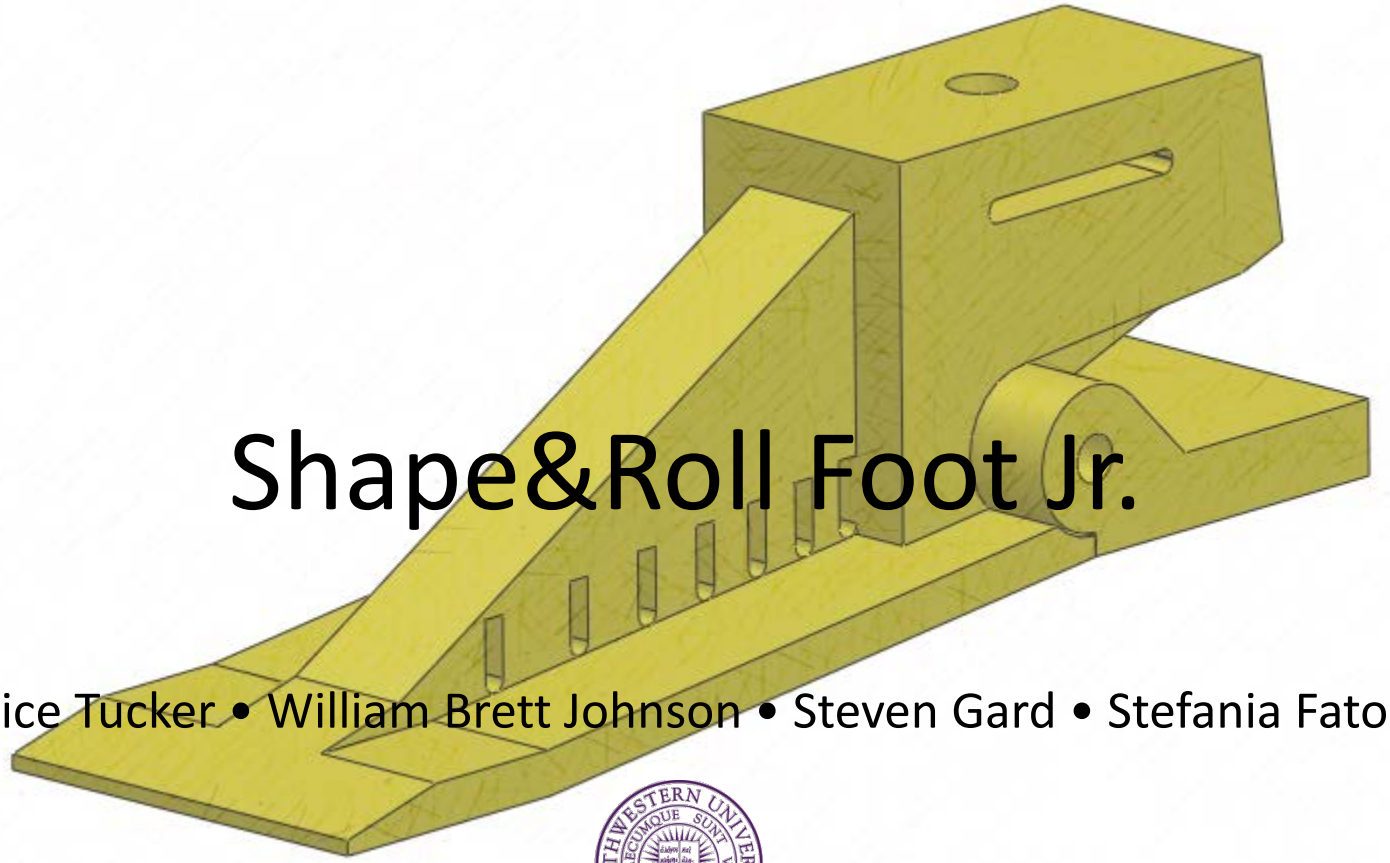
Fabrication Manual



Shape&Roll Foot Jr.

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Acknowledgements: We would like to acknowledge Andrew Hansen, PhD, for help with the initial project conception; Kerice Tucker for foot design, and William Brett Johnson, PhD, for foot testing and development of this manual.

Table of Contents

Introduction

The purpose of this manual is to provide instructions for creating a Shape&Roll Foot Jr.

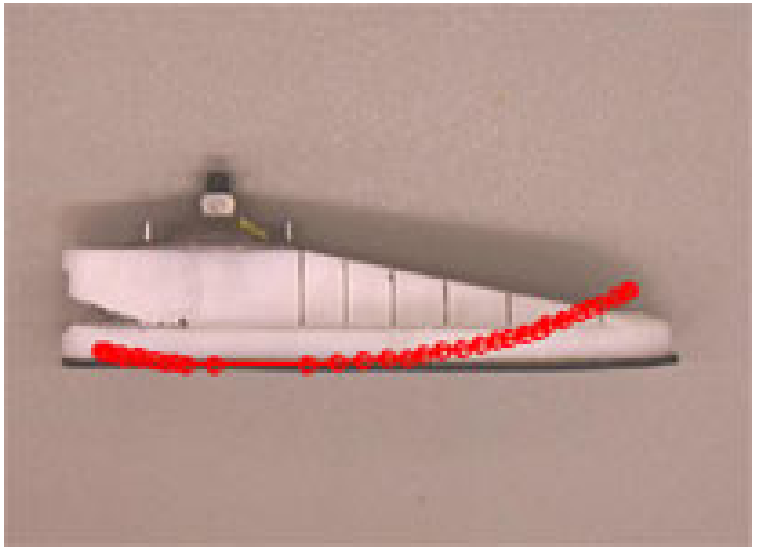
The Shape&Roll Foot Jr. was designed to provide a functional pediatric prosthetic foot in light of the dearth of “little feet” available for pediatric prosthesis users.[1]

[1]Shurr D (2007) Session I: Lower-Limb Prosthetics I: Foot/Ankle Mechanisms. In: Fatone S, Gard SA (eds) (2007) ‘P&O Research: Are We Addressing Clinically-Relevant Problems?’ Report on the State-of-the-Science Meeting in Prosthetics and Orthotics, February 28, 2006. Northwestern University Rehabilitation Engineering Research Center in Prosthetics and Orthotics, Feinberg School of Medicine, Northwestern University, Chicago, IL.

Introduction

In able-bodied walking, the path that the forces acting on the foot follow with respect to the leg resemble a rocker.

The original Shape&Roll Foot for adults was designed to mimic that rocker shape.[2]

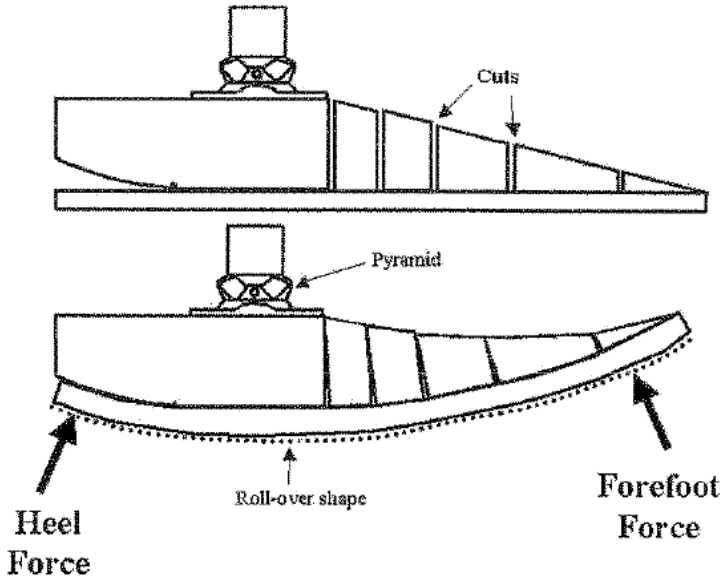


[2]Sam, M., Childress, D. S., Hansen, A. H., Meier, M.R., Lambla, S., Grahn, E. C., & Rolock, J.S. (2004). The 'shape&roll' prosthetic foot: I. Design and development of appropriate technology for low-income countries. *Medicine, Conflict and Survival,* 20(4), 294-306.

How Does the Shape&Roll Foot Work?

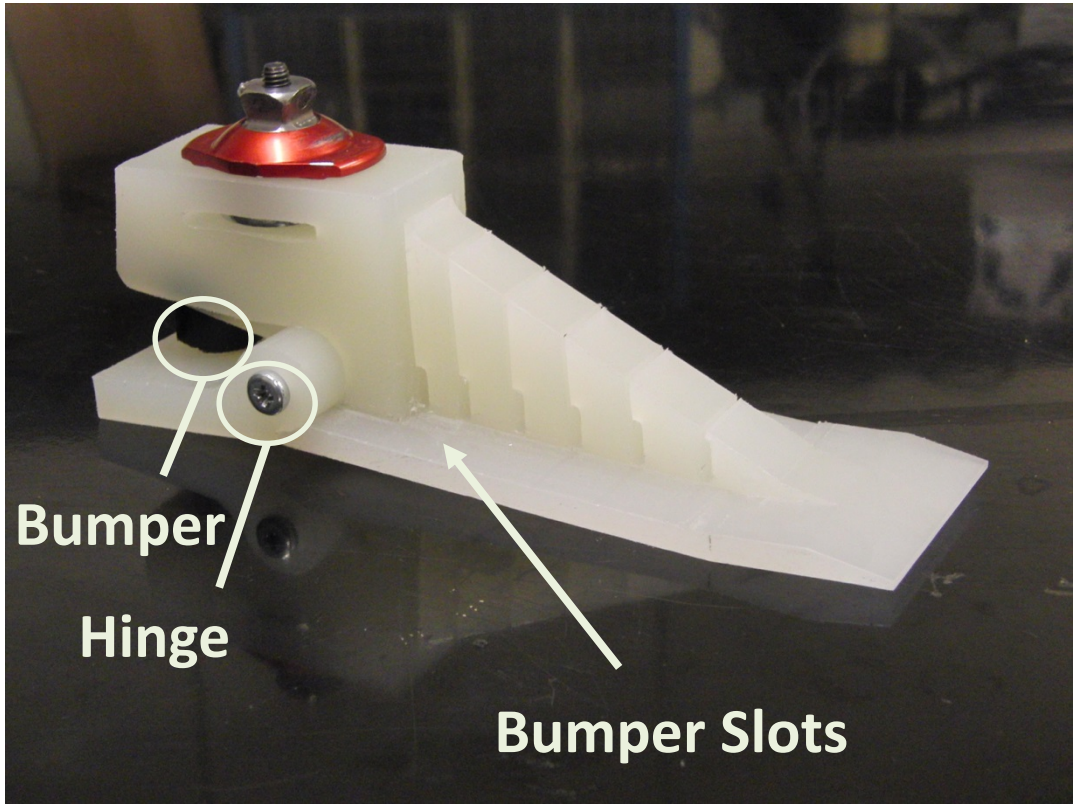
Cuts are made along the length of the foot so that the foot bends into a rocker as force is applied during walking.

FIGURE 2
THE SHAPE&ROLL FOOT: SAGITTAL PLANE DIAGRAMS



Design of Shape&Roll Foot Jr.

In addition to being smaller, the Shape&Roll Foot Jr. includes several design changes.



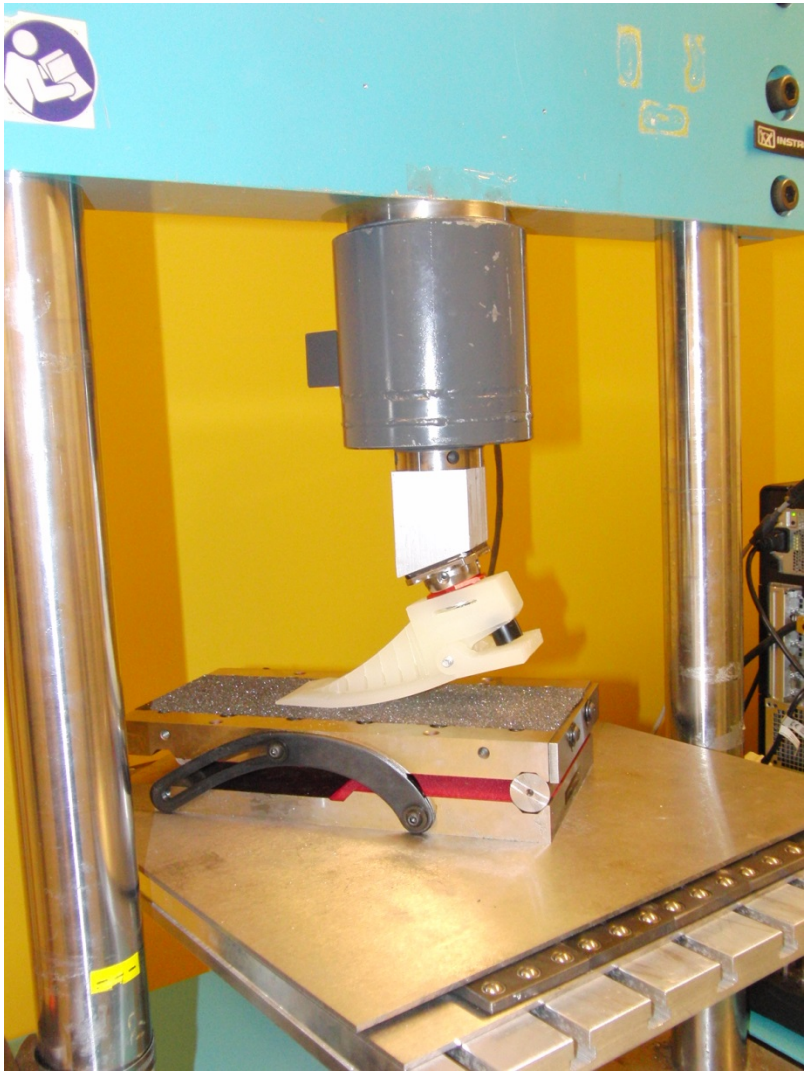
The heel has been redesigned with a hinge and bumper to reduce fatigue.

Instead of thickening the sole for heavier or more active users, slots have been cut in the forefoot so that polyurethane bumpers can be inserted.

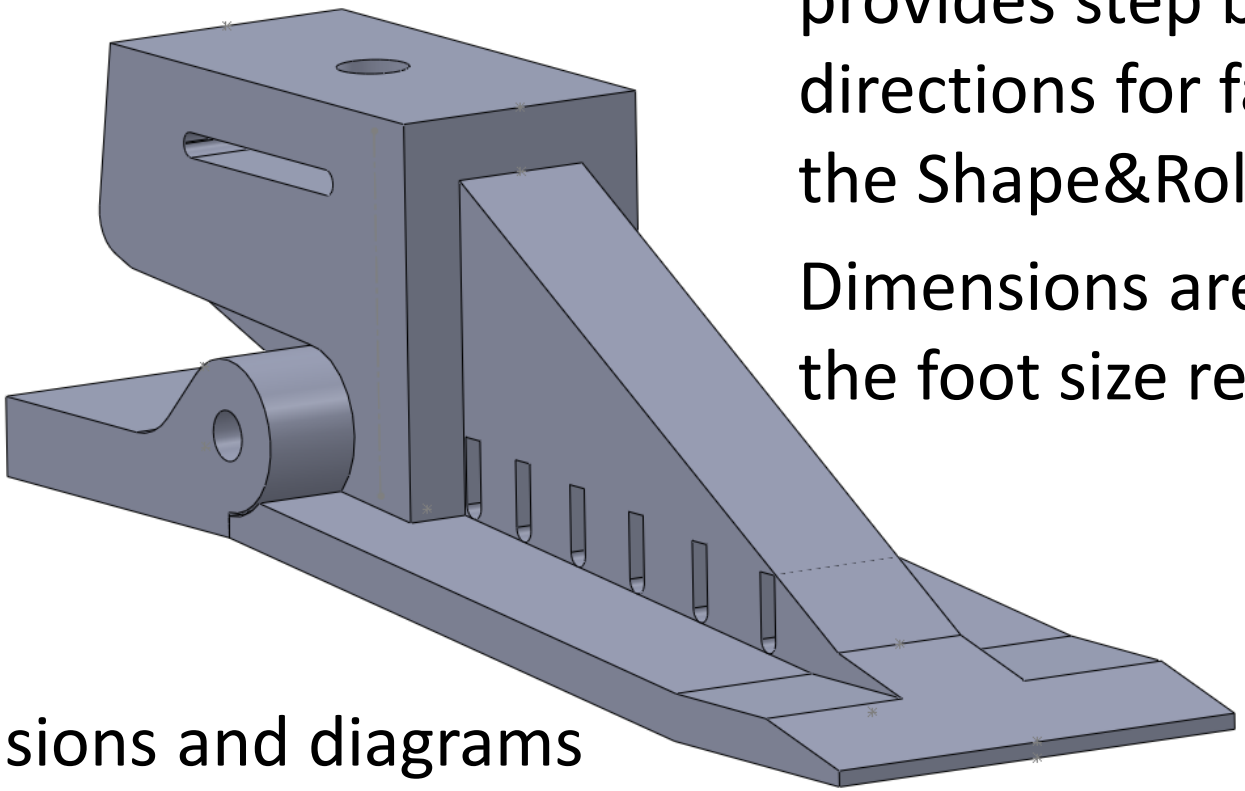
Testing the Shape&Roll Foot Jr.

Fatigue testing of prosthetic components involves repeated loading of the foot up to 800 N, simulating the steps of a 60 kg child.

Initial testing of the foot in a Material Testing System has reached over 5,000 cycles without failure.



Building the Shape&Roll Foot Jr.



This section of the manual provides step by step directions for fabricating the Shape&Roll Foot Jr.

Dimensions are specific to the foot size required.

Dimensions and diagrams for feet sizes 13-21 can be found in the Appendix.

Building the Shape&Roll Foot Jr.

Materials

Polypropylene Block

Polyurethane Cylinder

Pediatric Pyramid Adapter

Square Washer 1/8” x 3/4” with 1/4” hole

1/4” Bolt and Nut

Tools

Milling machine

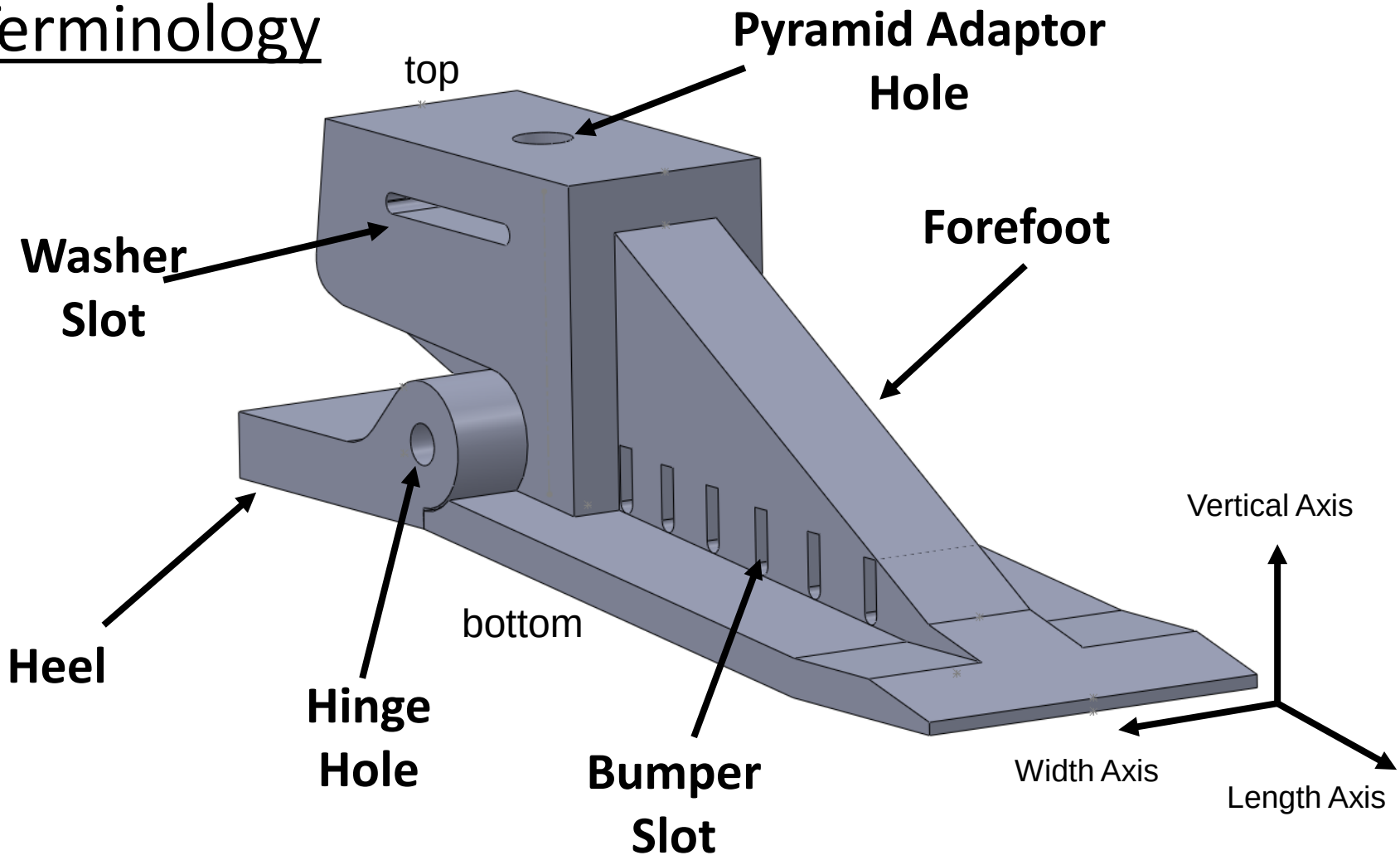
Band Saw or Table Saw

Long 1/8” End Mill

1/4”, 3/4”, 9 mm, 15 mm drill bits

Building the Shape&Roll Foot Jr.

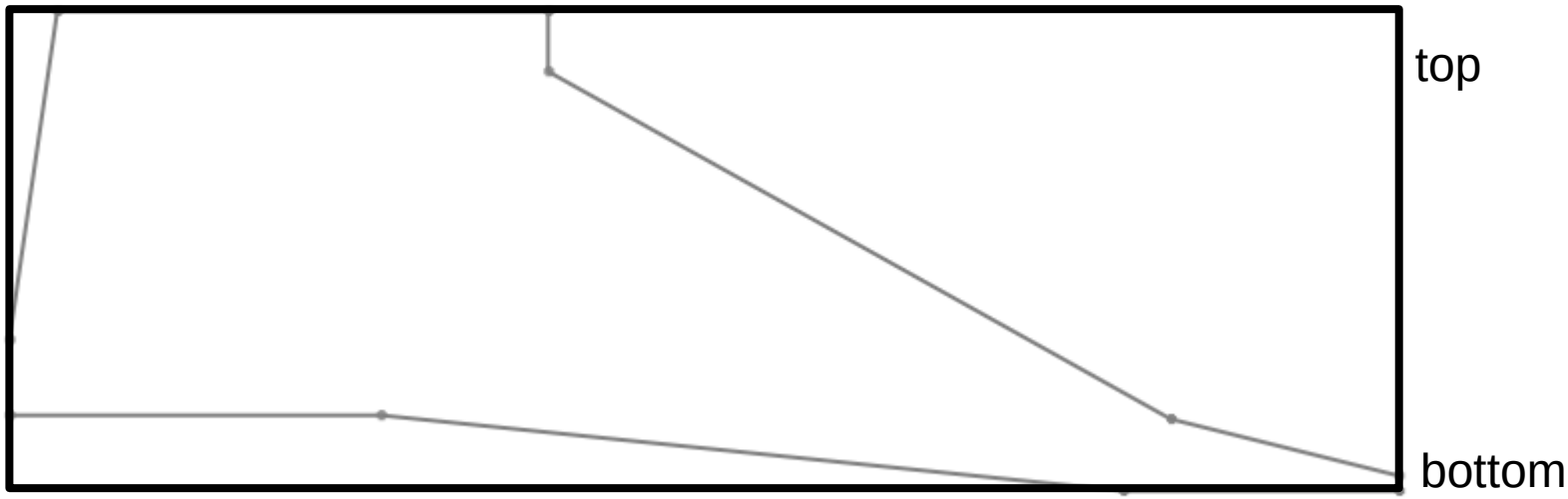
Terminology



Building the Shape&Roll Foot Jr.

Making the Forefoot

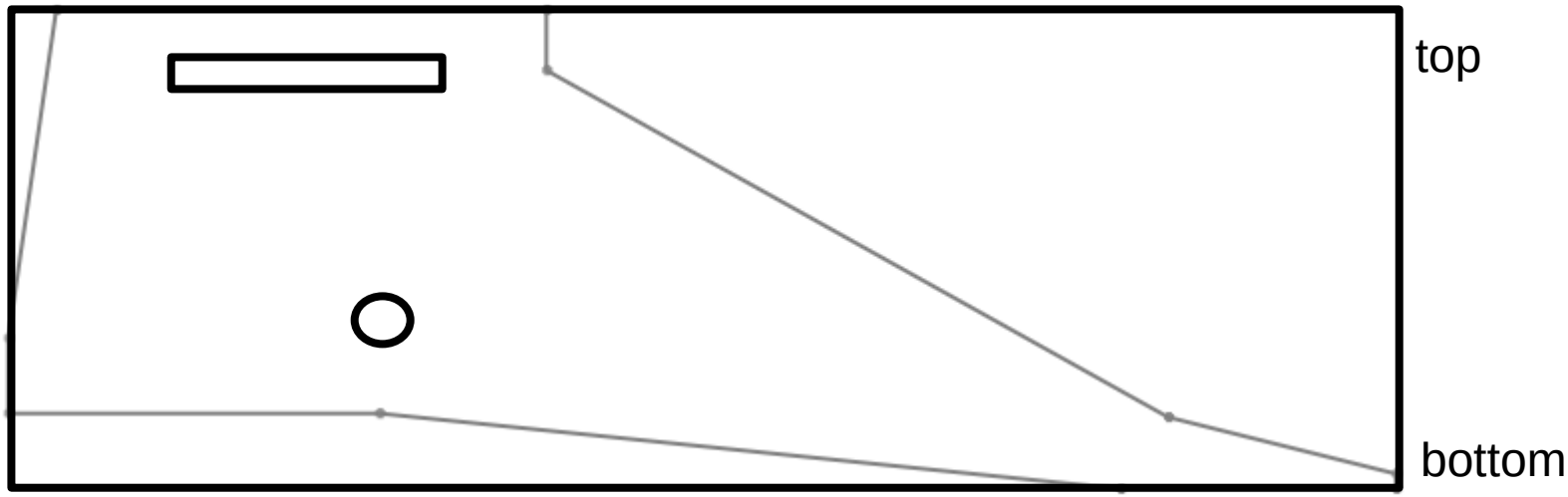
Select the diagram for the desired foot size from the Appendix and draw the lateral profile on an appropriately sized polypropylene block.



Building the Shape&Roll Foot Jr.

Making the Forefoot

Note the position of the **washer slot** and the **hinge hole**. Drill the **hinge hole** and mill out the **washer slot.**

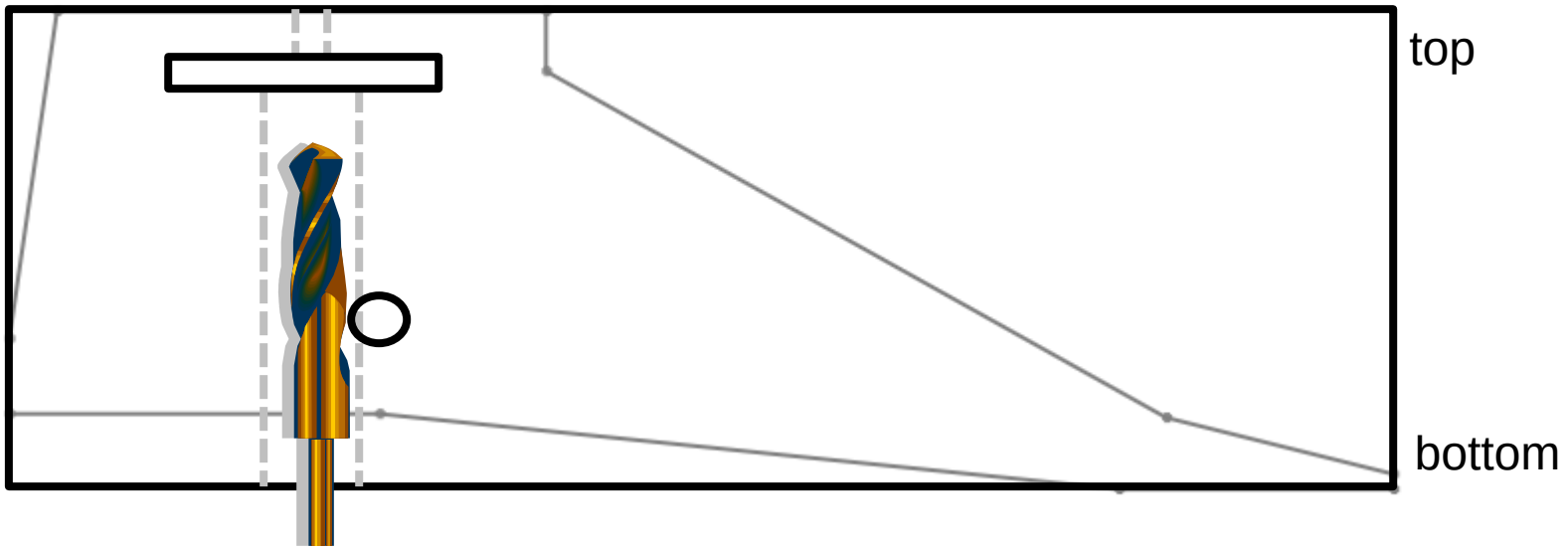


Building the Shape&Roll Foot Jr.

Making the Forefoot

Locate the **pyramid adaptor hole,** and drill it through the entire block.

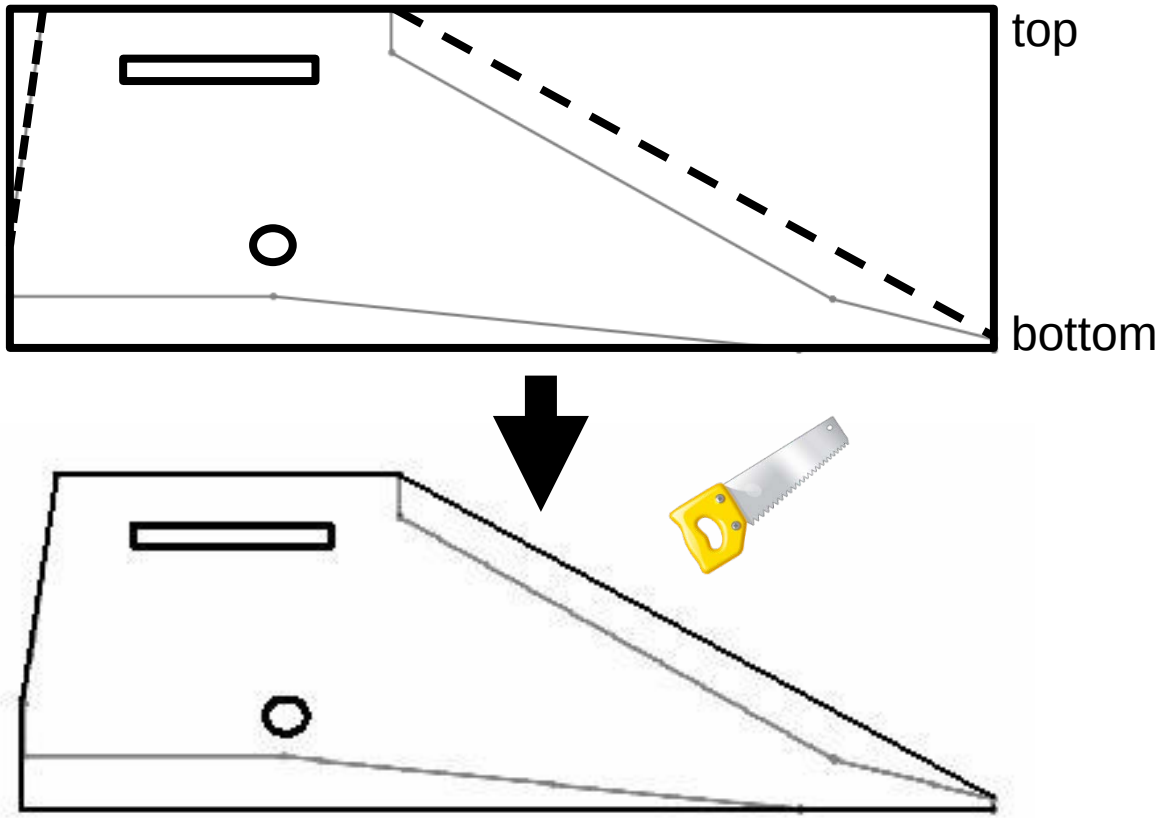
From the bottom of the block, use the **pyramid adaptor hole** as a guide to drill a wider hole all the way up to the **washer slot.**



Building the Shape&Roll Foot Jr.

Making the Forefoot

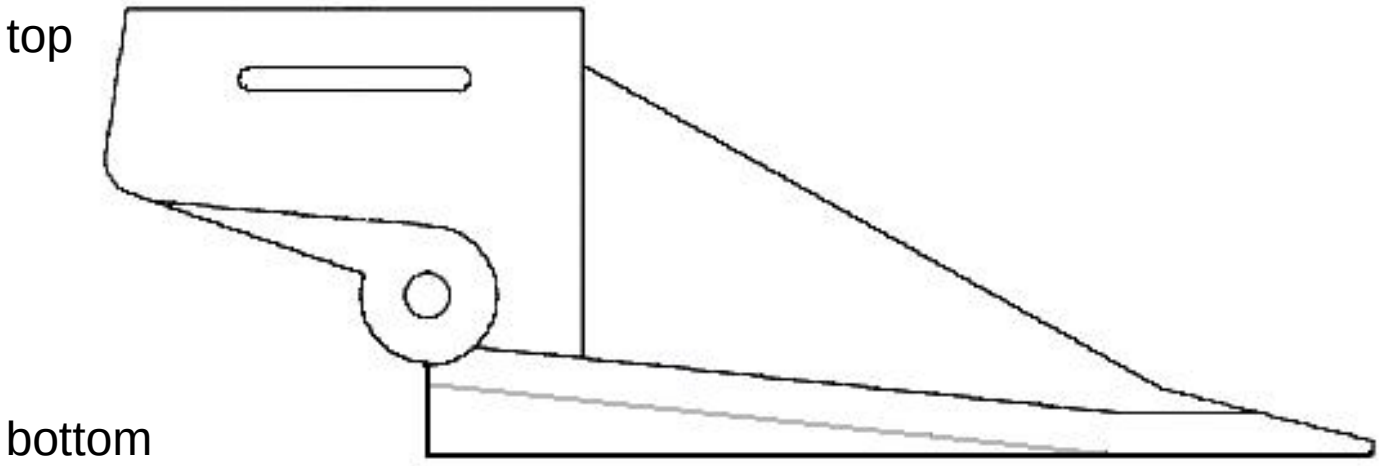
Use a band saw or table saw to remove excess material.



Building the Shape&Roll Foot Jr.

Making the Forefoot

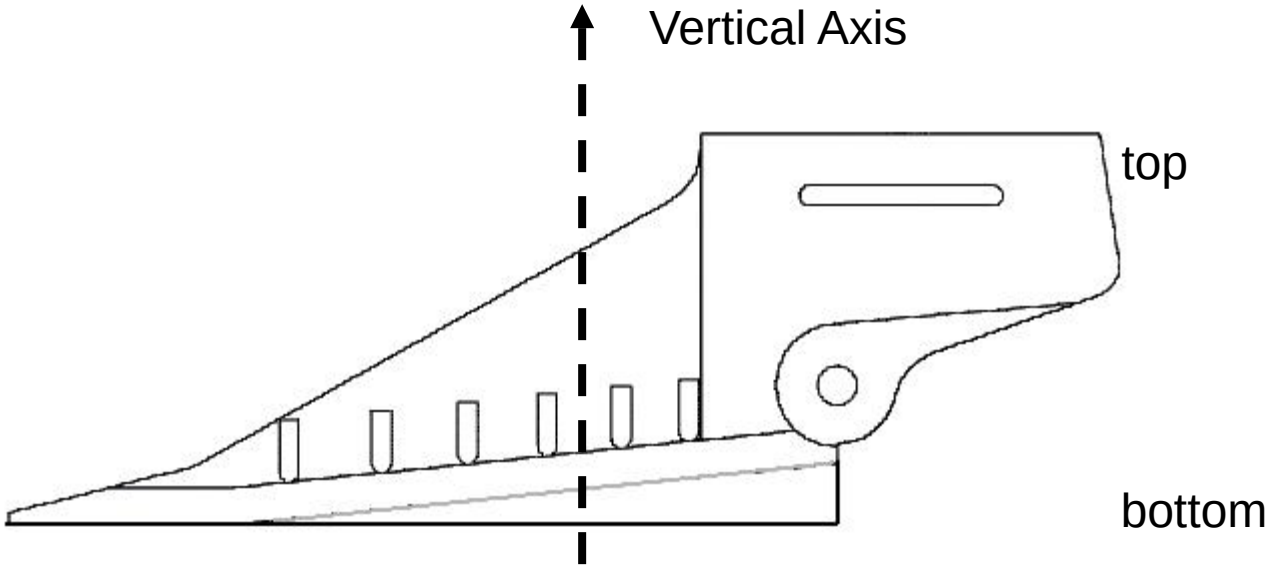
Mill away excess material according to the depths specified in the diagrams in the Appendix.



Building the Shape&Roll Foot Jr.

Making the Forefoot

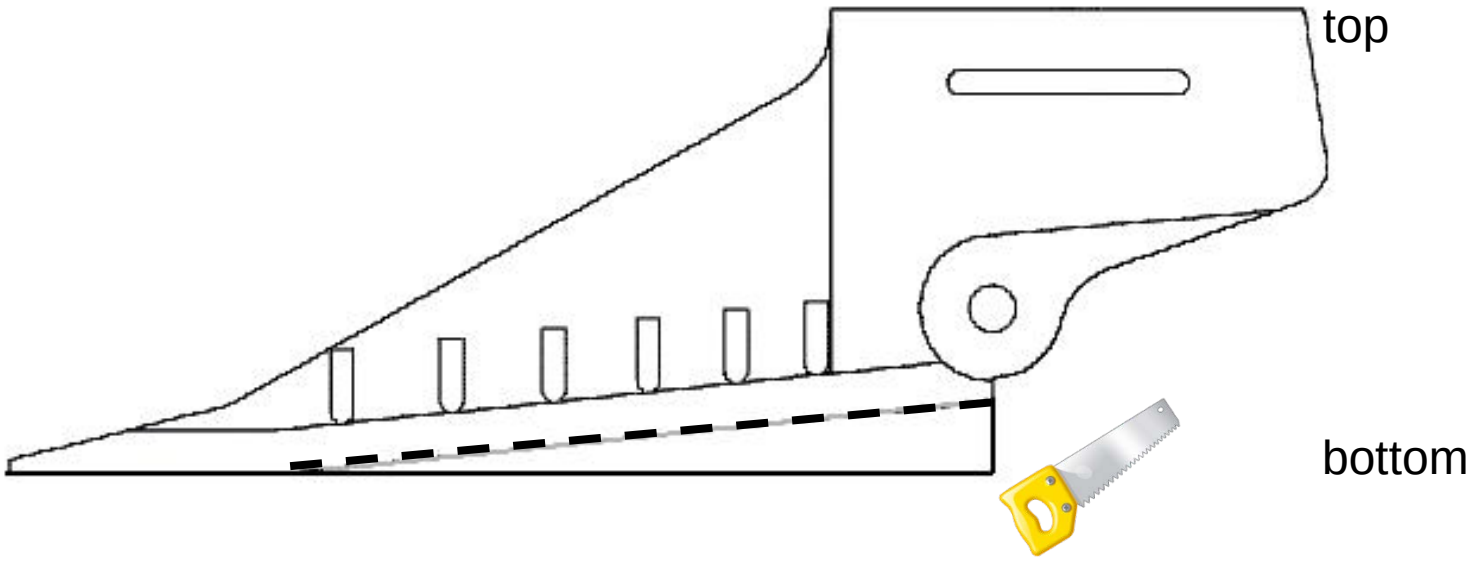
Flip the foot about height axis and mill away excess material according to the depths specified in the diagrams in the Appendix, and mill out the bumper slots.



Building the Shape&Roll Foot Jr.

Making the Forefoot

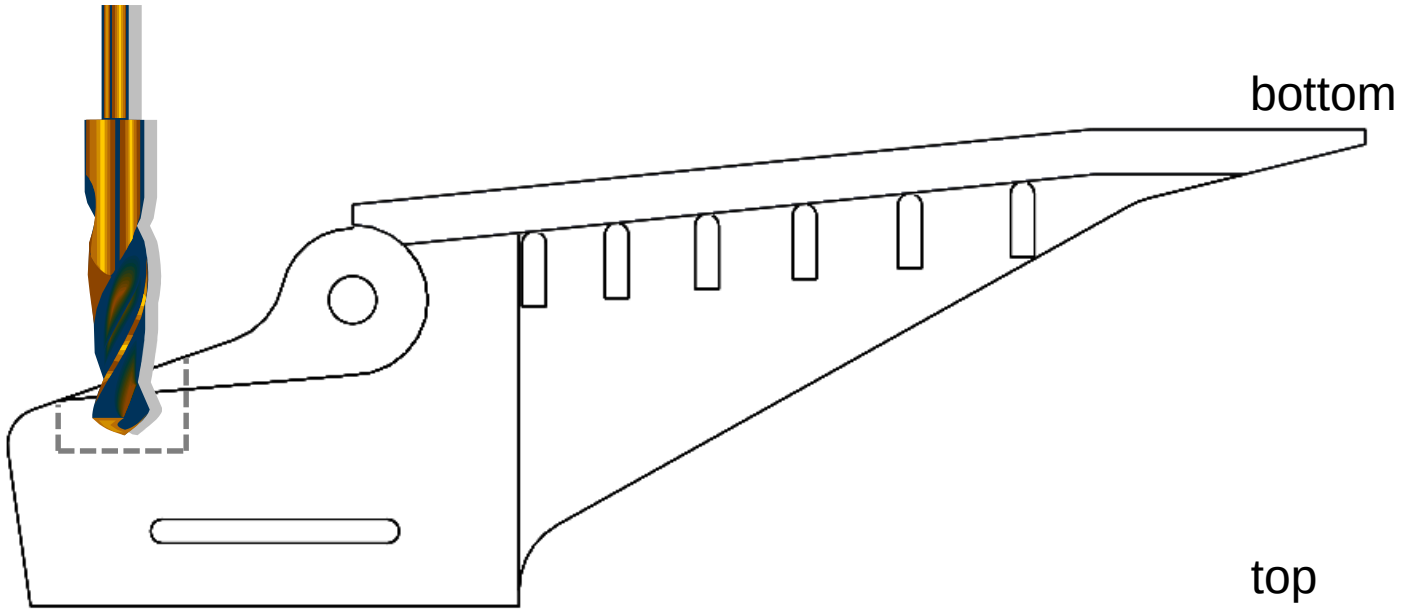
Use a band saw or table saw to cut along the dotted line.



Building the Shape&Roll Foot Jr.

Making the Forefoot

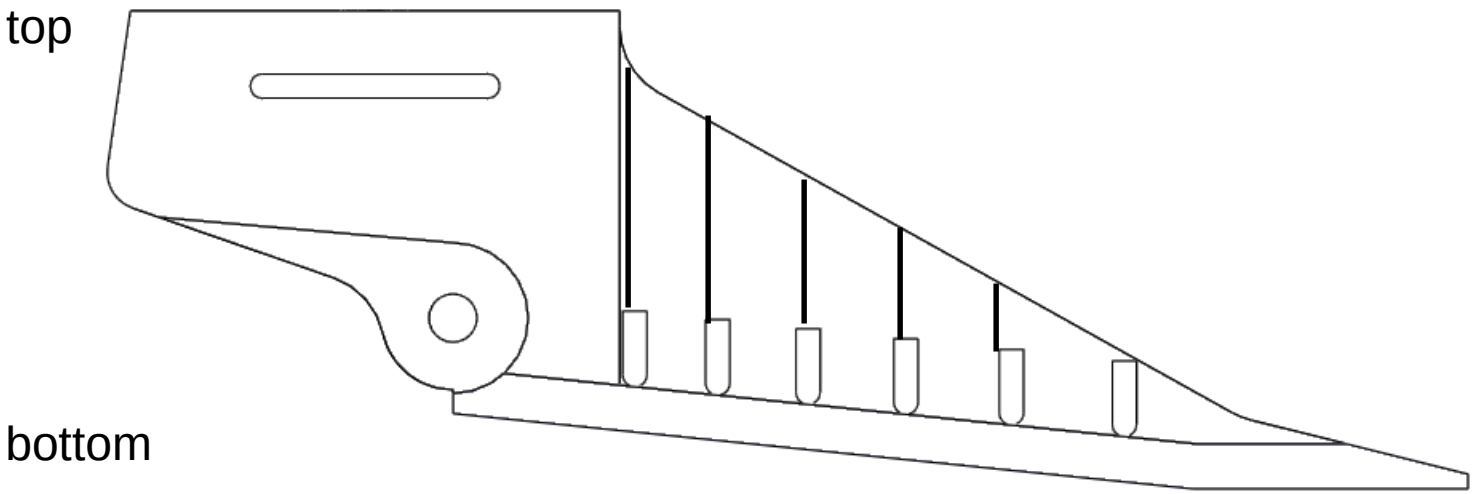
Turn the foot upside down, and drill the hole for the heel bumper to the specified depth.



Building the Shape&Roll Foot Jr.

Making the Forefoot

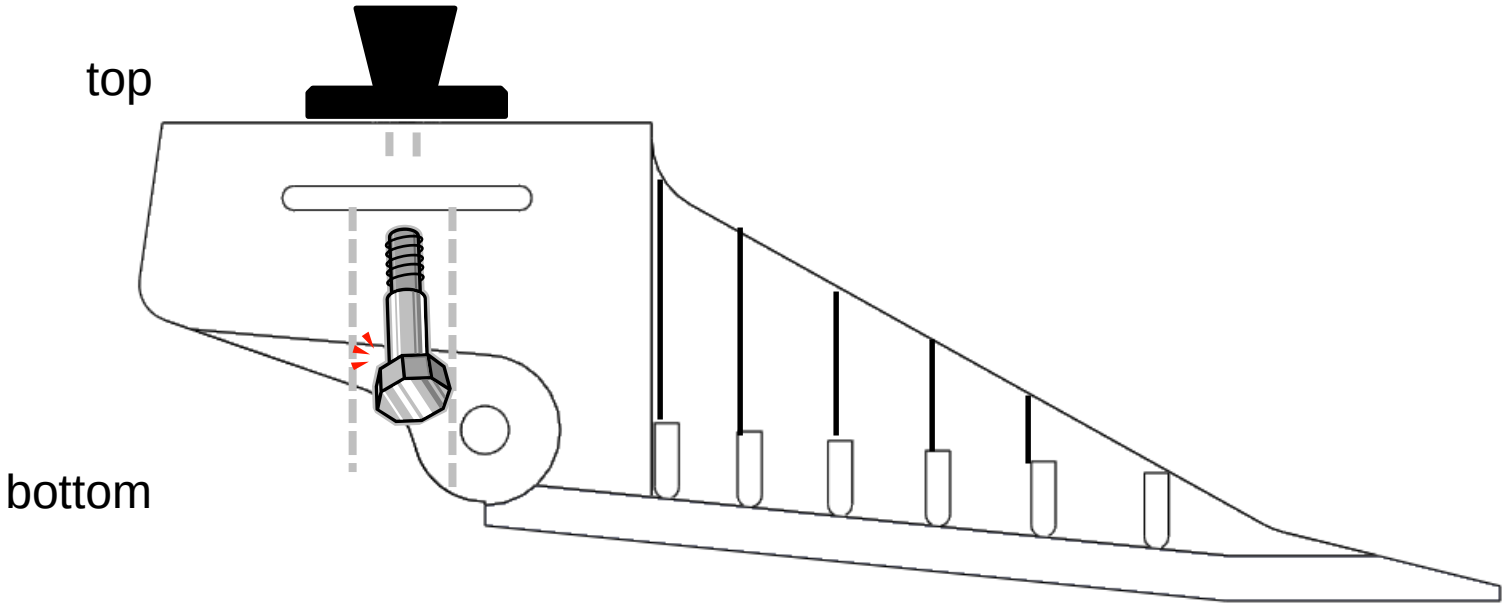
Use a band saw with a 1 mm thick blade to make vertical cuts from the bumper slots to the top edge of the foot.



Building the Shape&Roll Foot Jr.

Making the Forefoot

Attach the pyramid adaptor to the top of the foot by running a bolt through the **pyramid adaptor hole** from the bottom.



Building the Shape&Roll Foot Jr.

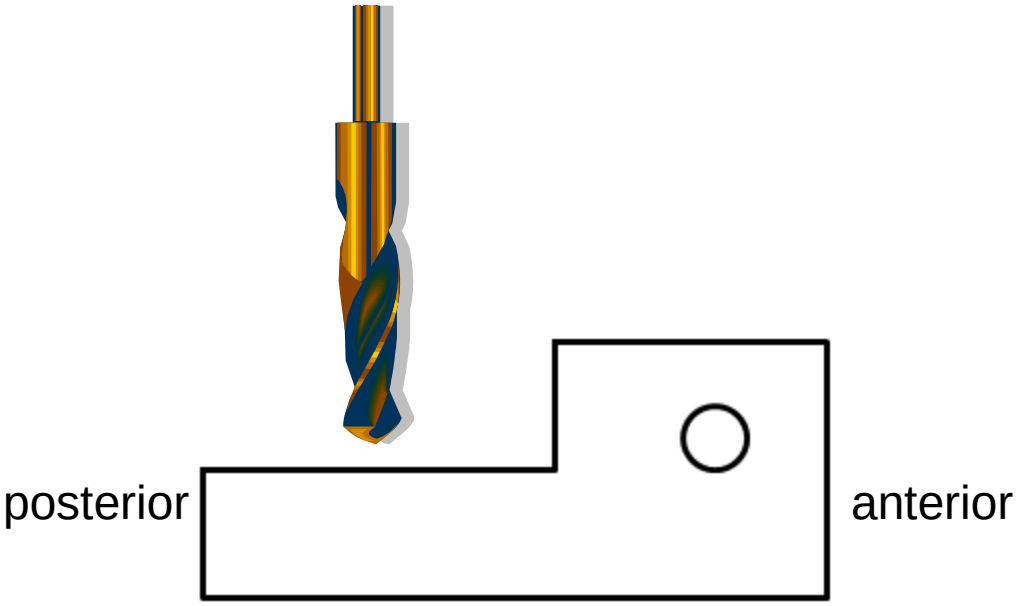
Making the Heel

Start with an appropriate size polypropylene block. Mark the location of the **hinge hole** and drill it through the entire block.

Building the Shape&Roll Foot Jr.

Making the Heel

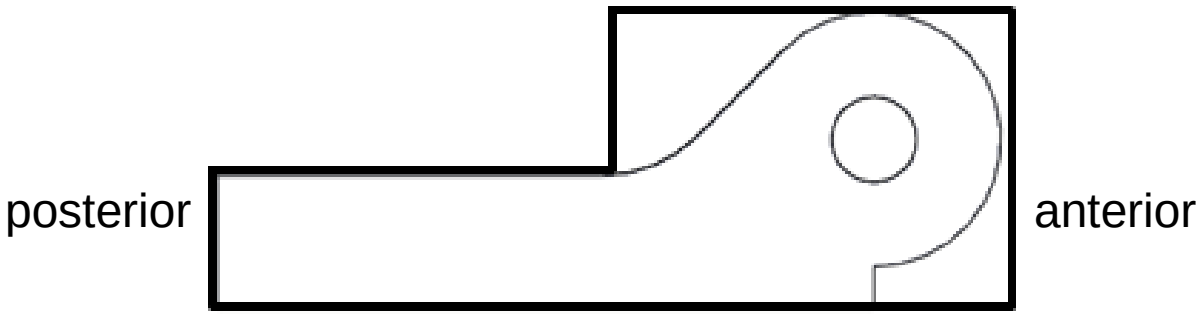
Mill off excess material from the top, posterior portion of the heel.



Building the Shape&Roll Foot Jr.

Making the Heel

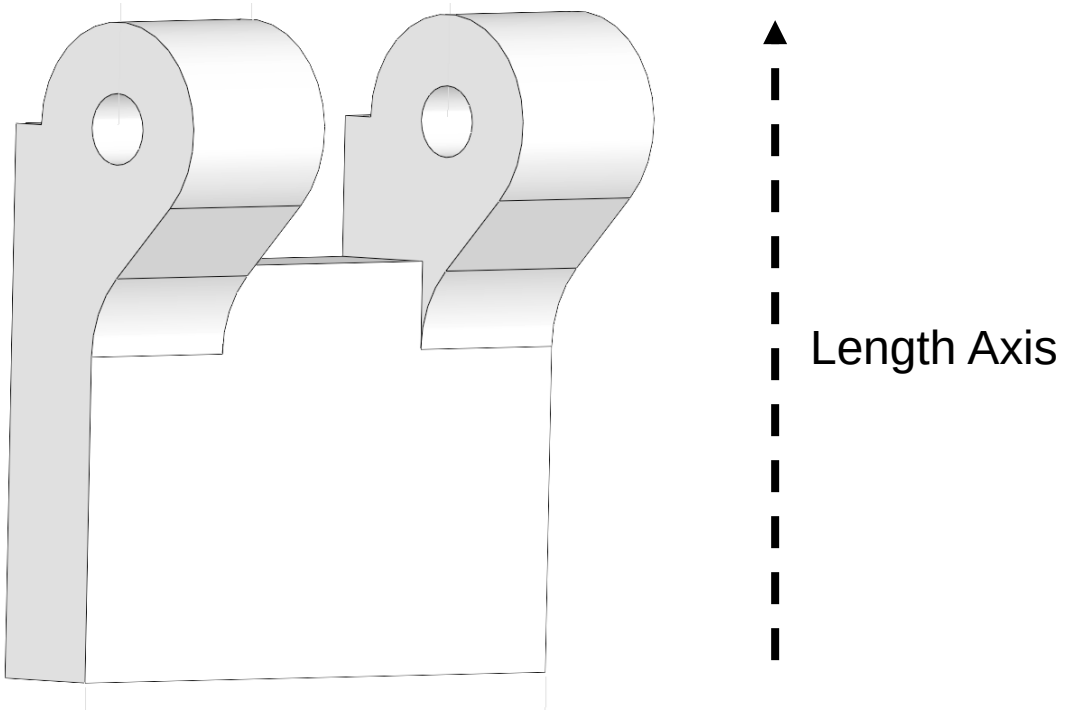
Use the mill to cut out the barrels of the hinge joint to the designated depth.



Building the Shape&Roll Foot Jr.

Making the Heel

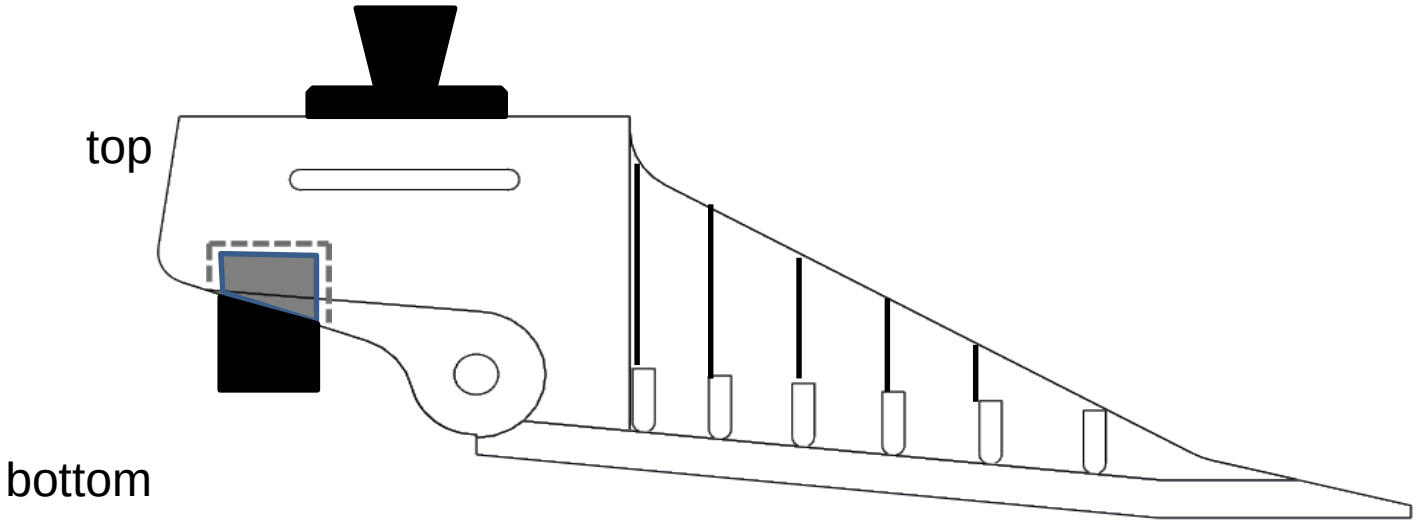
Aligning the length axis of the heel with the vertical, the mill can be used to remove material between the two barrels.



Building the Shape&Roll Foot Jr.

Assembling the Foot

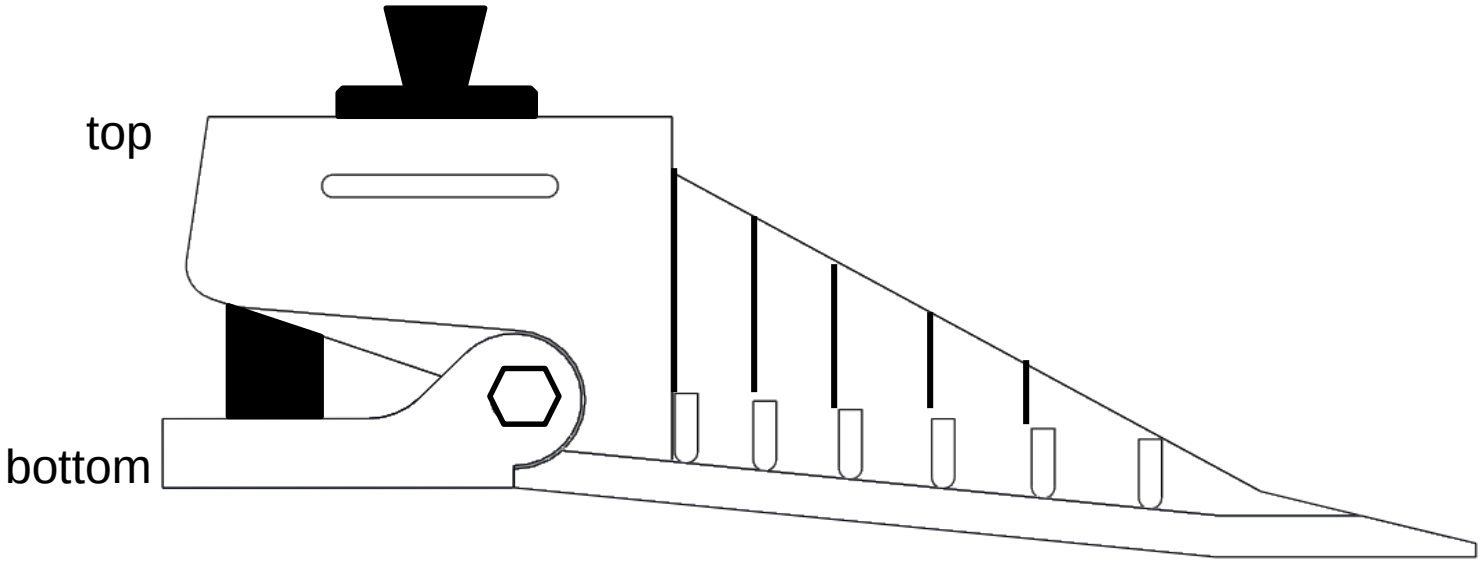
Cut the polyurethane rod to the specified length and insert it into the rearfoot.



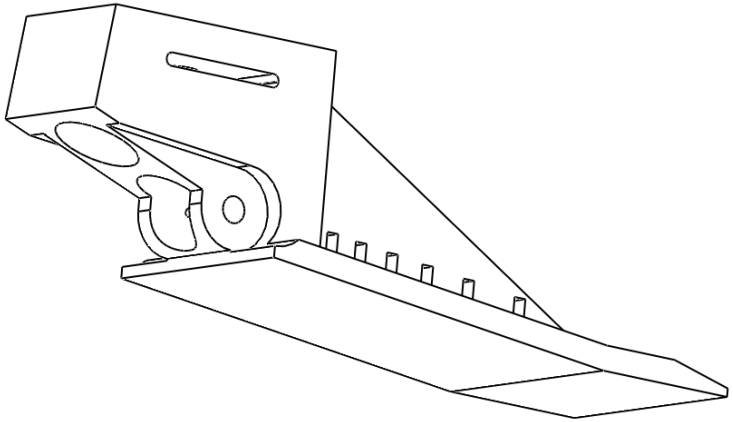
Building the Shape&Roll Foot Jr.

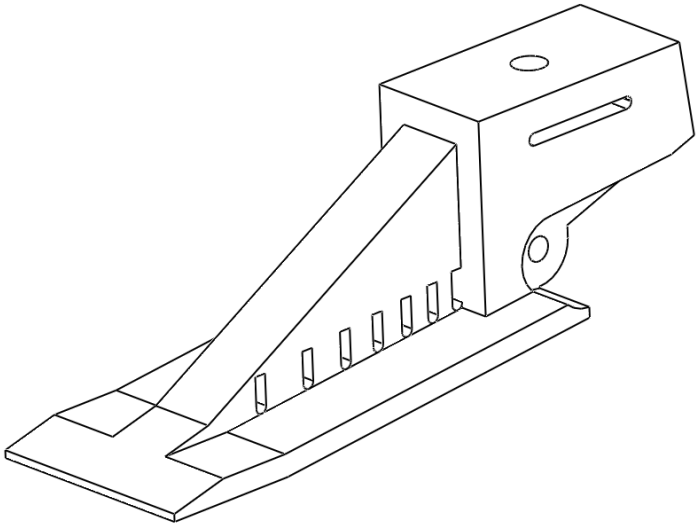
Assembling the Foot

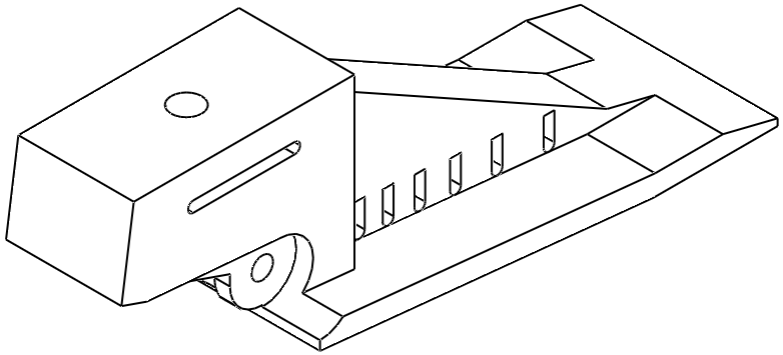
Line up the **hinge holes** and secure a bolt through them.



Appendix







Appendix provides diagrams and dimensions for manufacturing feet sizes 13 to 21.
All measurements are specified in mm.

Size 21 Foot

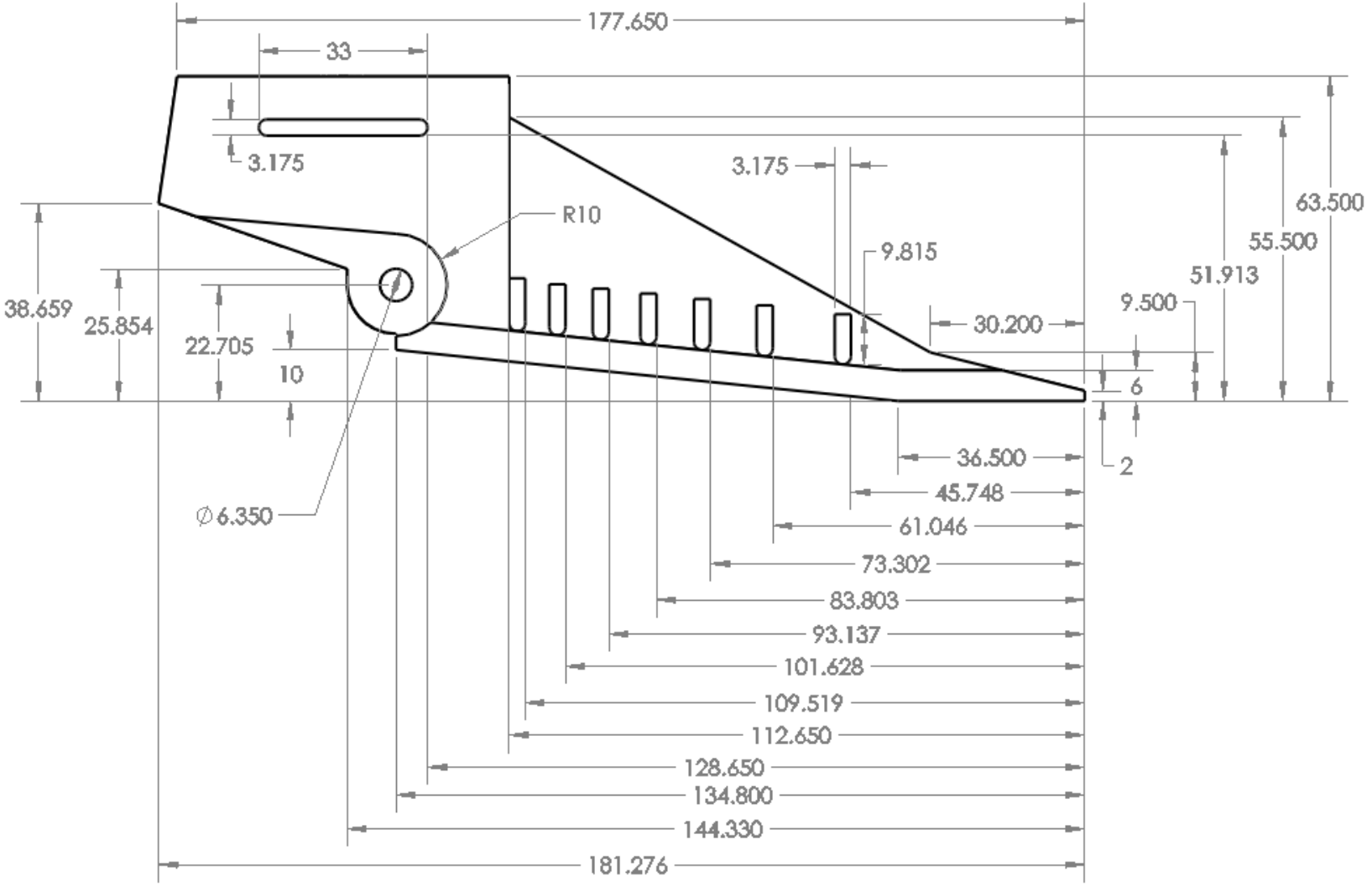
Minimum Starting Block Dimensions:

63.5 mm x 181.28 mm x 58 mm

Polyurethane Rod Dimensions (D=diameter of rod):

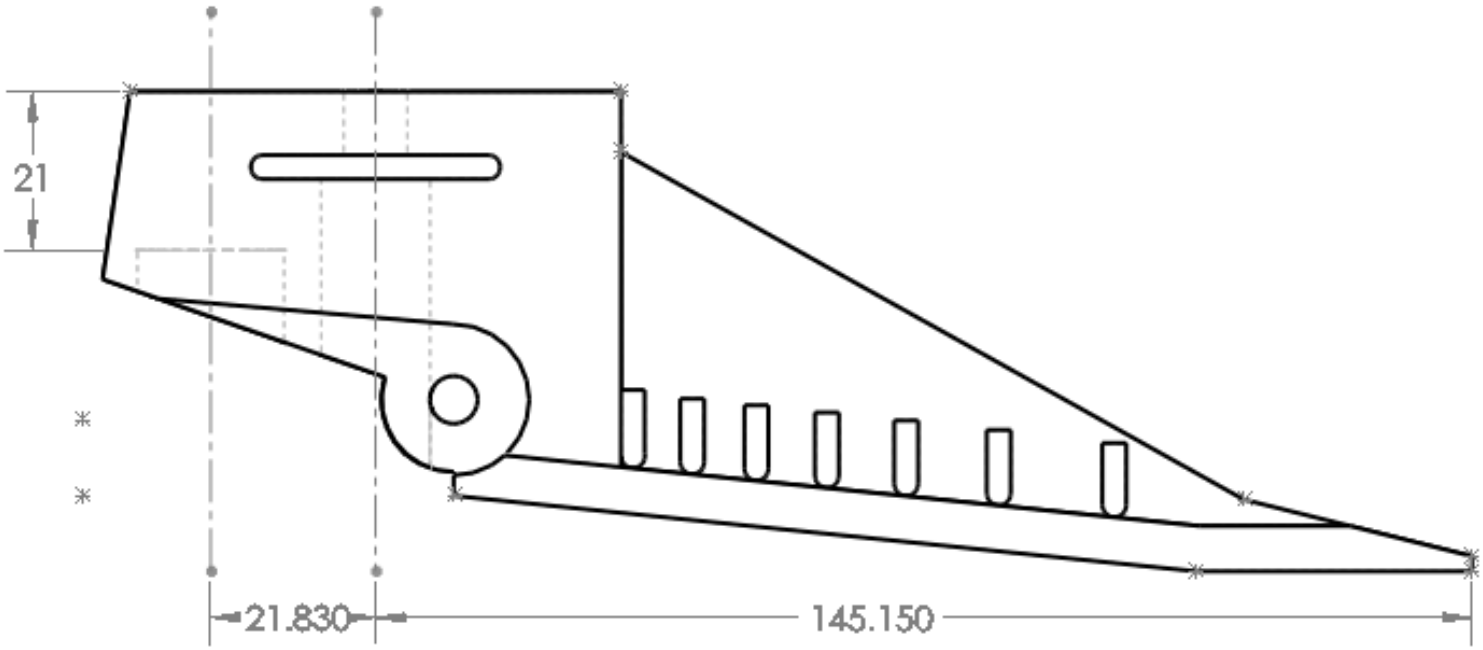
D0.75” x 22.5 mm

Size 21 Forefoot Lateral View

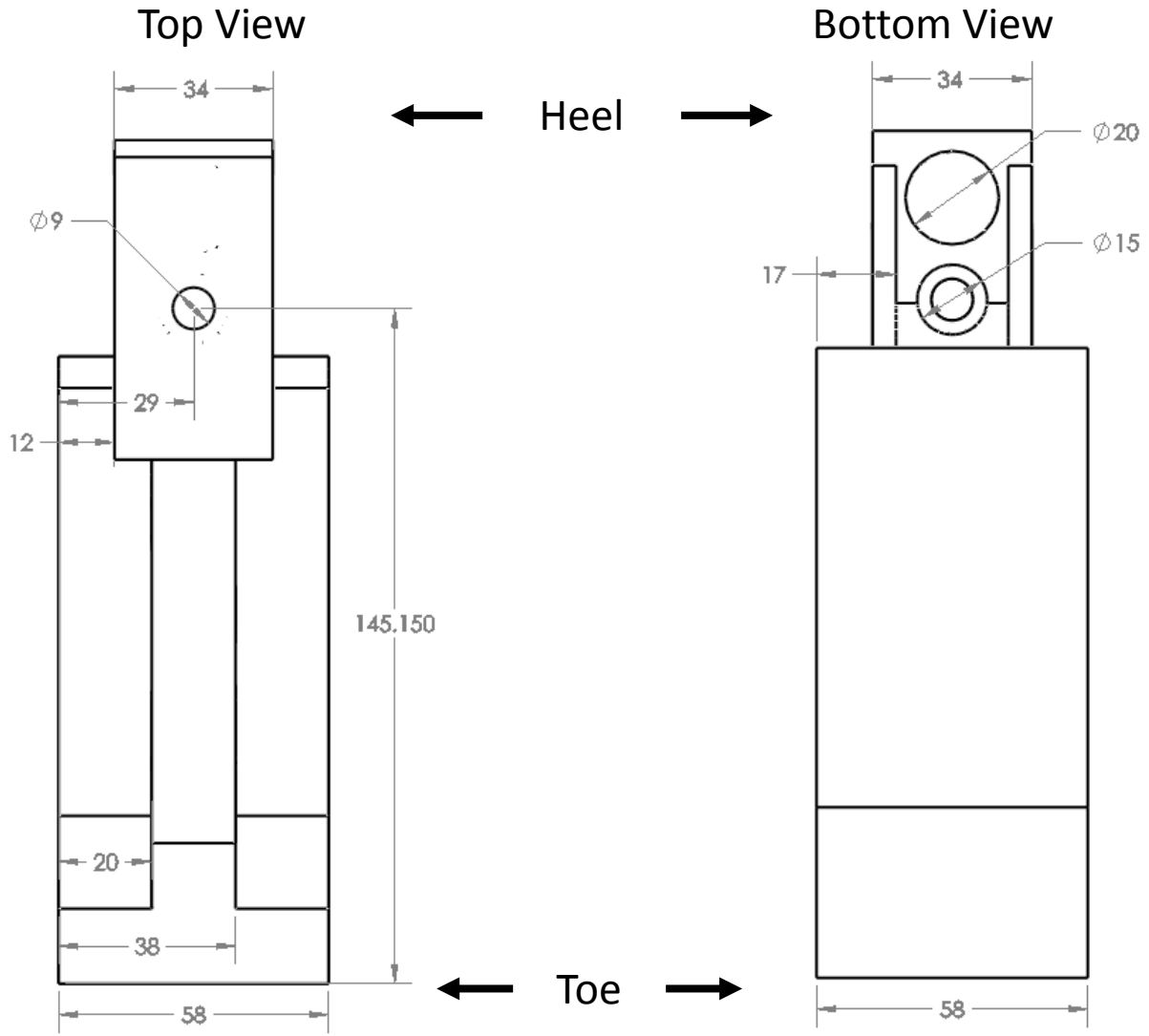


A3

Size 21 Forefoot Transparent View

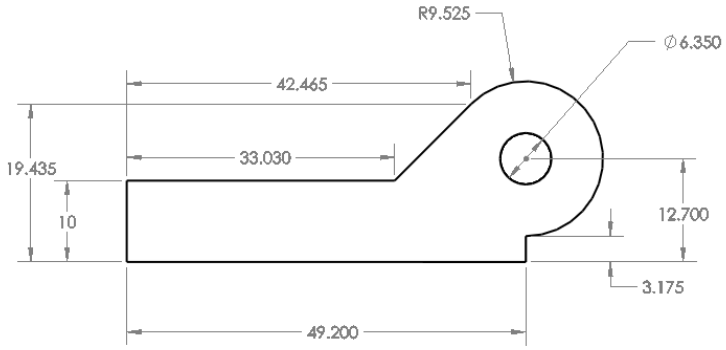


Size 21 Forefoot Top and Bottom Views

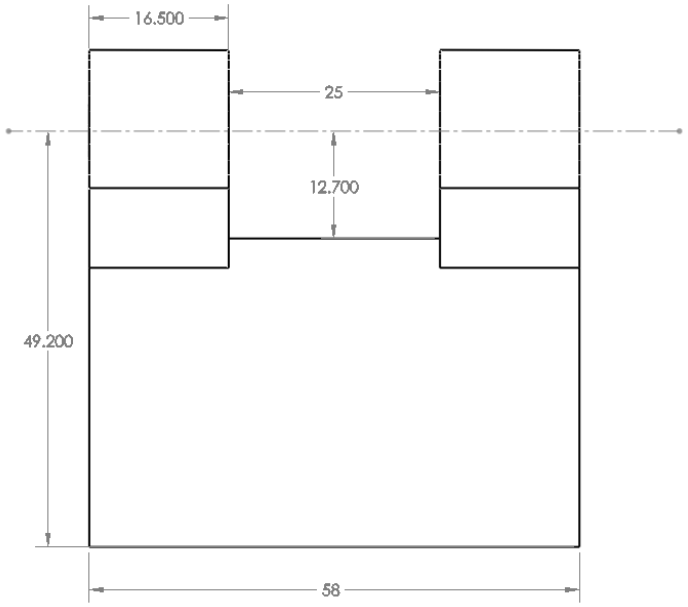


Size 21 Heel

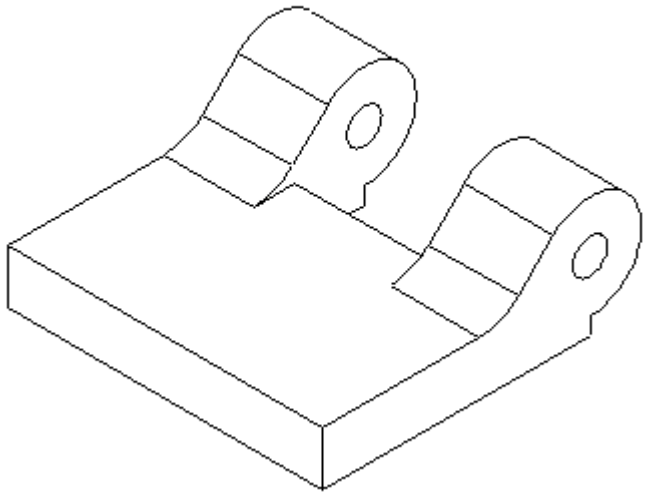
Lateral View



Top View



3/4 Perspective



Size 20 Foot

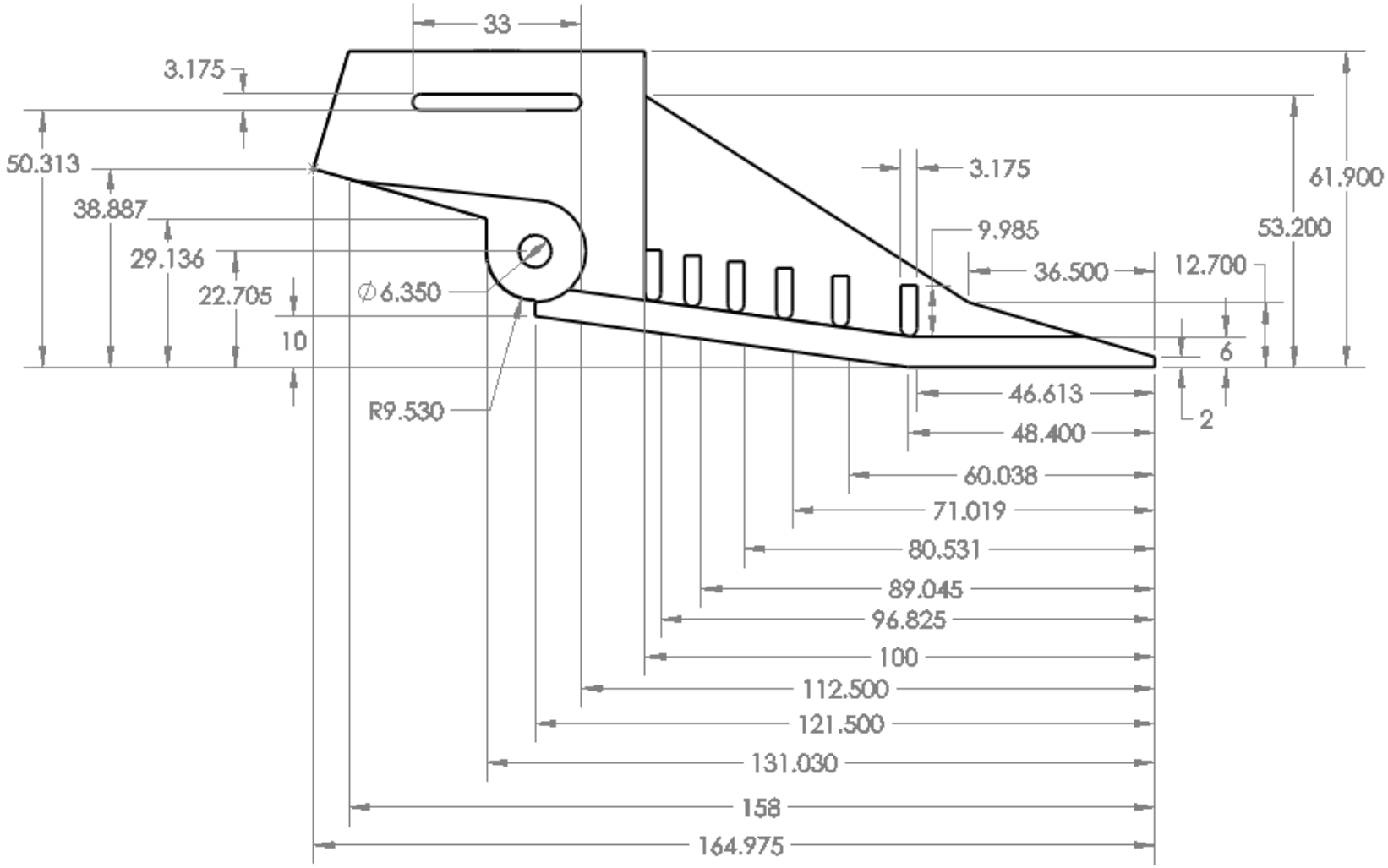
Minimum Starting Block Dimensions:

164.98 mm x 61.9 mm x 50 mm

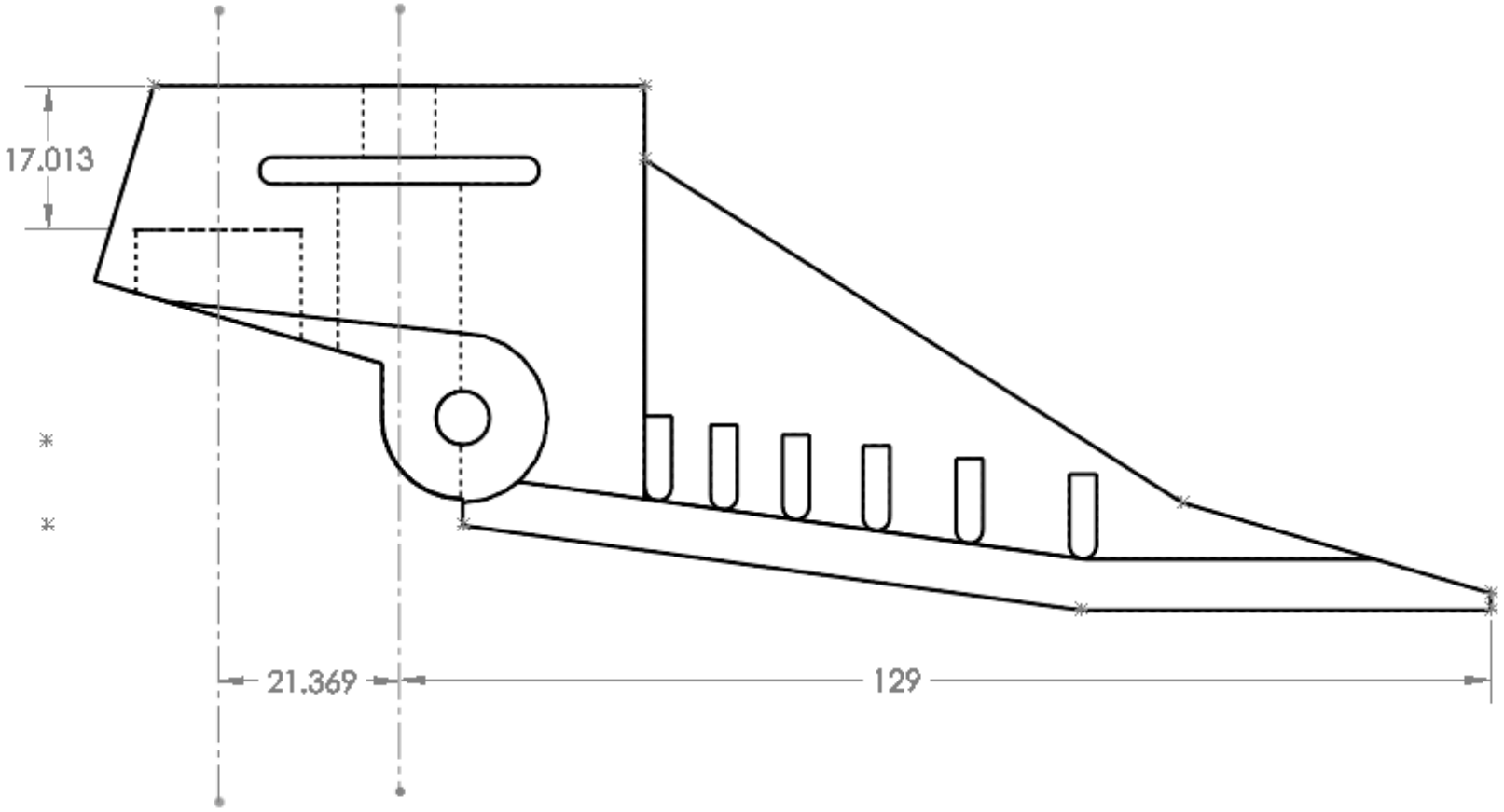
Polyurethane Rod Dimensions (D=diameter of rod):

D0.75” x 24.82 mm

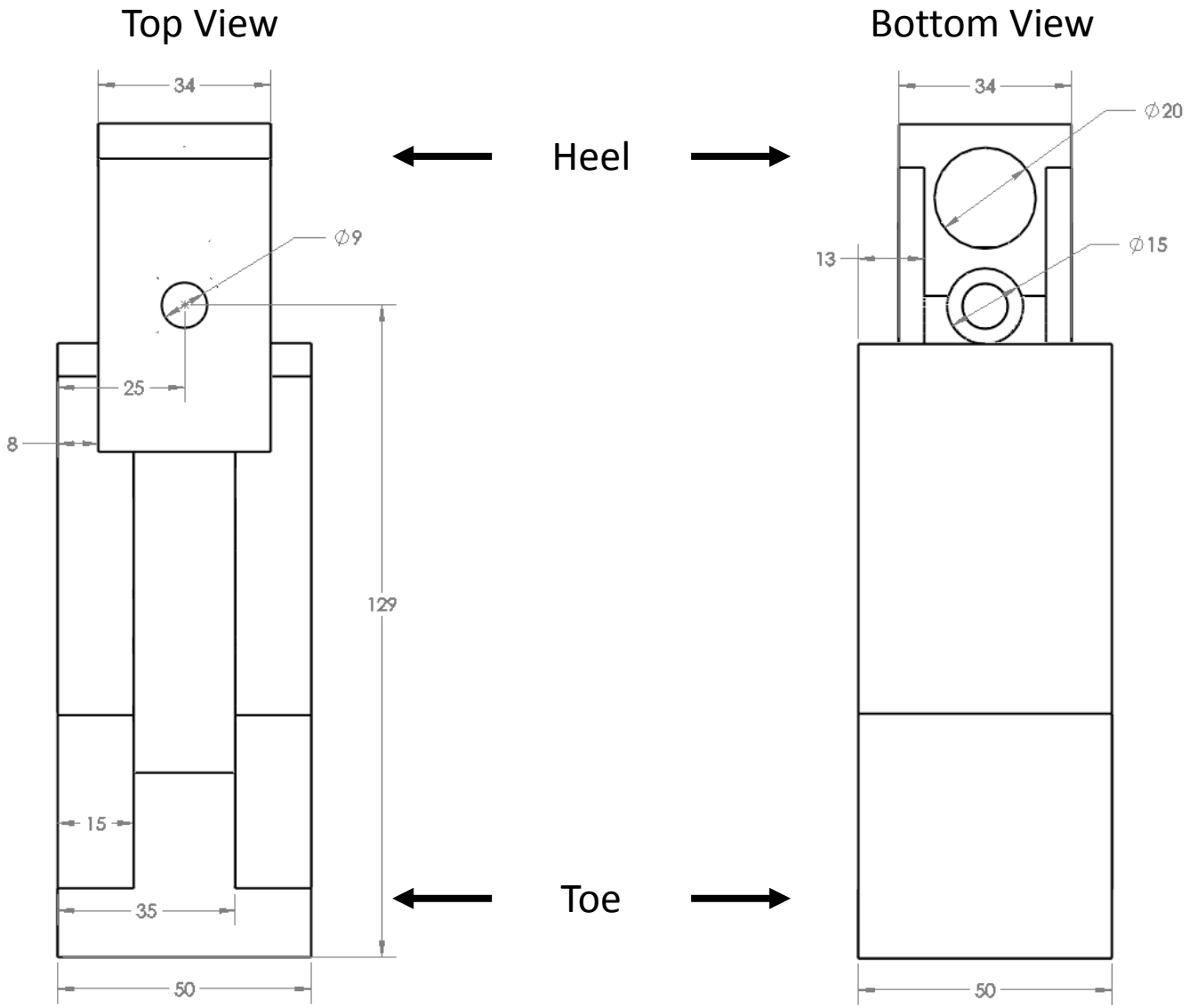
Size 20 Forefoot Lateral View



Size 20 Forefoot Transparent View

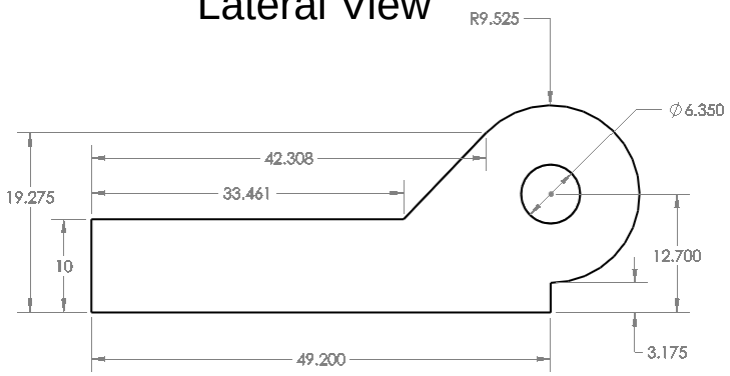


Size 20 Forefoot Top and Bottom Views

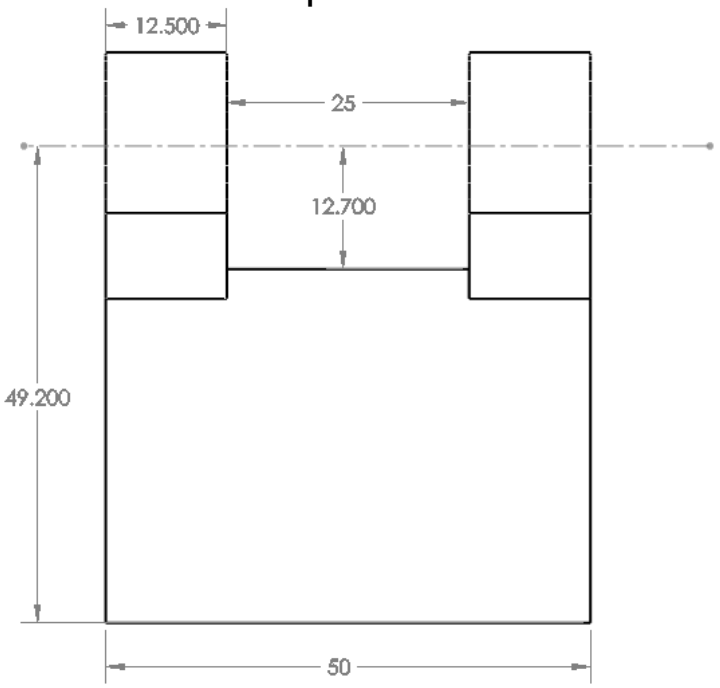


Size 20 Heel

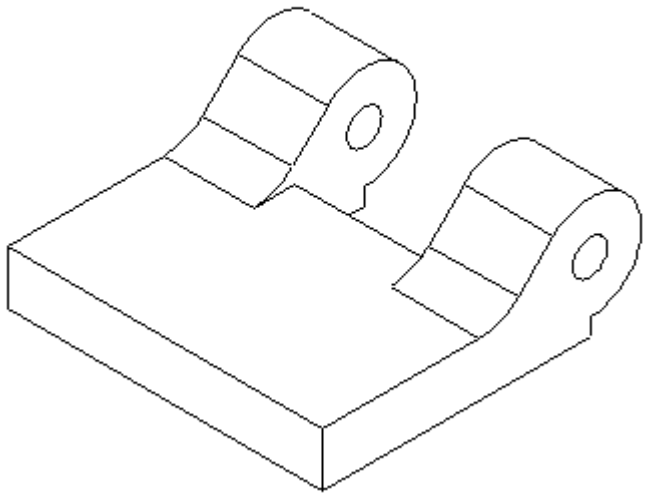
Lateral View



Top View



3/4 Perspective



Size 19 Foot

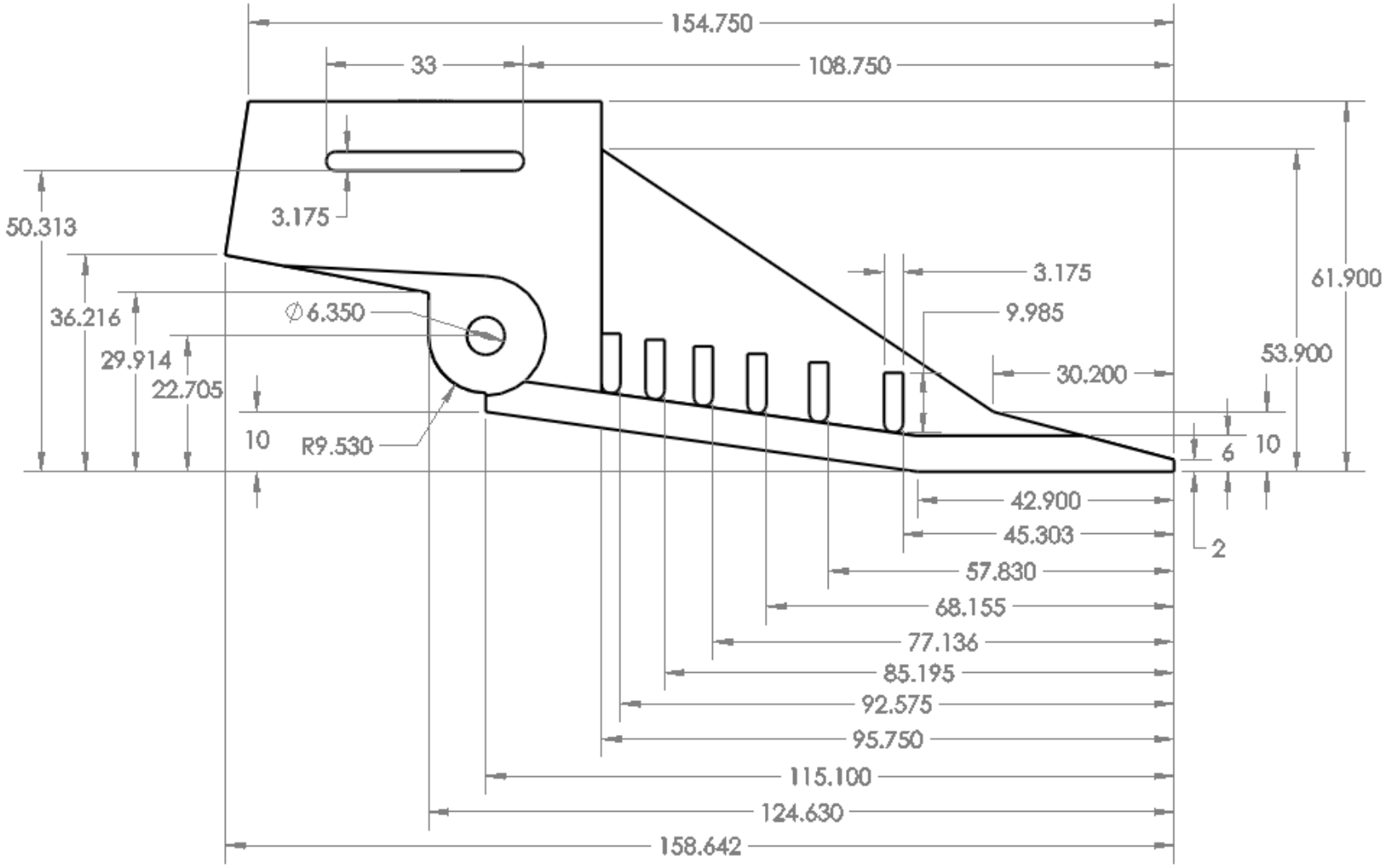
Minimum Starting Block Dimensions:

158.64 mm x 61.9 mm x 50 mm

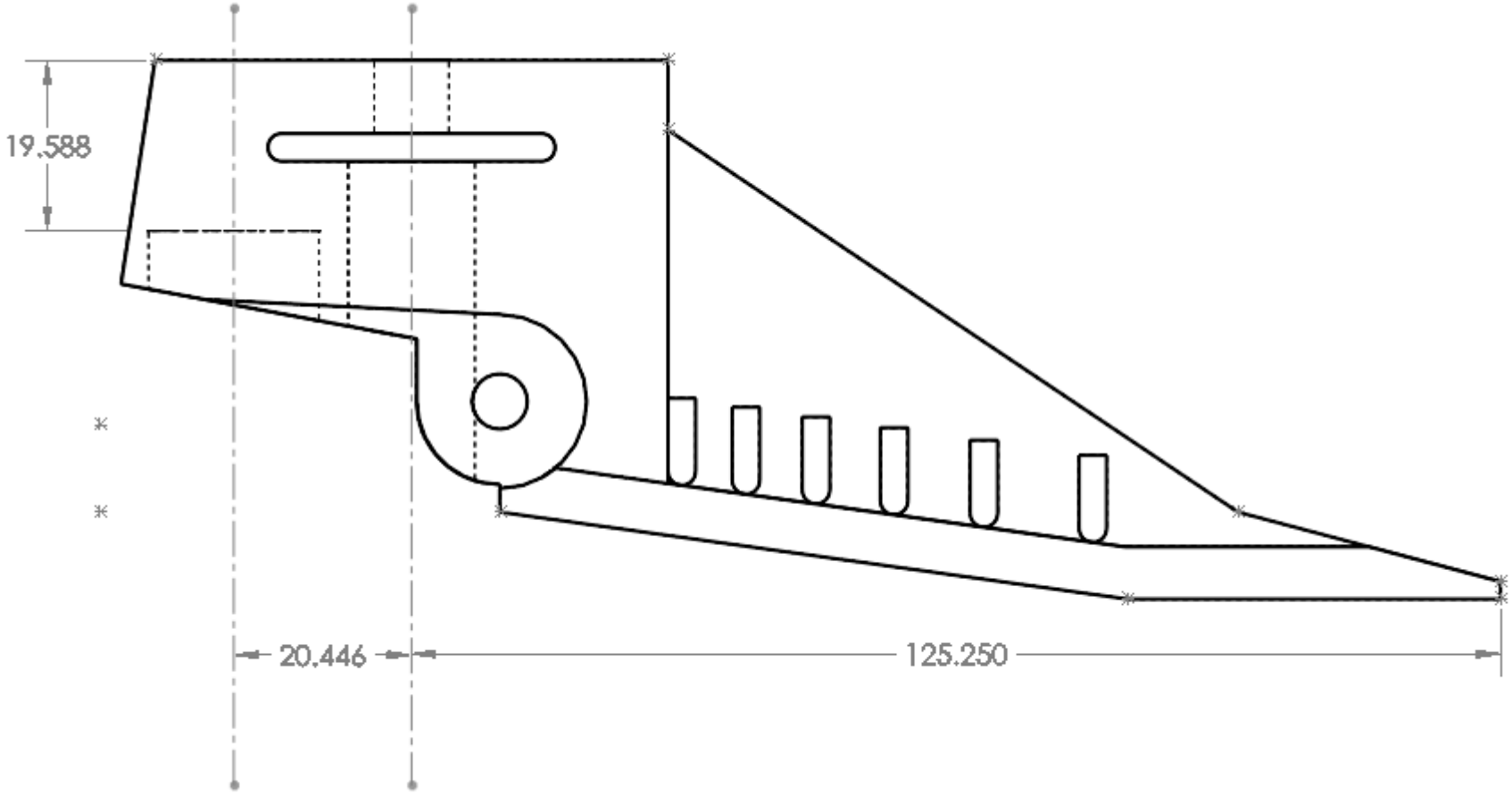
Polyurethane Rod Dimensions (D=diameter of rod):

D0.75” x 22.31 mm

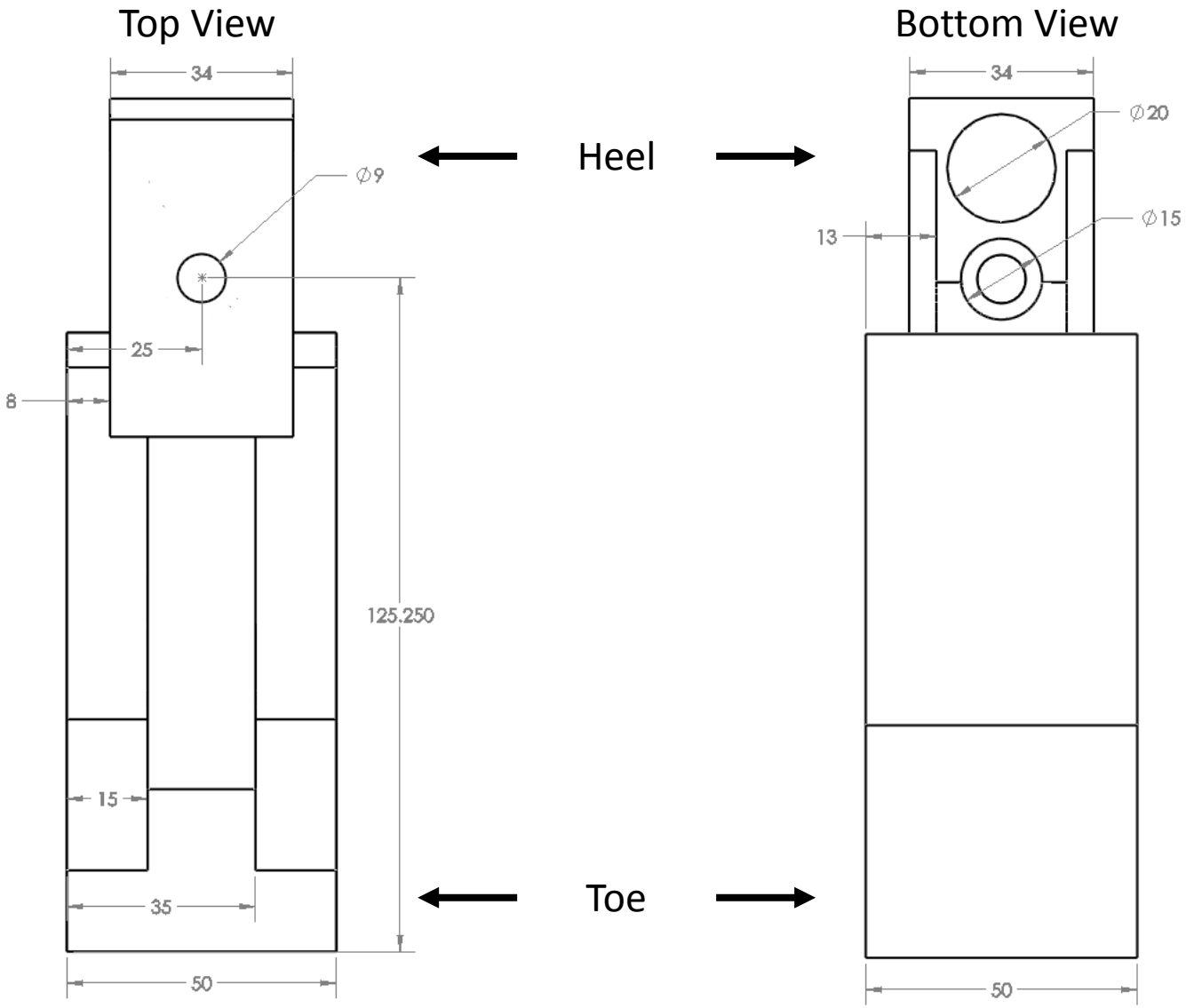
Size 19 Forefoot Lateral View



Size 19 Forefoot Transparent View

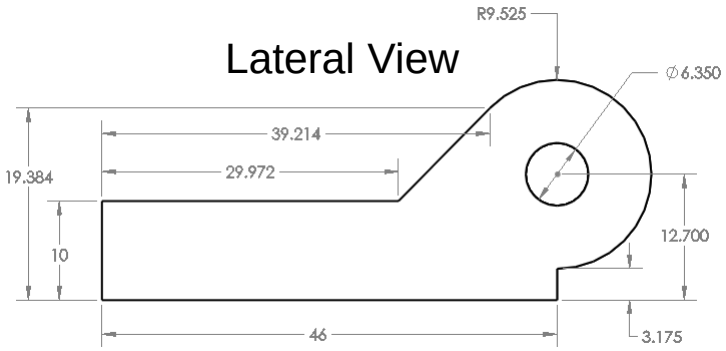


Size 19 Forefoot Top and Bottom Views

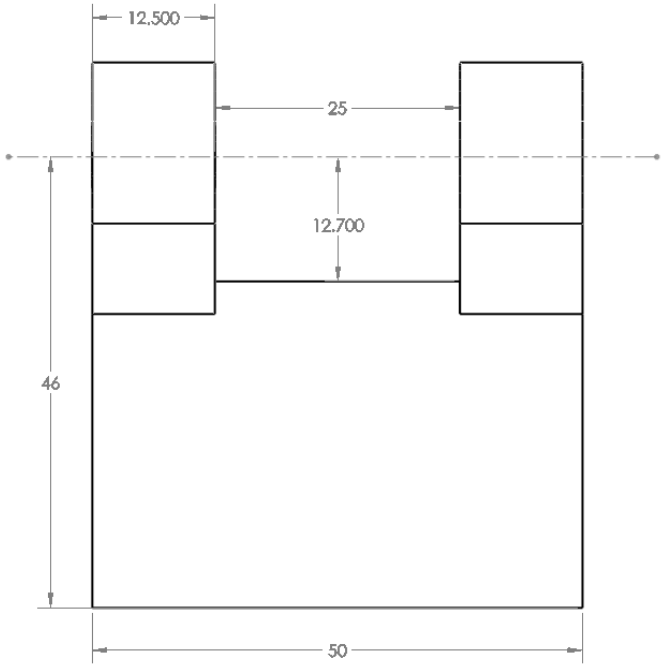


Size 19 Heel

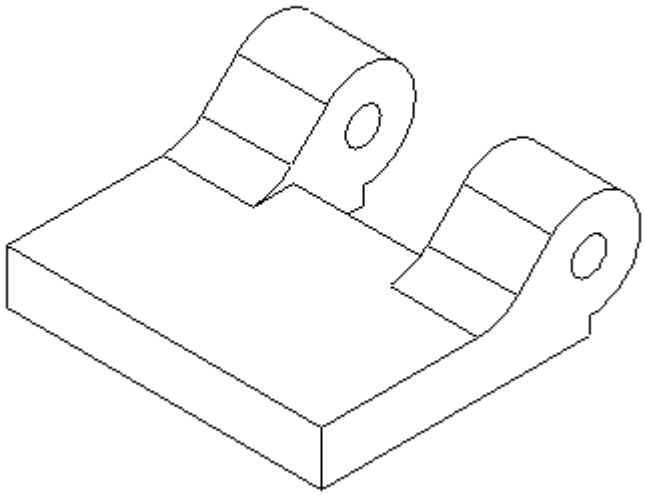
Lateral View



Top View



3/4 Perspective



Size 18 Foot

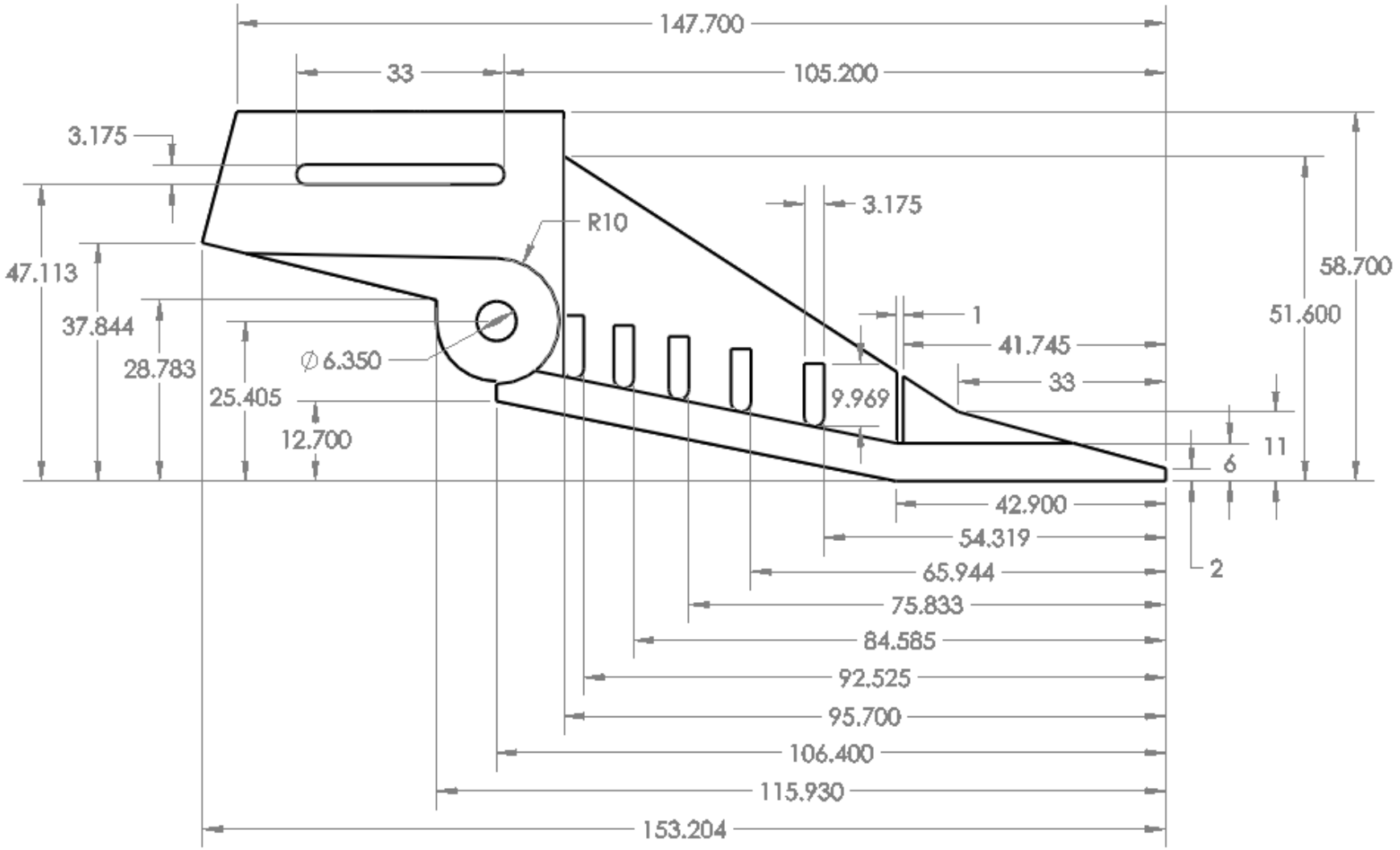
Minimum Starting Block Dimensions:

153.20 mm x 58.7 mm x 46 mm

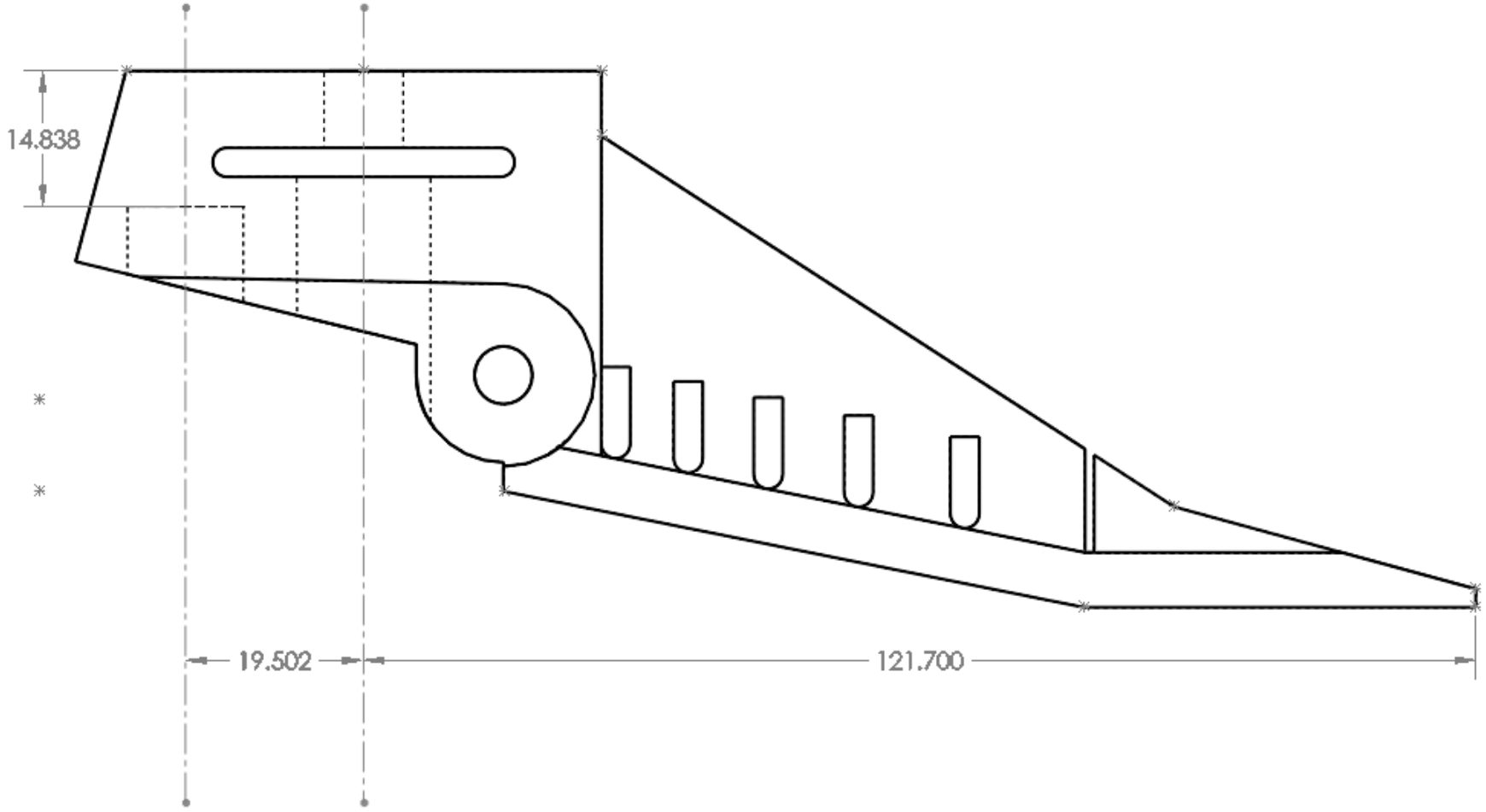
Polyurethane Rod Dimensions (D=diameter of rod):

D0.5” x 21.03 mm

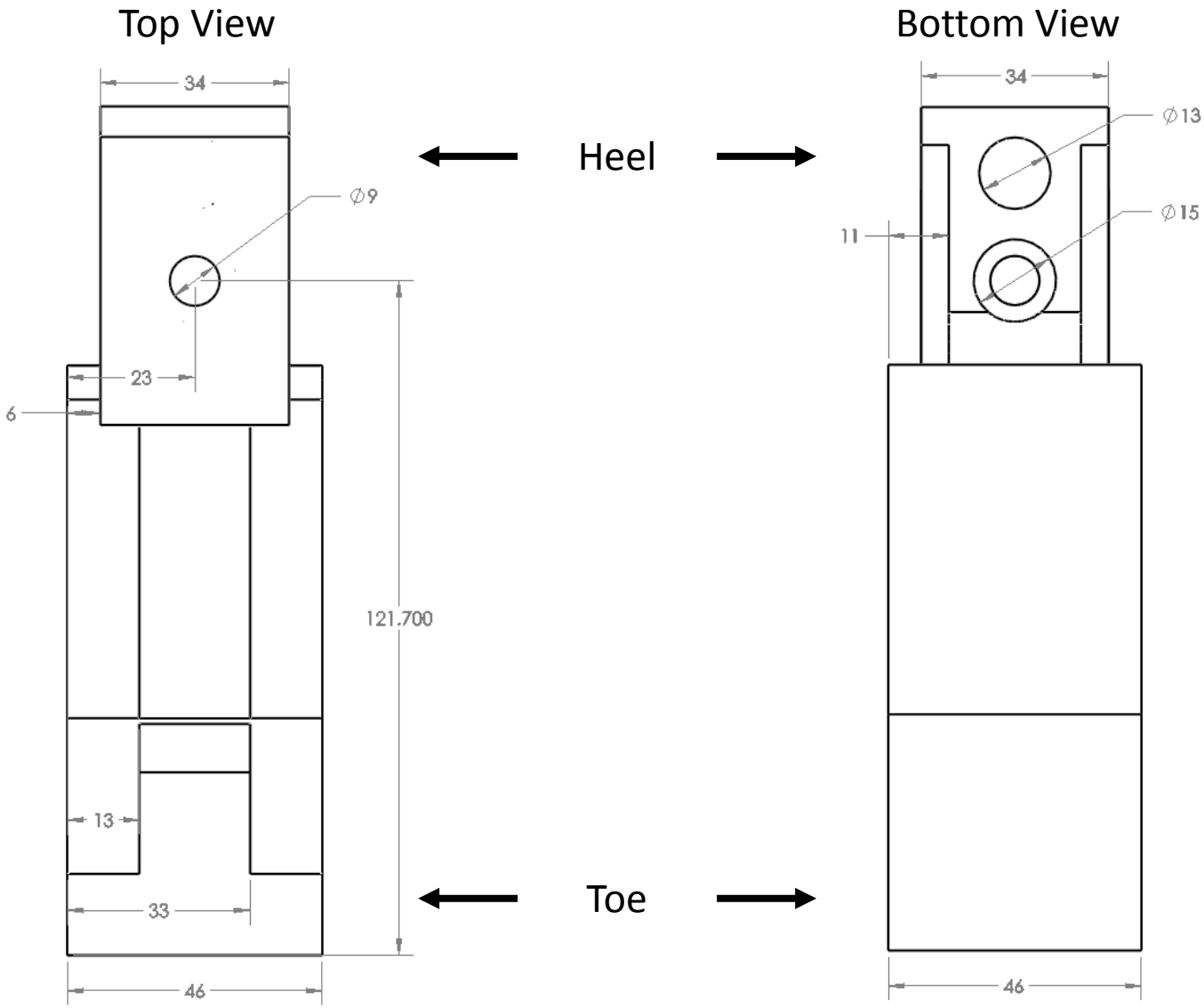
Size 18 Forefoot Lateral View



Size 18 Forefoot Transparent View

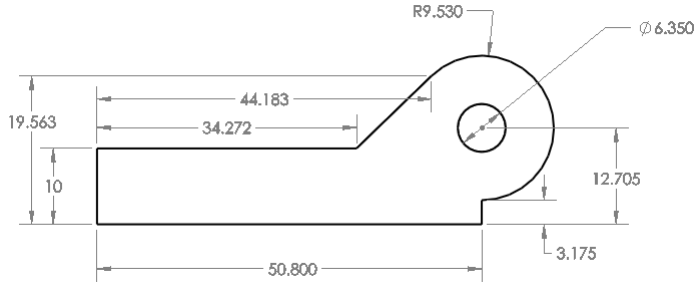


Size 18 Forefoot Top and Bottom Views

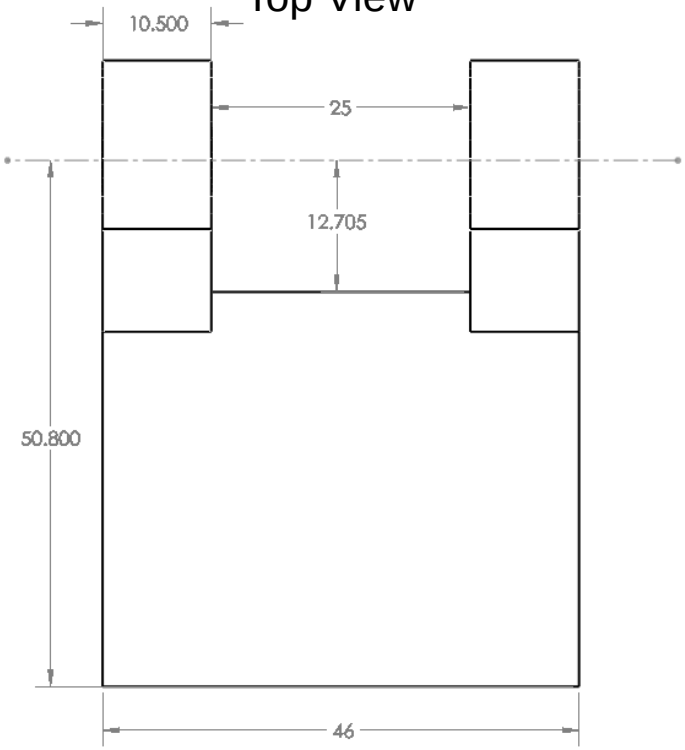


Size 18 Heel

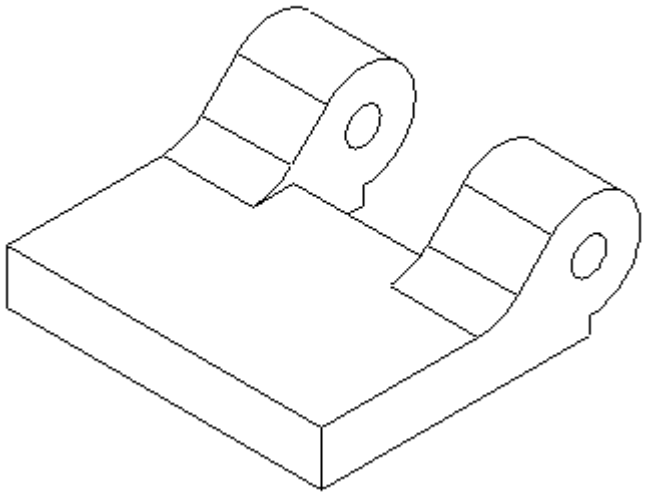
Lateral View



Top View



3/4 Perspective



Size 17 Foot

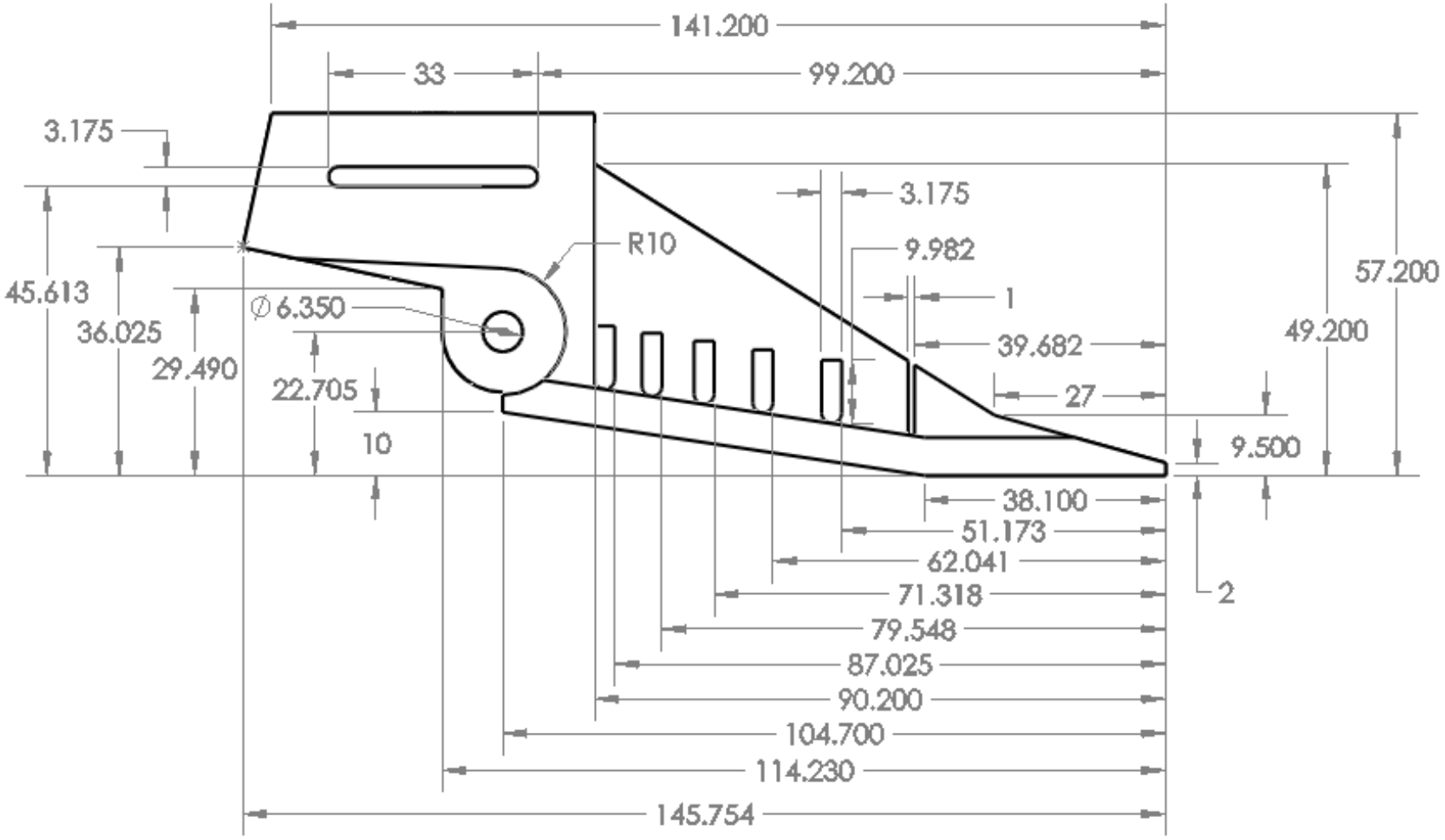
Minimum Starting Block Dimensions:

145.75 mm x 57.2 mm x 46 mm

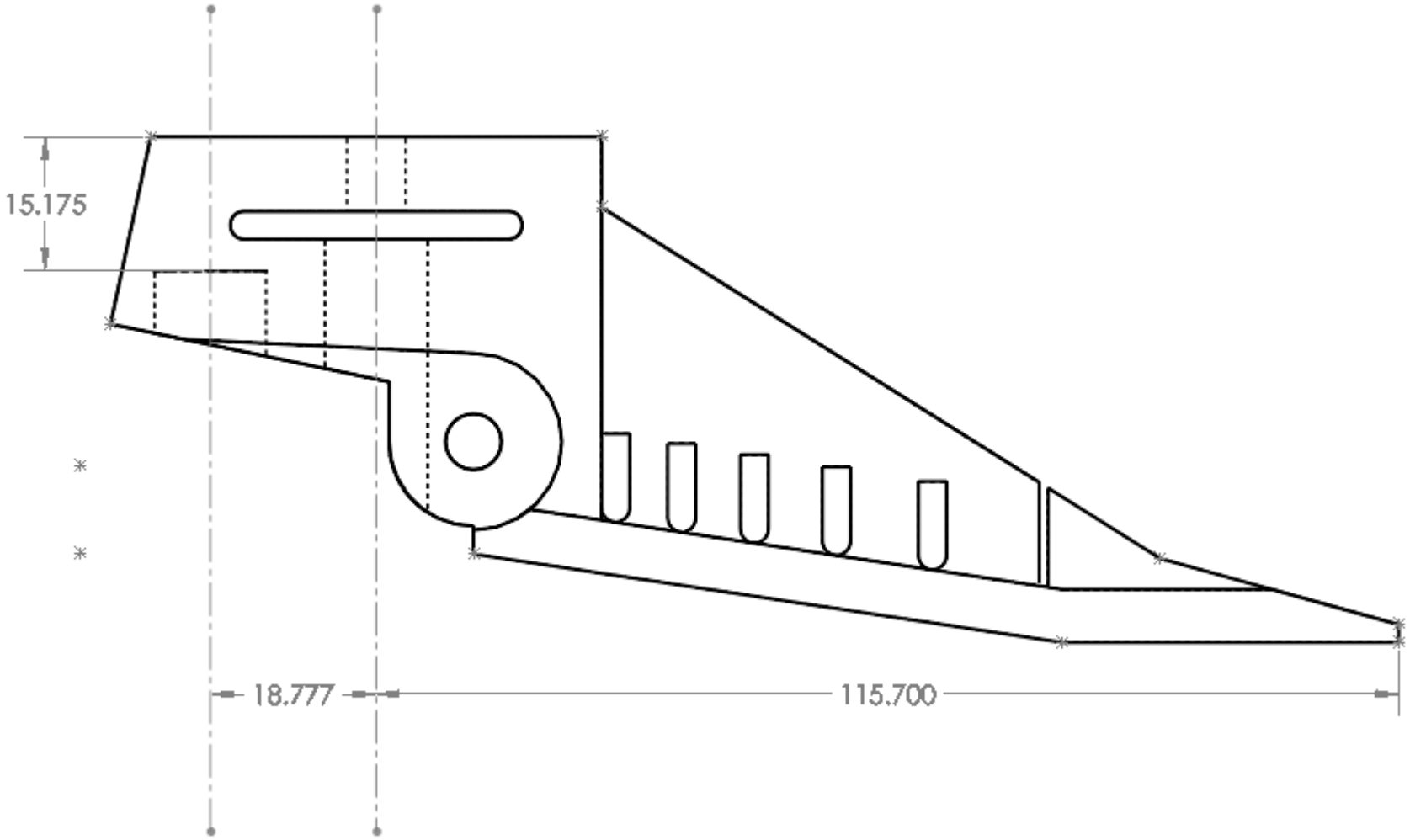
Polyurethane Rod Dimensions (D=diameter of rod):

D0.5” x 21.98 mm

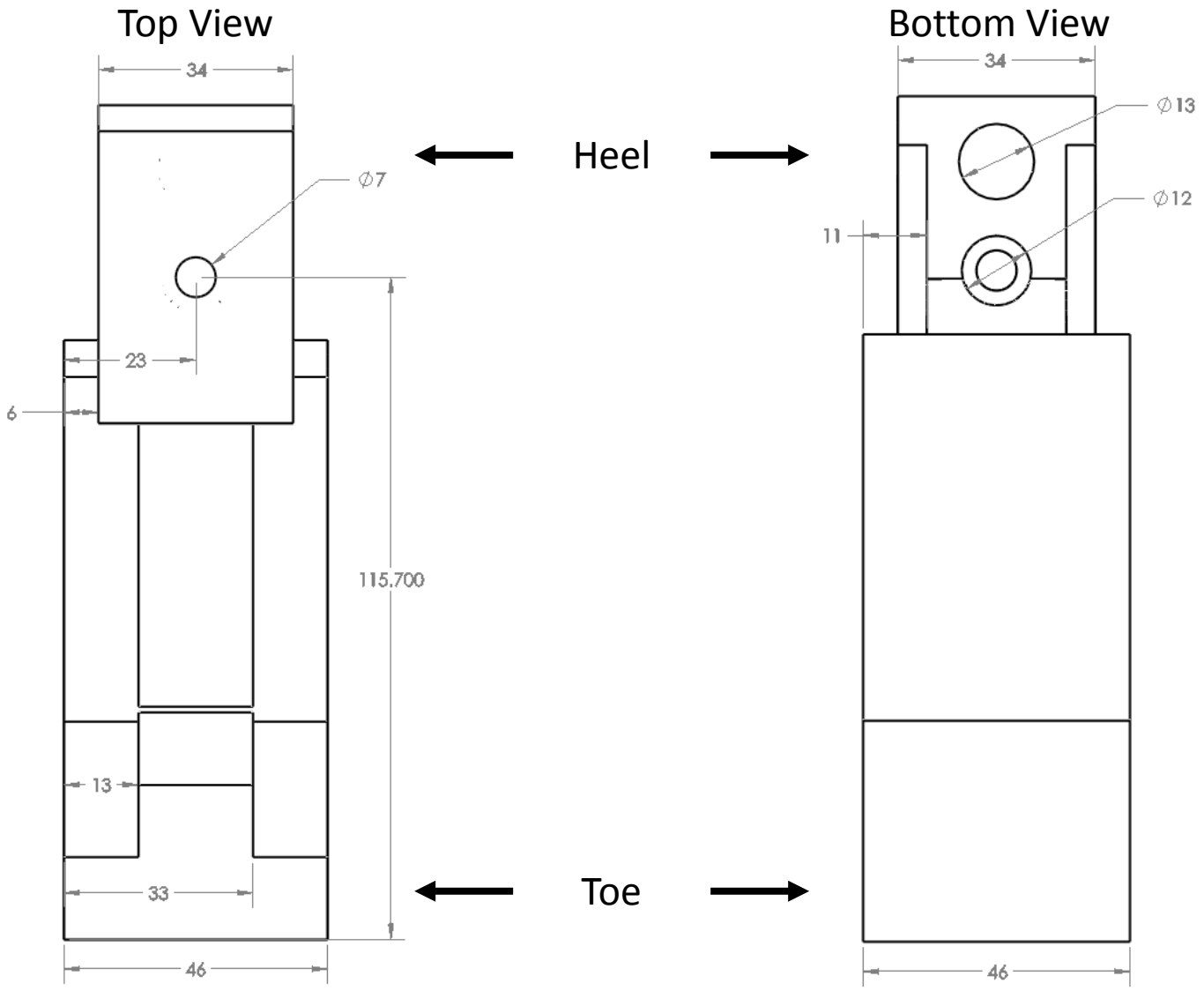
Size 17 Forefoot Lateral View



Size 17 Forefoot Transparent View

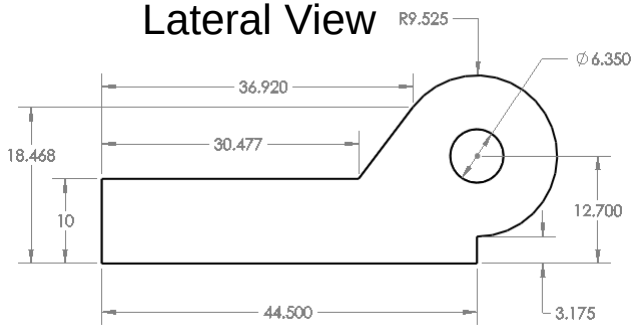


Size 17 Forefoot Top and Bottom Views

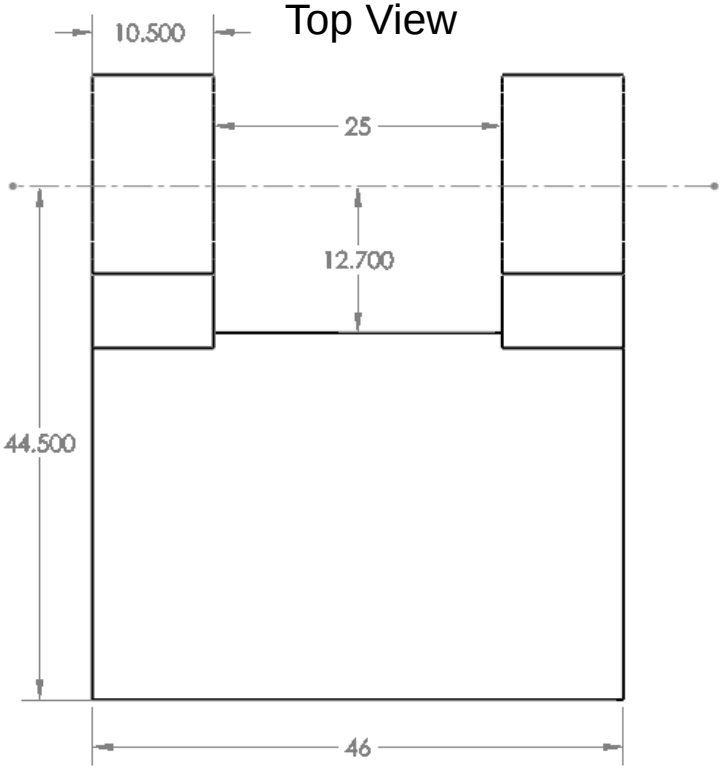


Size 17 Heel

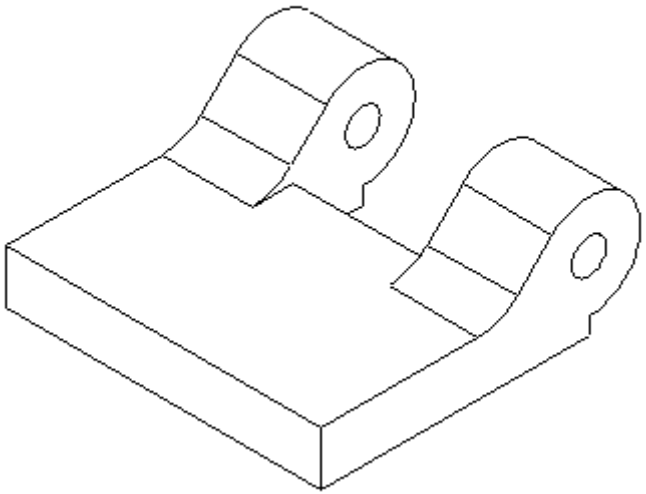
Lateral View



Top View



3/4 Perspective



Size 16 Foot

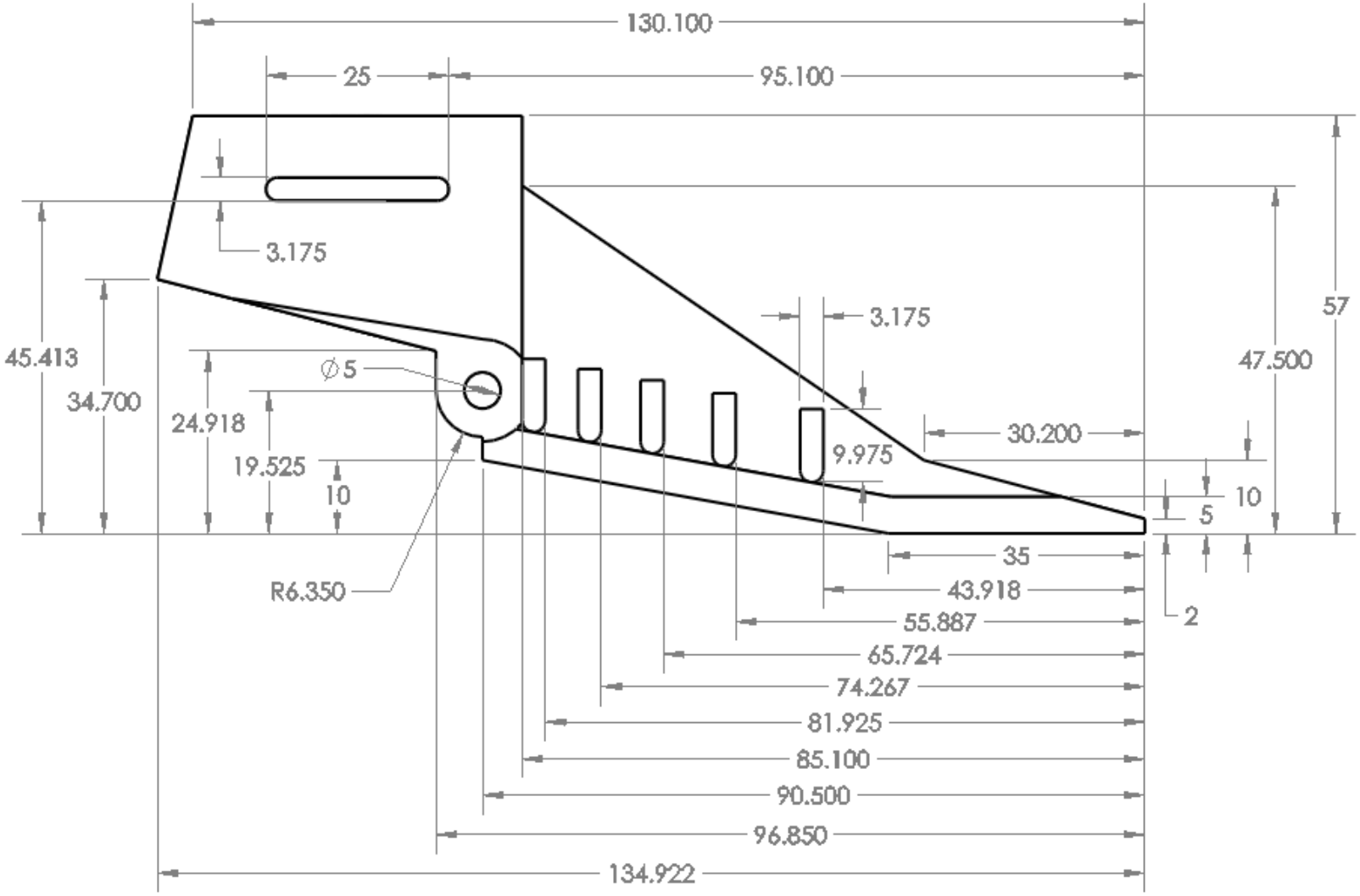
Minimum Starting Block Dimensions:

134.99 mm x 57 mm x 42 mm

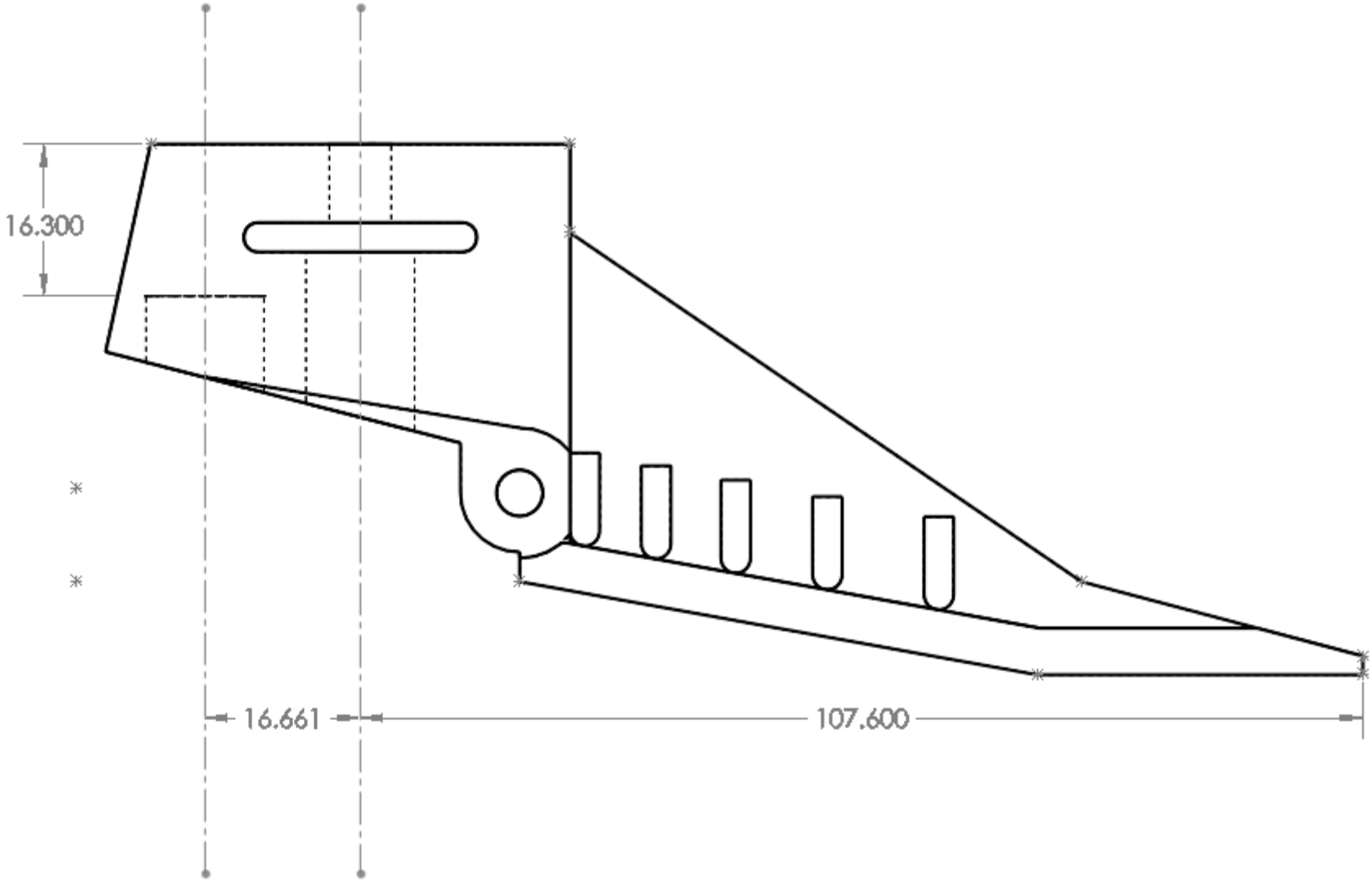
Polyurethane Rod Dimensions (D=diameter of rod):

D0.5” x 21.18 mm

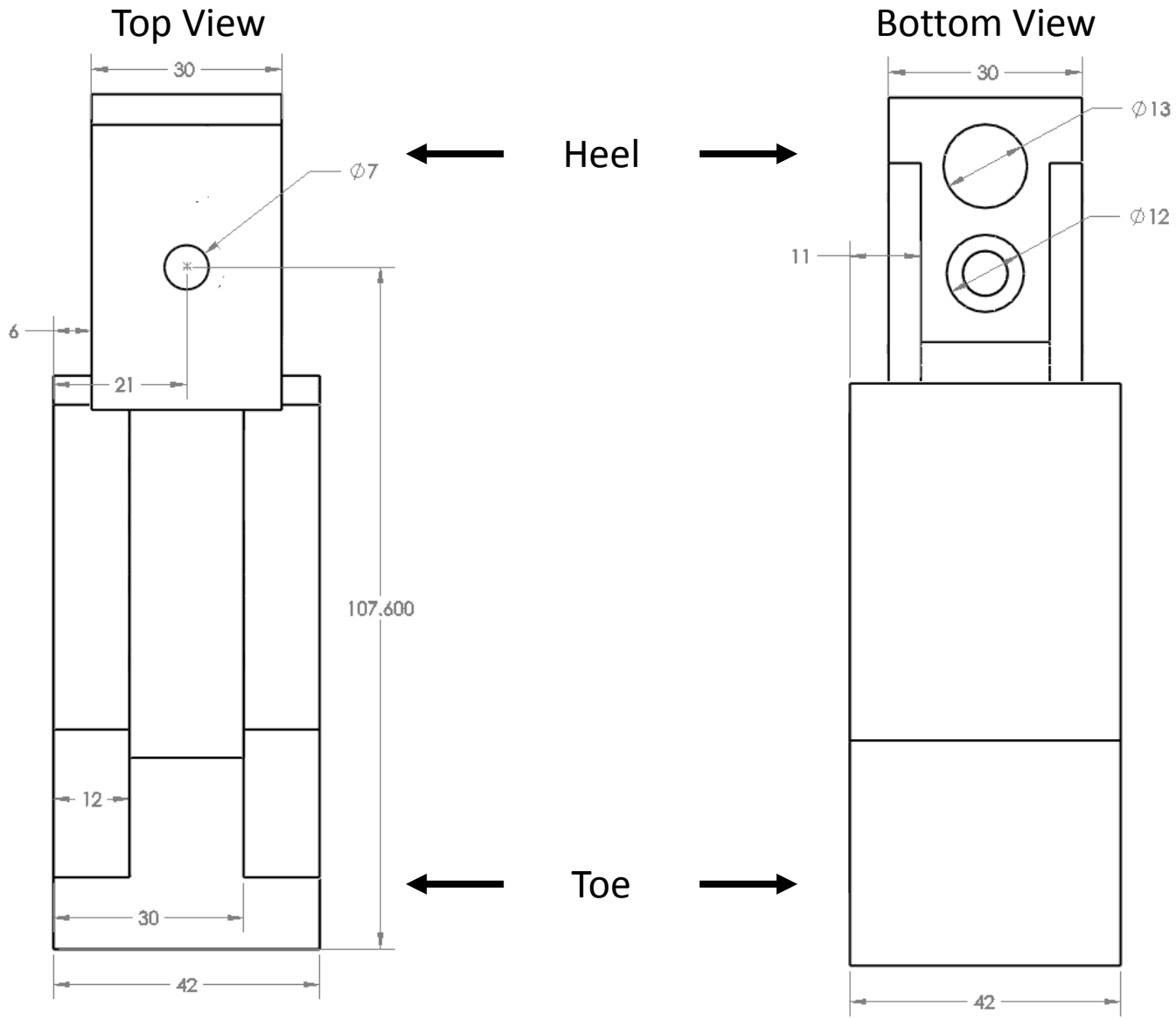
Size 16 Forefoot Lateral View



Size 16 Forefoot Transparent View

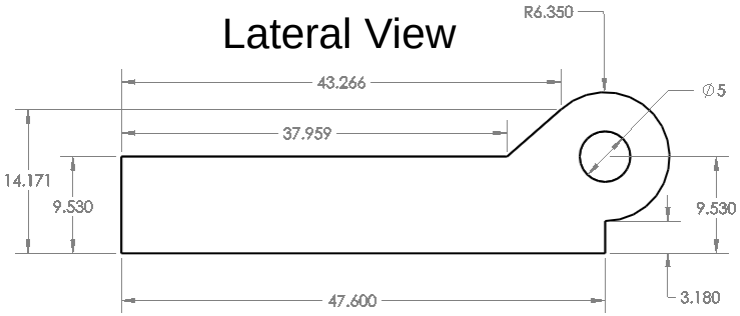


Size 16 Forefoot Top and Bottom Views

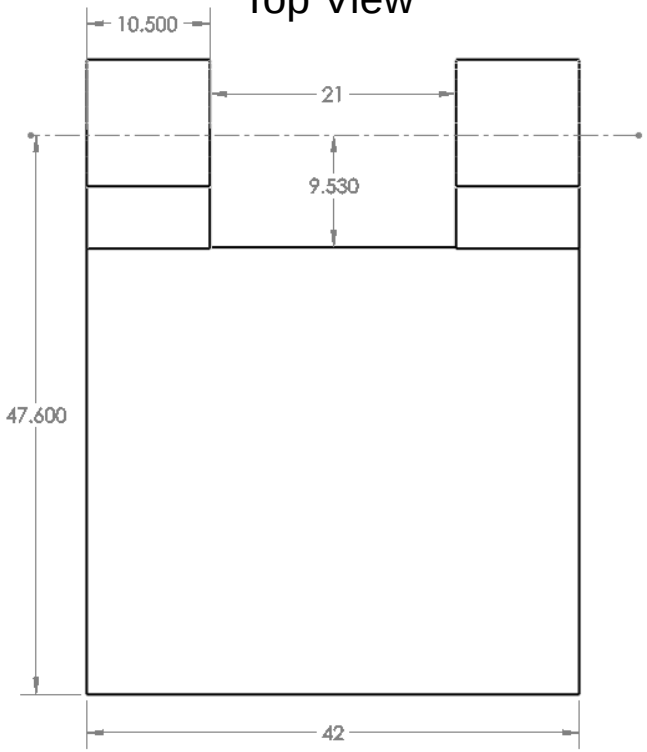


Size 16 Heel

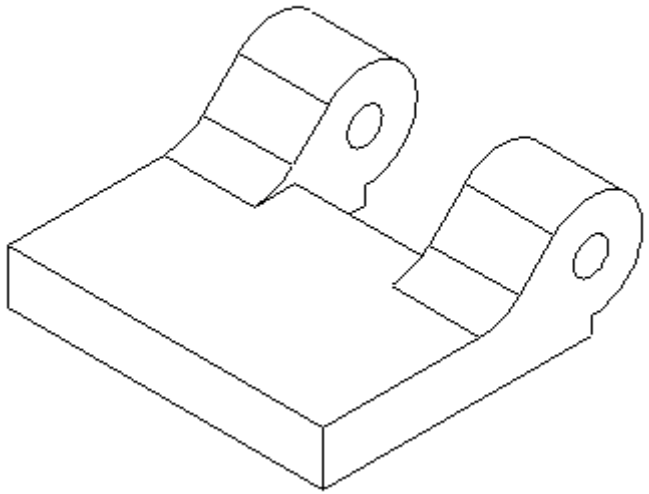
Lateral View



Top View



3/4 Perspective



Size 15 Foot

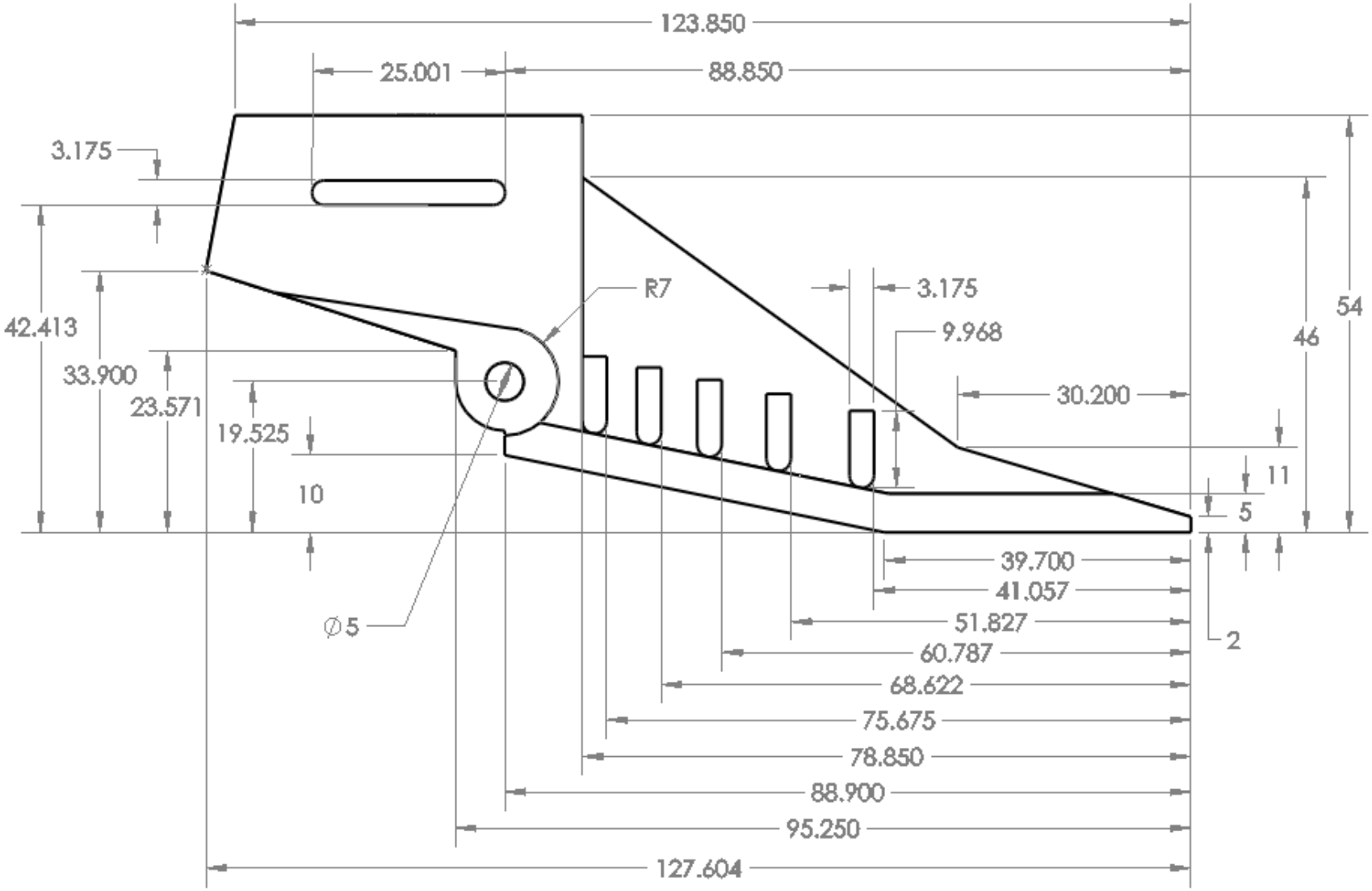
Minimum Starting Block Dimensions:

127.60 mm x 54 mm x 45 mm

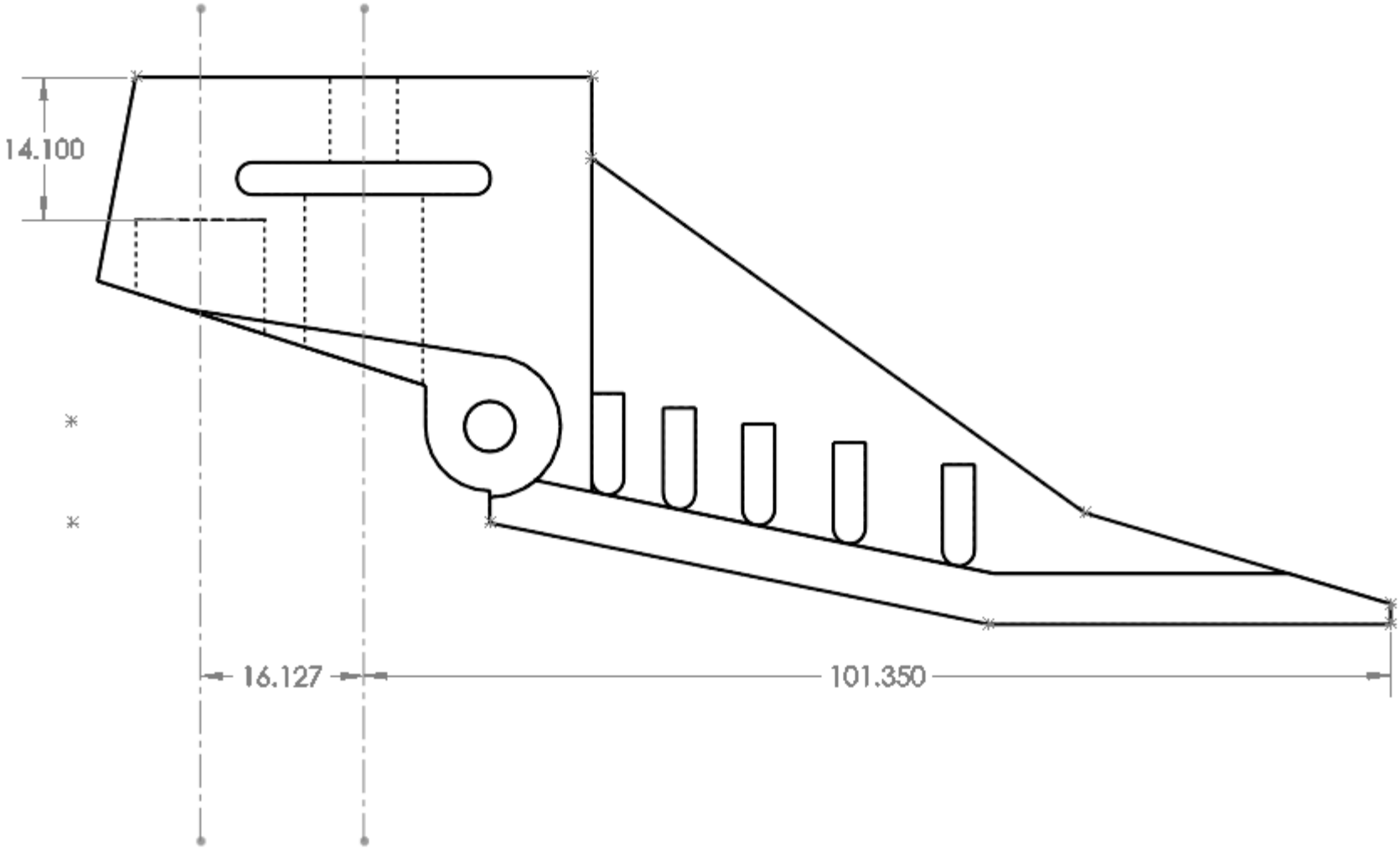
Polyurethane Rod Dimensions (D=diameter of rod):

D0.5” x 20.38 mm

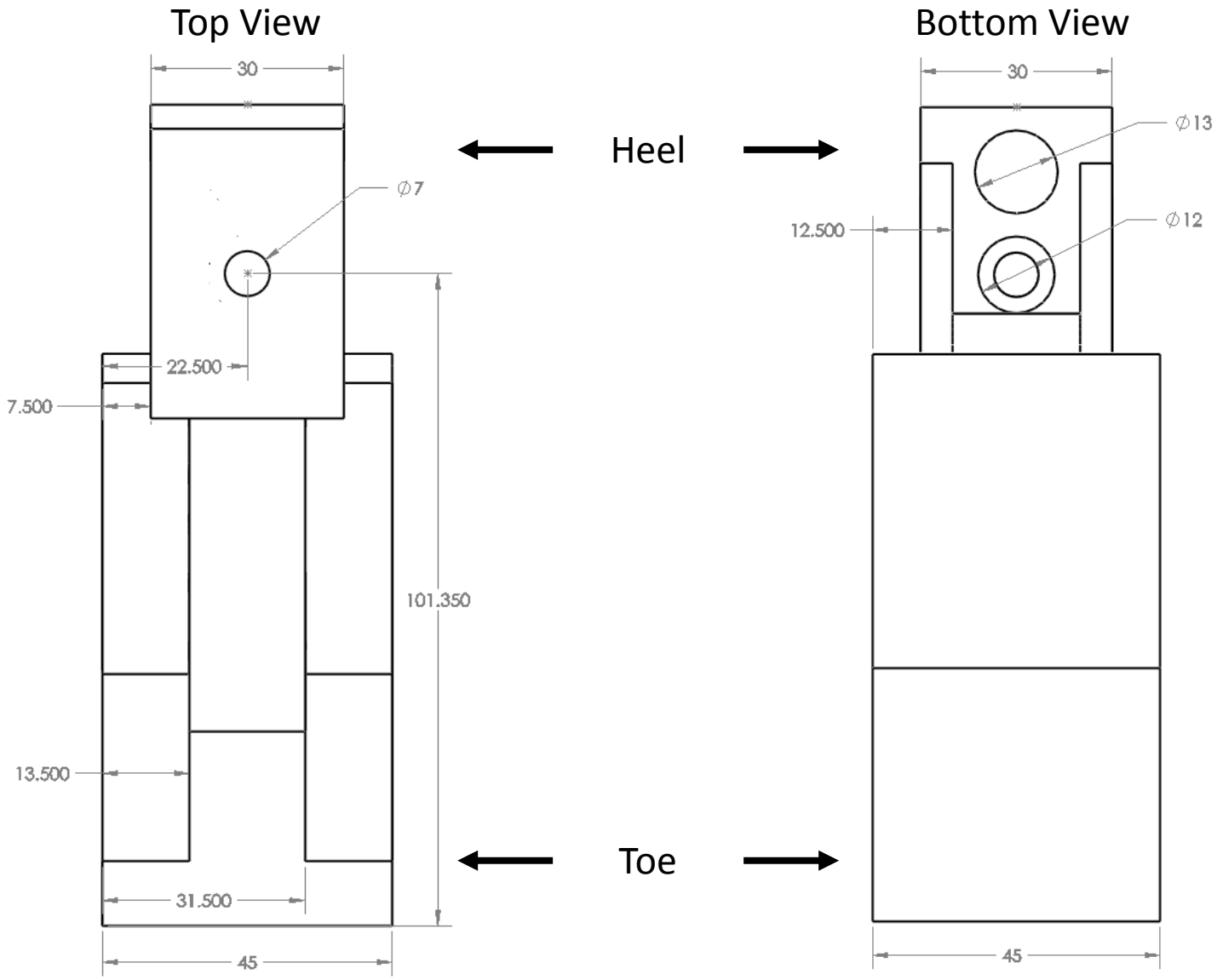
Size 15 Forefoot Lateral View



Size 15 Forefoot Transparent View

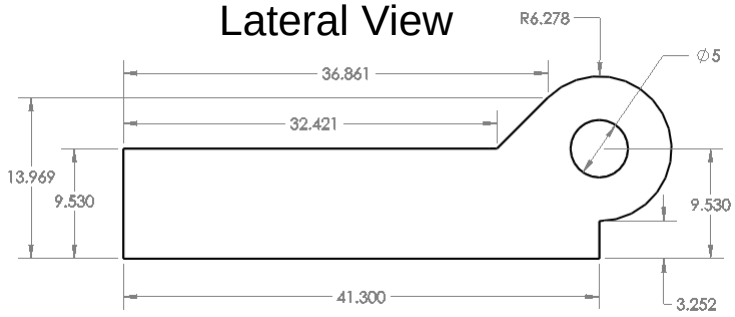


Size 15 Forefoot Top and Bottom Views

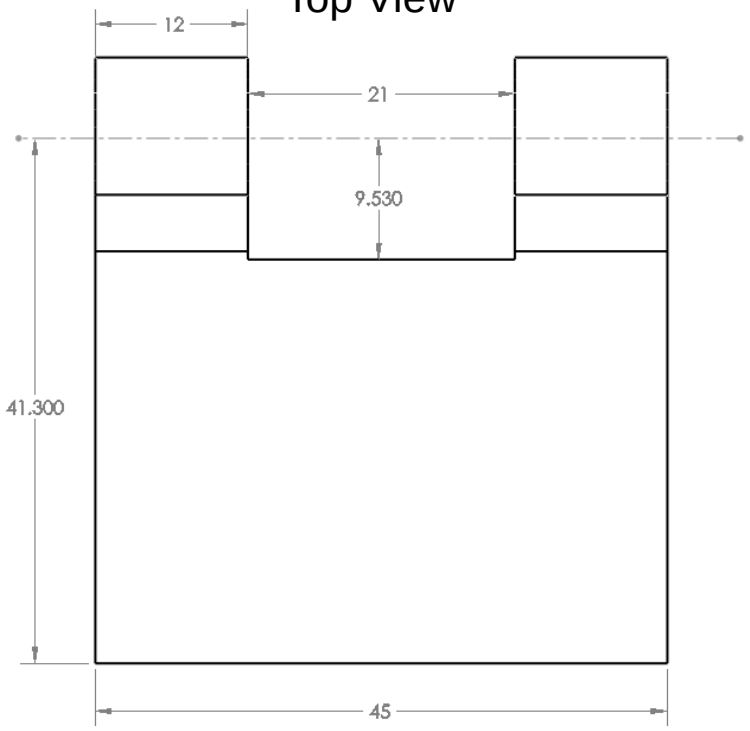


Size 15 Heel

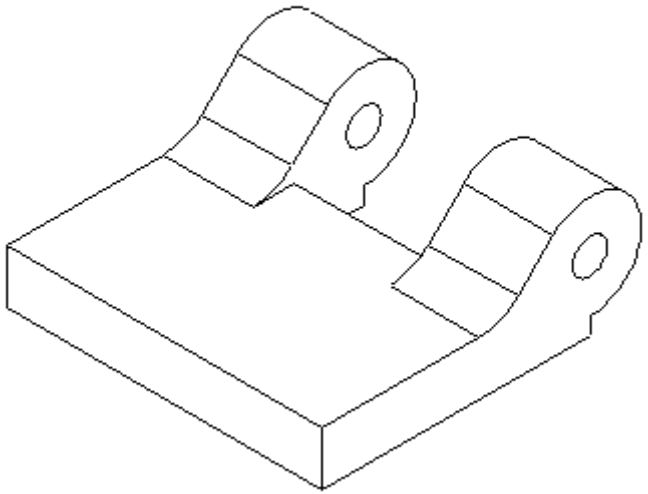
Lateral View



Top View



3/4 Perspective



Size 14 Foot

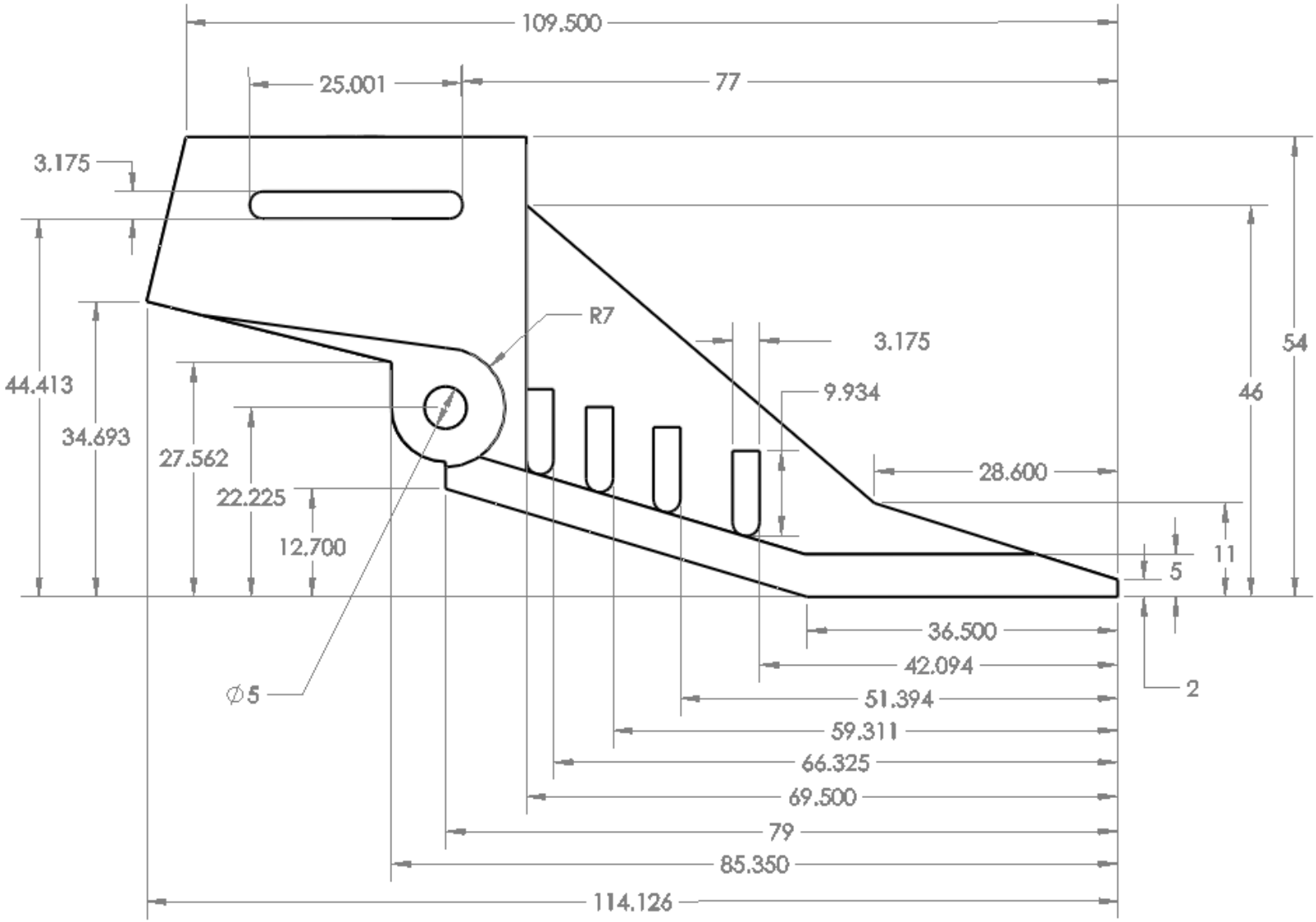
Minimum Starting Block Dimensions:

114.13 mm x 54 mm x 42 mm

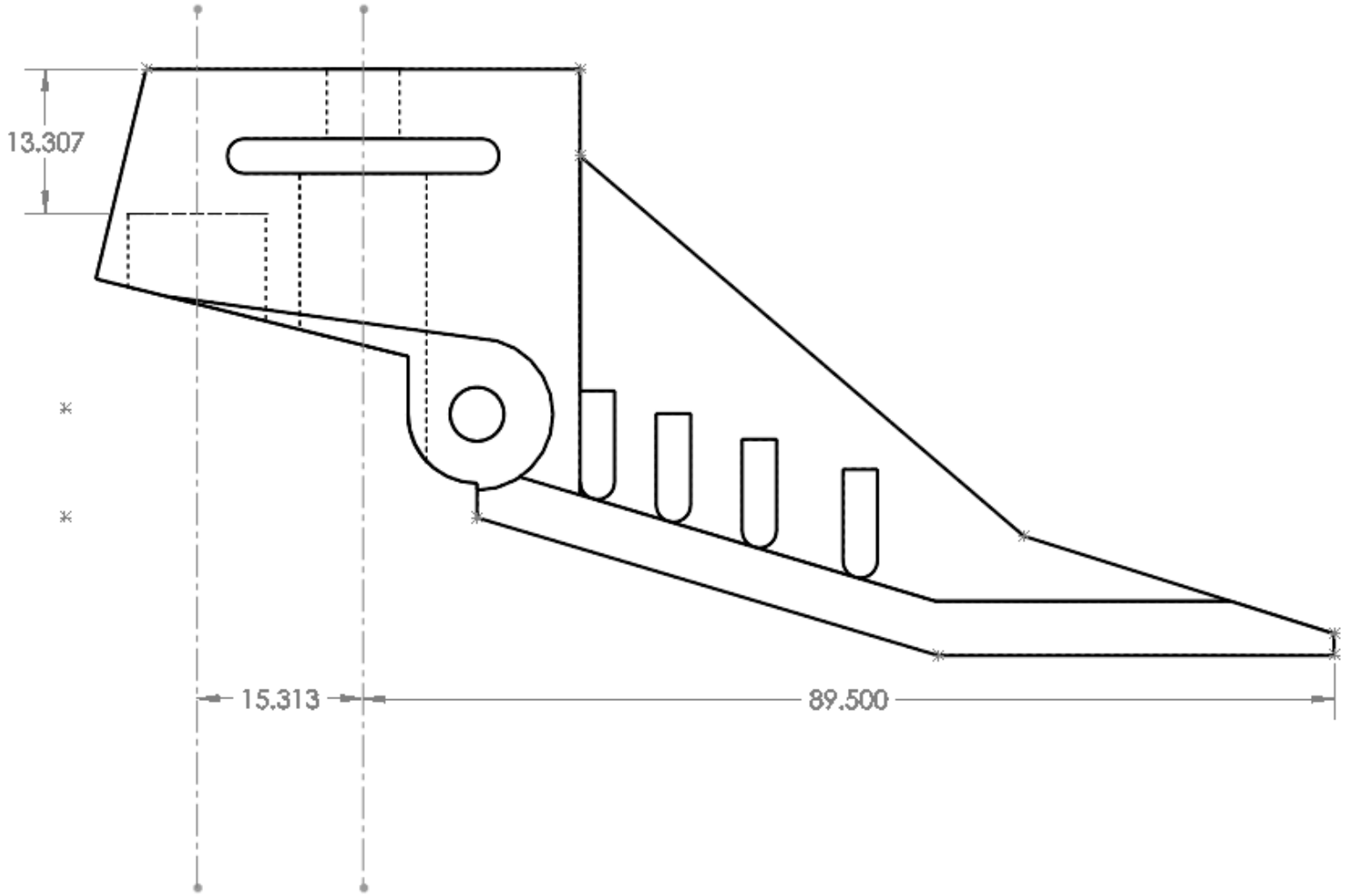
Polyurethane Rod Dimensions (D=diameter of rod):

D0.5” x 18.39 mm

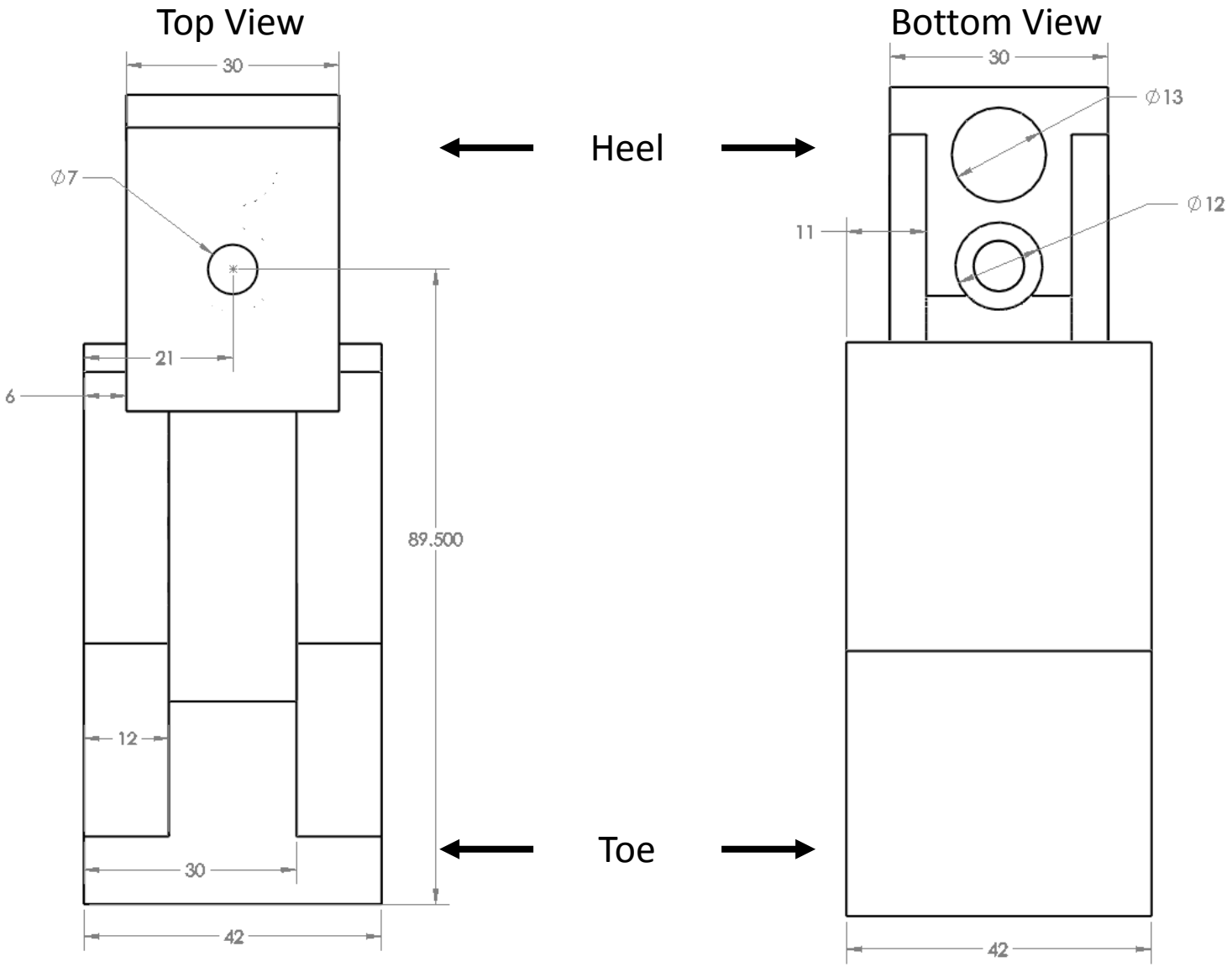
Size 14 Forefoot Lateral View



Size 14 Forefoot Transparent View

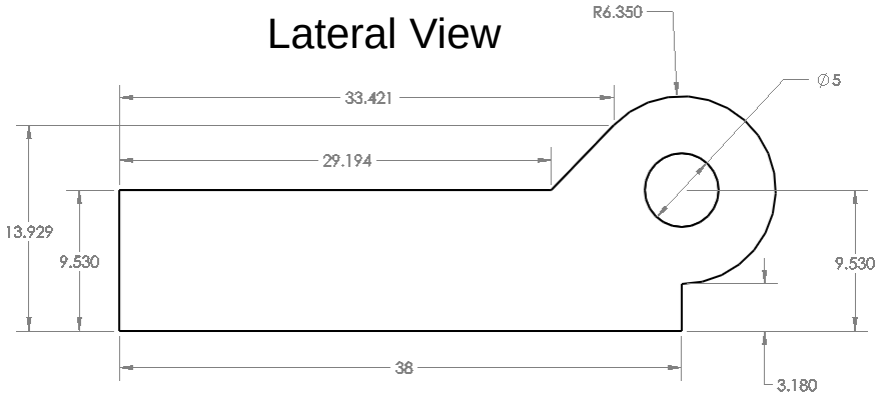


Size 14 Forefoot Top and Bottom Views

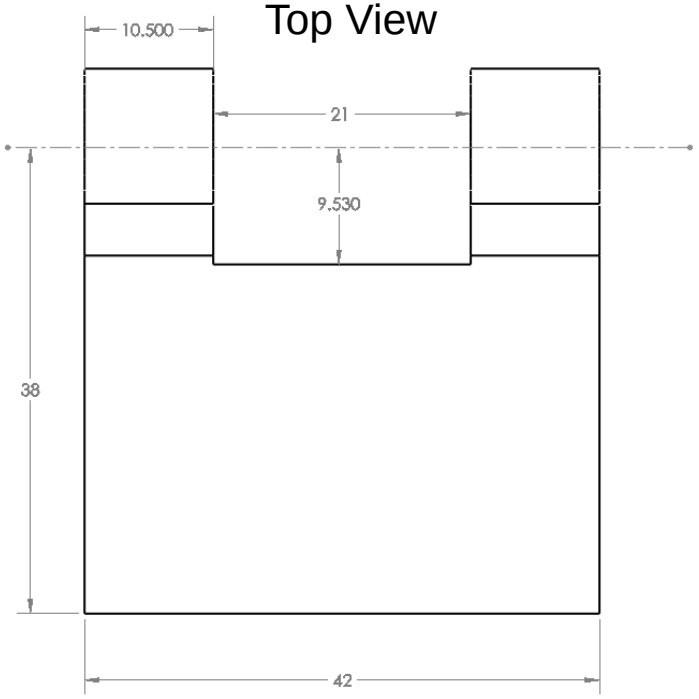


Size 14 Heel

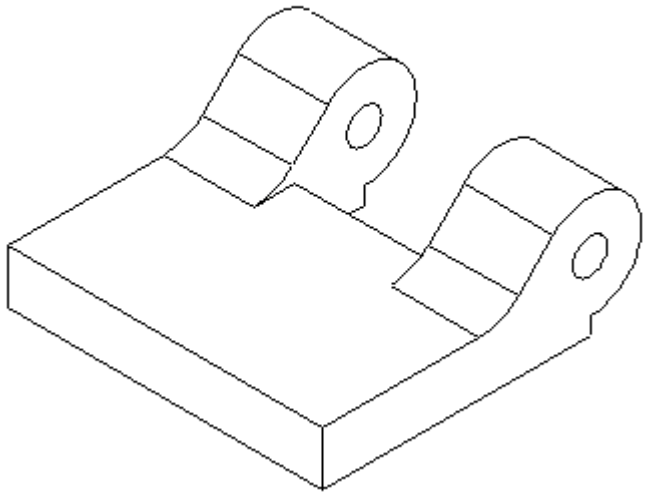
Lateral View



Top View



3/4 Perspective



Size 13 Foot

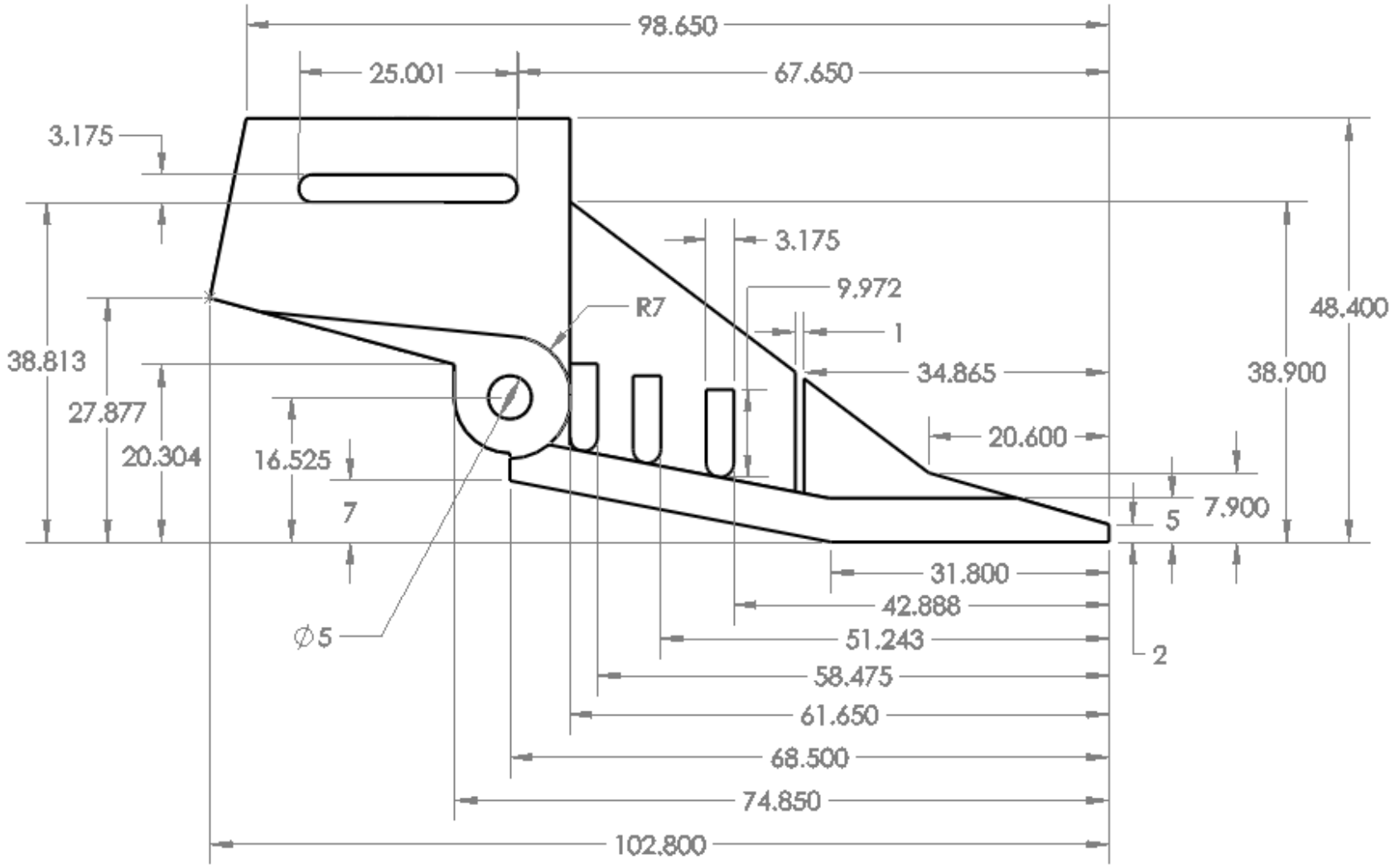
Minimum Starting Block Dimensions:

102.80 mm x 48.4 mm x 42 mm

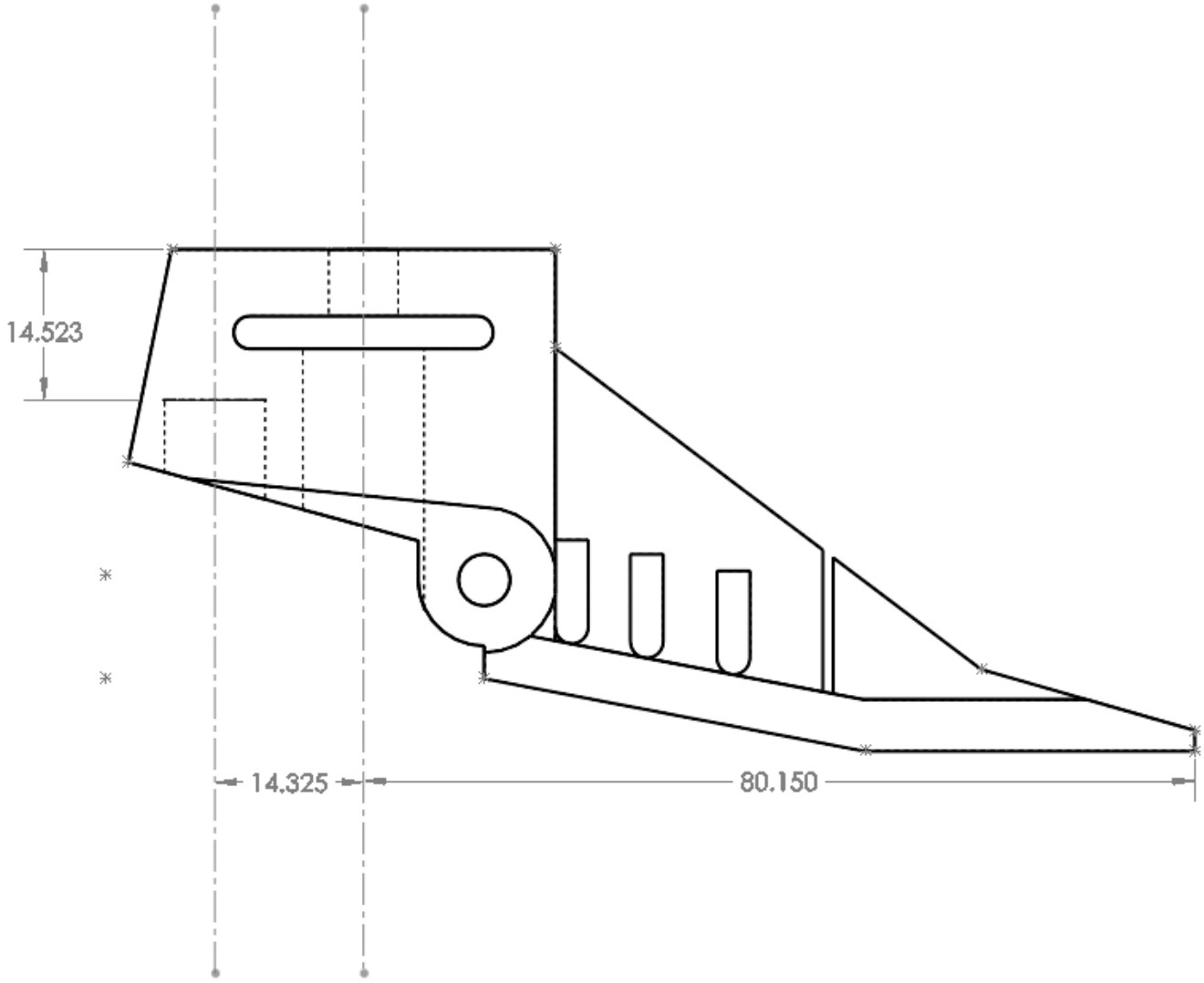
Polyurethane Rod Dimensions (D=diameter of rod):

D0.38” x 17.41 mm

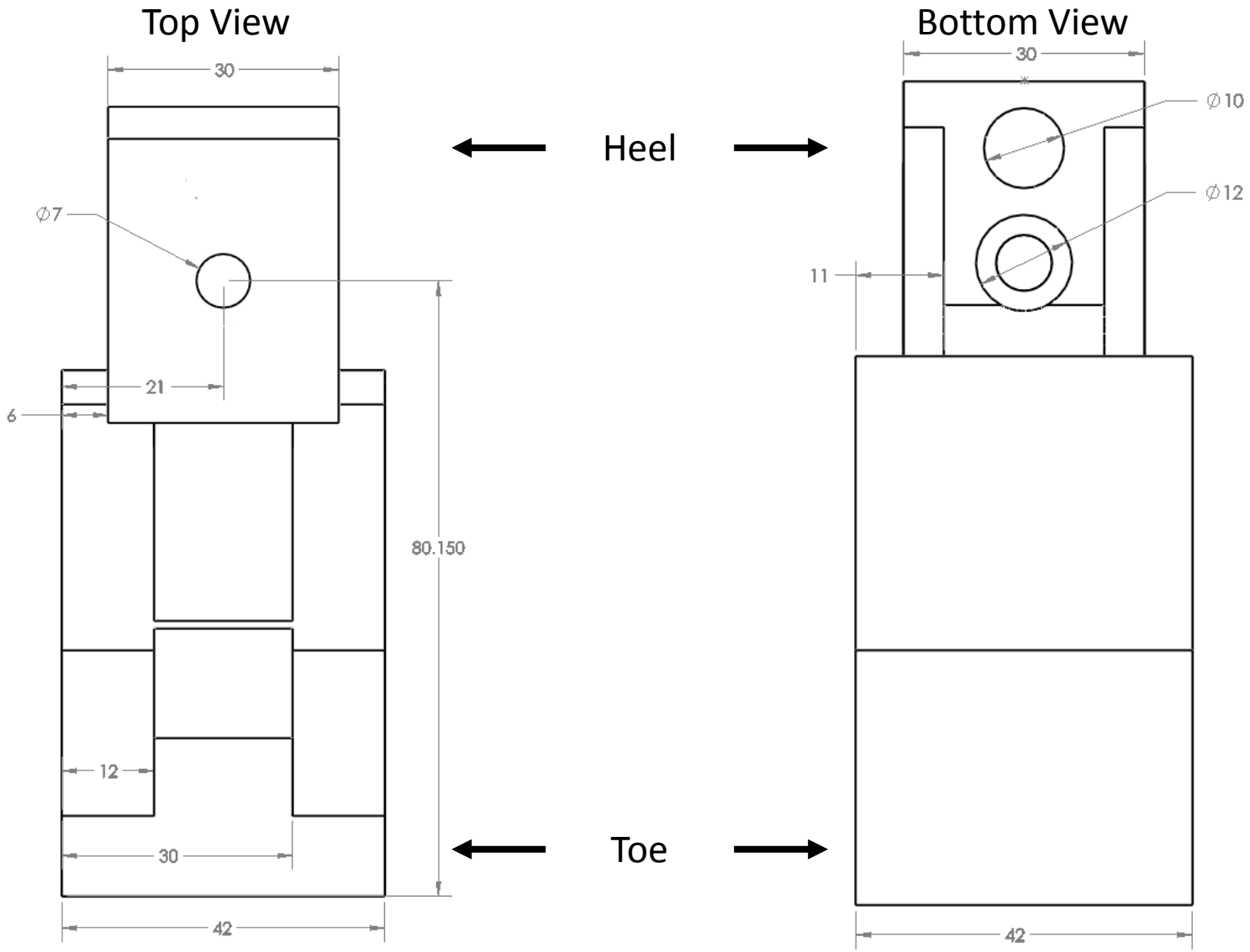
Size 13 Forefoot Lateral View



Size 13 Forefoot Transparent View

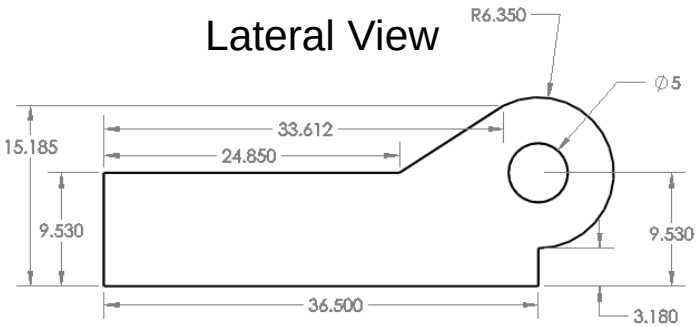


Size 13 Forefoot Top and Bottom Views

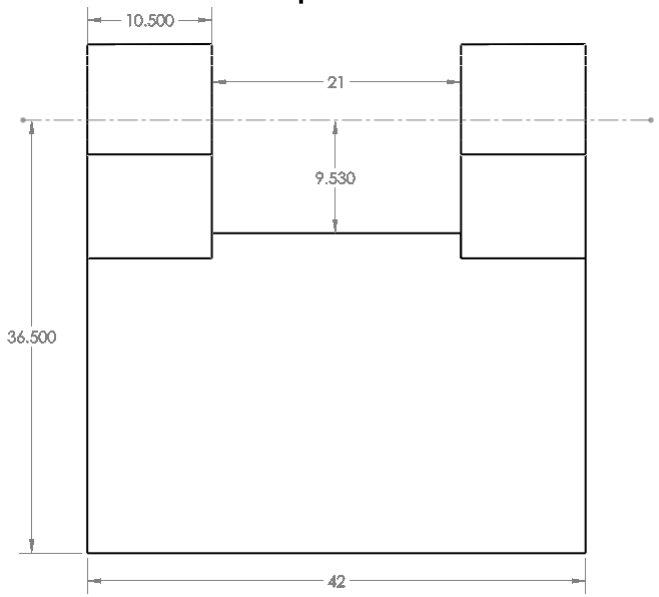


Size 13 Heel

Lateral View



Top View



3/4 Perspective