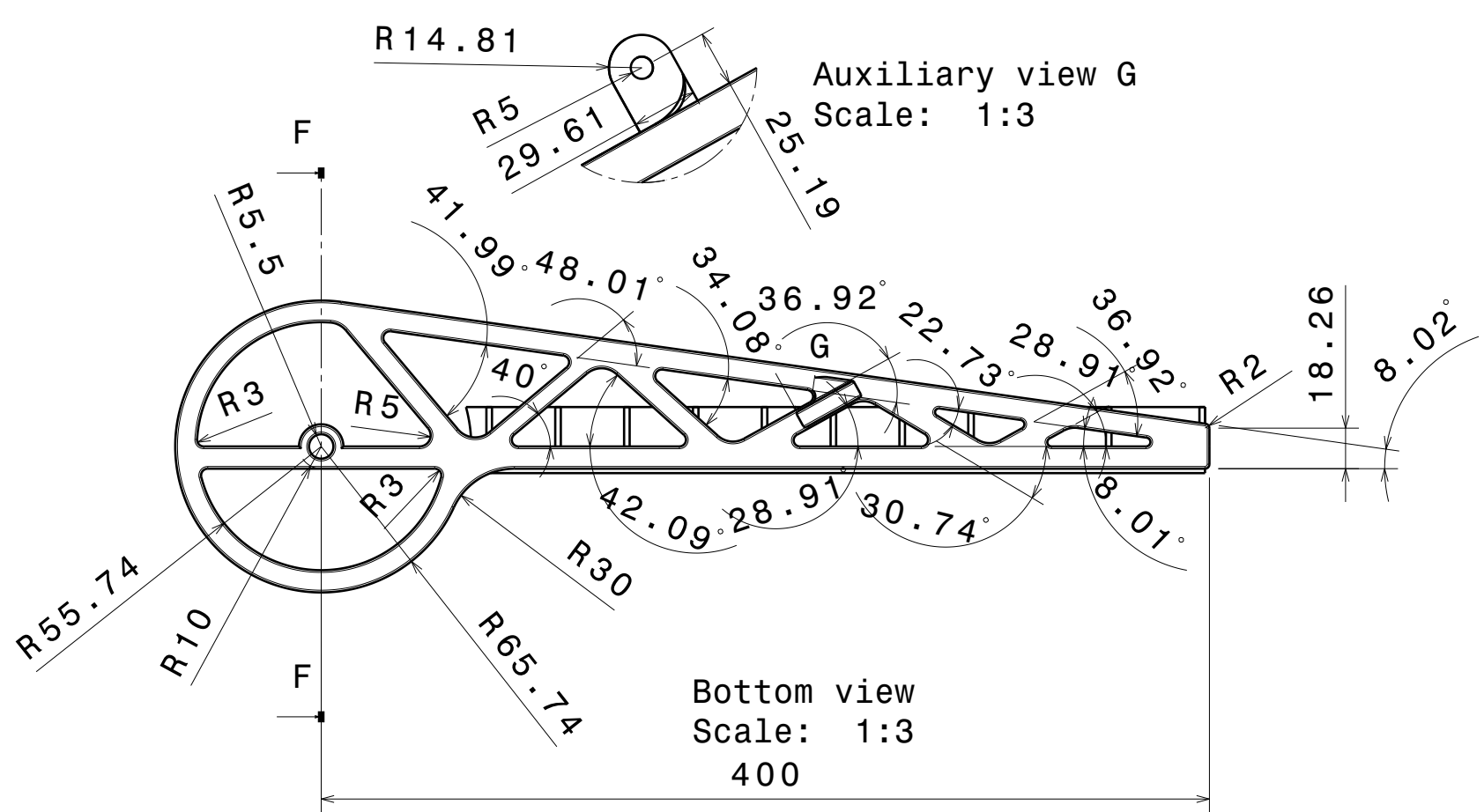
Front view  
Scale: 1:5



Isometric view  
Scale: 1:10

		<b>Drawbridge</b>			
		DRAWING TITLE			
DRAWN BY <b>David Hdez</b>		DATE 5/02/2020		<b>Static bridge</b>	
		SIZE <b>A3</b>	PART NUMBER <b>4</b>		
		SCALE 1:5			SHEET 5/6



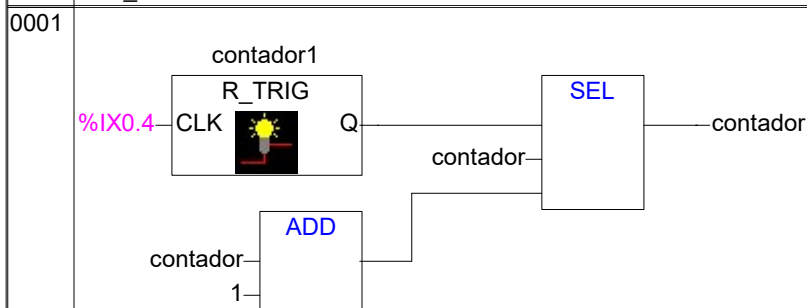


		<b>Drawbridge</b>			
		DRAWING TITLE			
DRAWN BY <b>David Hdez</b>		DATE 5/02/2020		<b>Rotatory bridge</b>	
		SIZE <b>A3</b>		PART NUMBER <b>5</b>	
		SCALE 1:3		SHEET 6/6	

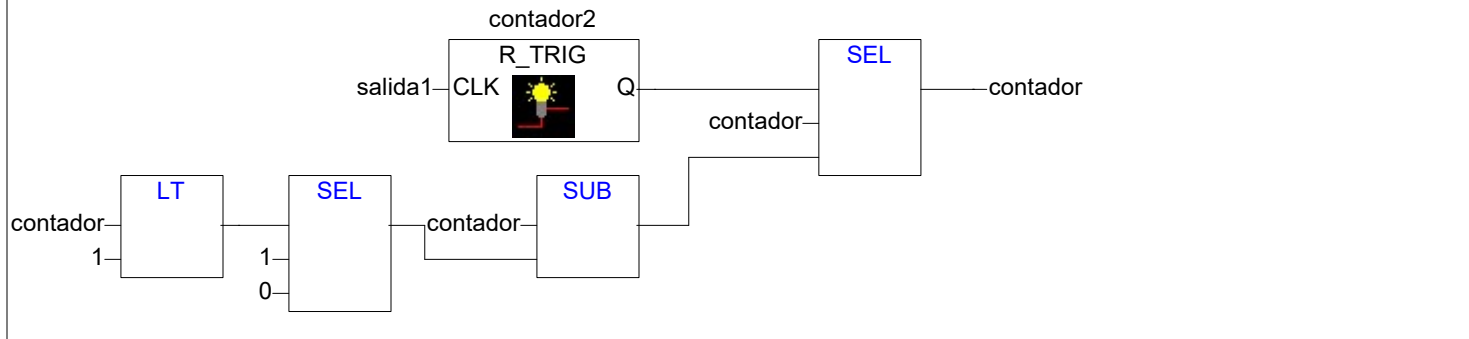
```

0001 PROGRAM Z_ACTIVASALIDAS
0002 VAR
0003     T1: TON;
0004     ENABLE_SALIDAS: BOOL := TRUE;
0005     contador: WORD := 0;
0006
0007     contador_3: WORD := 0;
0008     contador_2: WORD := 0;
0009
0010     contador5: R_TRIG;
0011     Contador4: R_TRIG;
0012     contador3: R_TRIG;
0013     contador2: R_TRIG;
0014     contador6: R_TRIG;
0015     timer1: TON;
0016     openbridge: BOOL;
0017     closebridge: BOOL;
0018     botonabrir AT%IX0.0:BOOL;
0019     botoncerrar AT%IX0.1:BOOL;
0020     puenteabierto AT%IX0.2:BOOL;
0021     positionbridge AT%IX0.3:BOOL;
0022     entrada1 AT%IX0.4:BOOL;
0023     salida1 AT%IX0.5:BOOL;
0024     entrada2 AT%IX0.6:BOOL;
0025     salida2 AT%IX0.7:BOOL;
0026     barco1 AT%IX0.8:BOOL;
0027     barco2 AT%IX0.9:BOOL;
0028     led_rojo_barco AT%QX0.0:BOOL;
0029     led_verde_barco AT%QX0.7:BOOL;
0030     led_rojo_cars AT%QX0.6:BOOL;
0031     led_verde_cars AT%QX0.3:BOOL;
0032     relemotor AT%QX0.4:BOOL;
0033     sentidomotor AT%QX0.5:BOOL;
0034     contador1: R_TRIG;
0035     openbridge1: BOOL;
0036     openbridge2: BOOL;
0037     closebridge2: BOOL;
0038     closebridge1: BOOL;
0039     closabridge2: BOOL;
0040     led_rojo_cars1: BOOL;
0041     led_rojo_barco1: BOOL;
0042     led_rojo_barco2: BOOL;
0043     led_rojo_cars2: BOOL;
0044     led_rojo_cars3: BOOL;
0045     led_rojo_barco3: BOOL;
0046     led_rojo_barco4: BOOL;
0047     led_rojo_cars4: BOOL;
0048     led_rojo_barco5: BOOL;
0049     led_rojo_barco6: BOOL;
0050     led_rojo_cars5: BOOL;
0051     timer_cerrar: TON;
0052 END_VAR

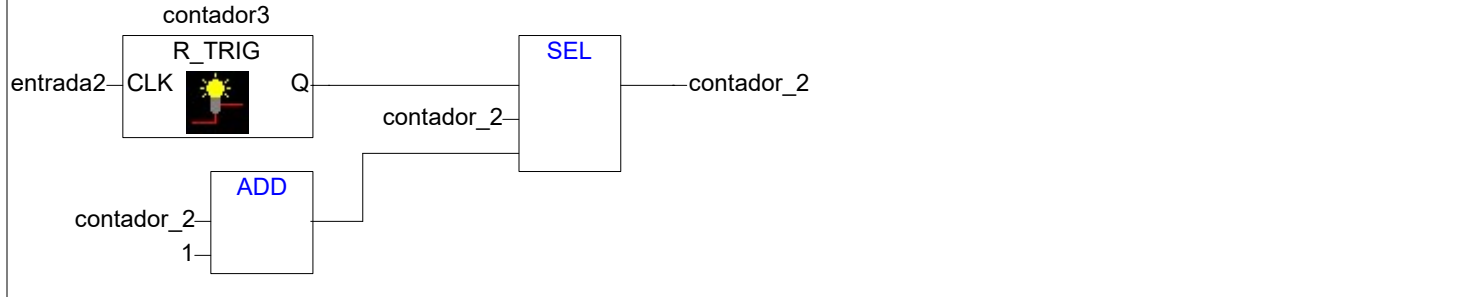
```



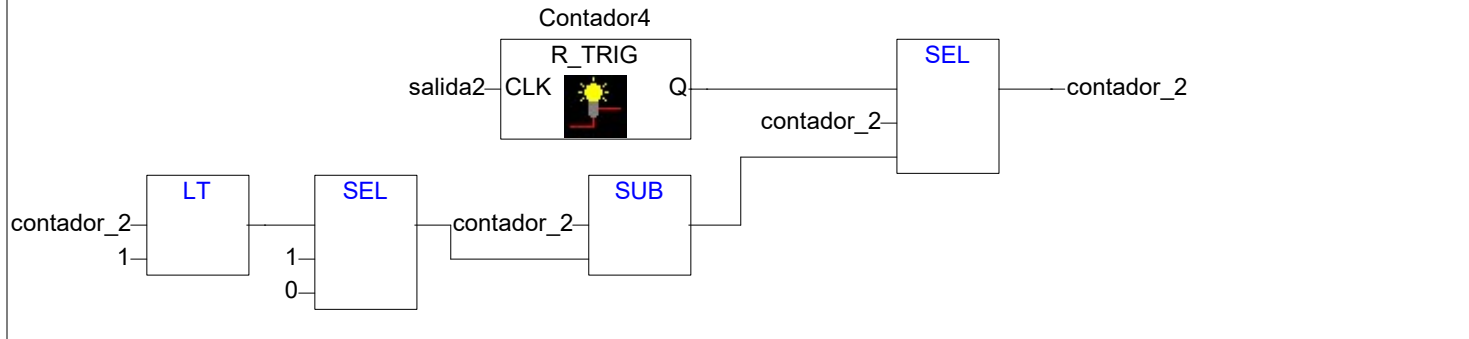
0002



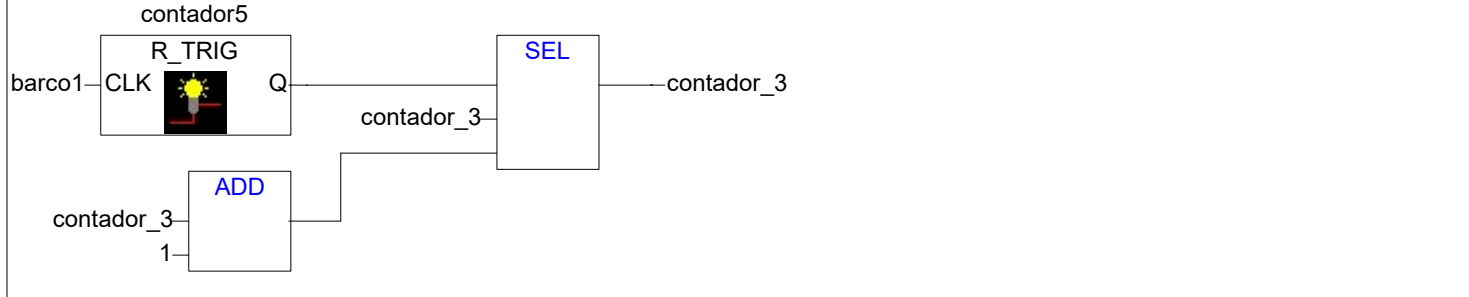
0003



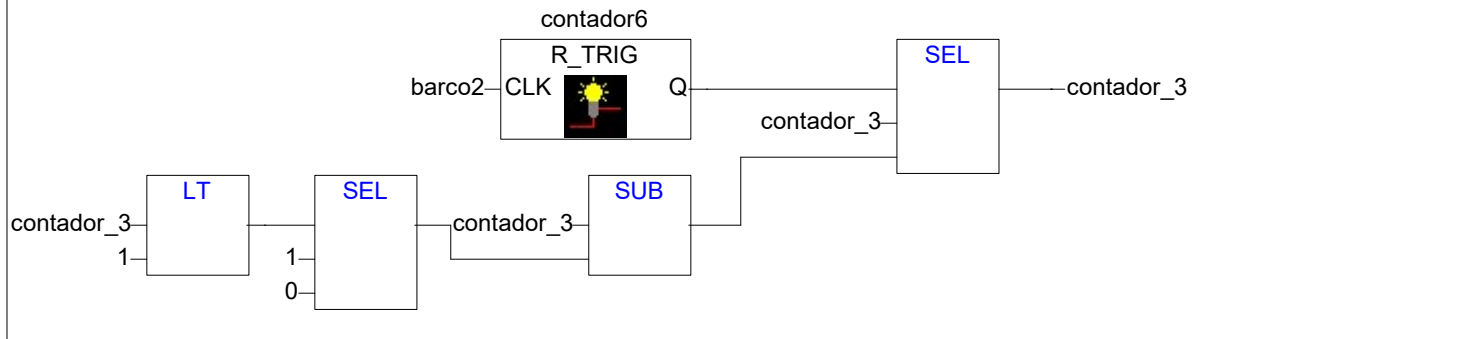
0004



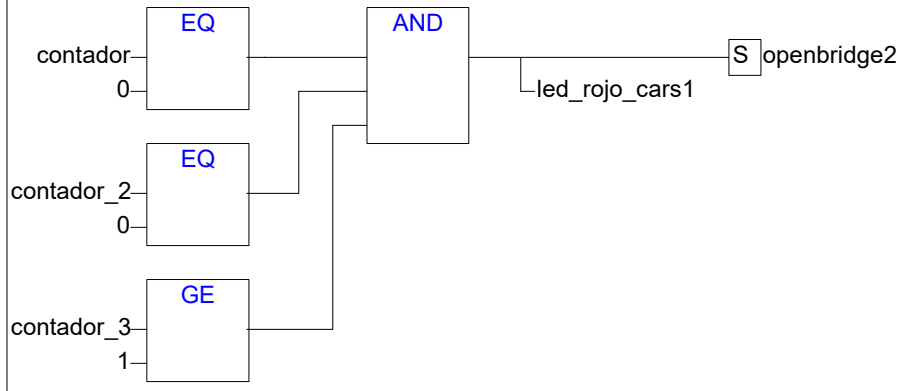
0005



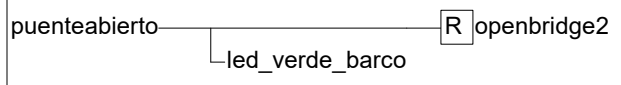
0006



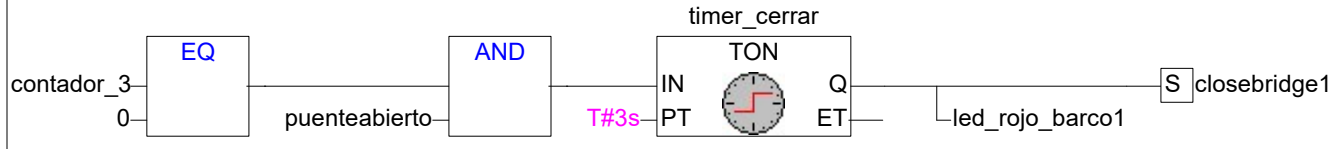
0007



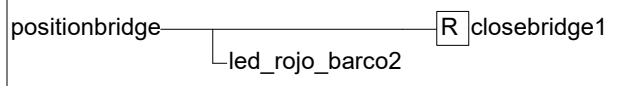
0008



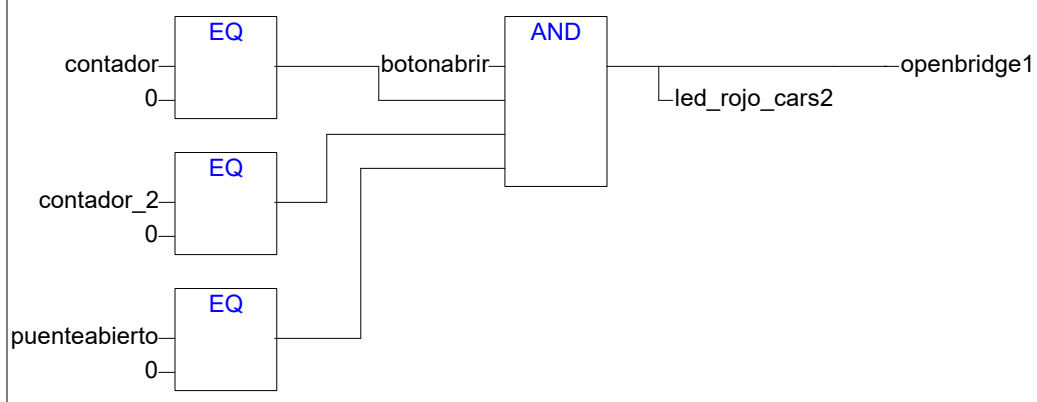
0009



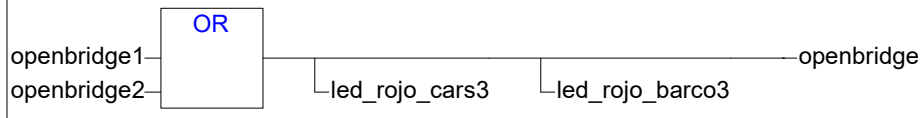
0010



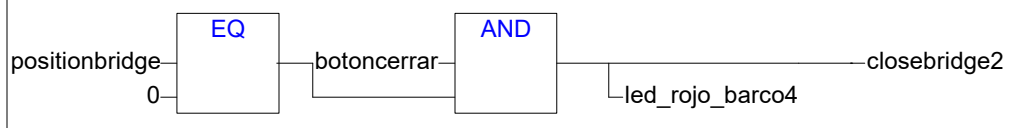
0011



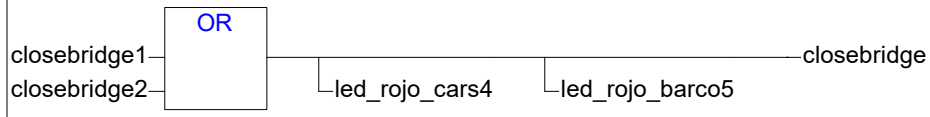
0012



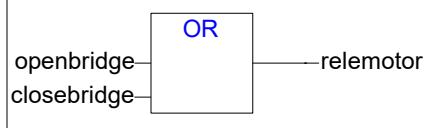
0013



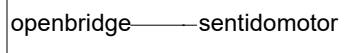
0014



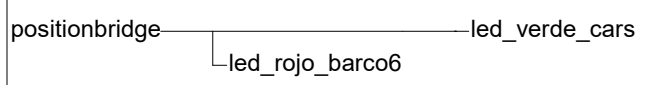
0015



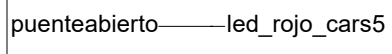
0016



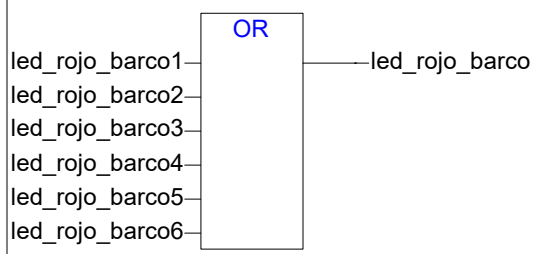
0017



0018



0019



0020

