Design Brief

Design Requirements

I am required to design a pulley bracket for a mechanical design firm that must fit into a system with a fixed point and a moveable pulley.

My role is to design a custom part according to the specifications and constraints listed below.

Specifications

Lifting capacity of 120kg Uses 2x SKF 16100 deep grooveball bearings Outside of pulley Ø70 Uses smooth shank bolt to attach pulley to bracket Must be able to attach and re-attach to a truss

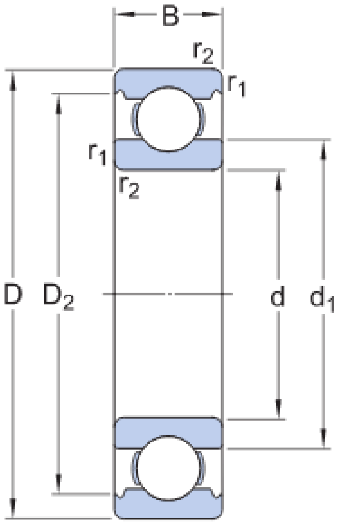
Constraints

Large enough to fit on a 114×38mm Truss Pulley wheel and housing can fit a Ø10mm rope Attached so the pulley wheel faces down Must fit within the given system, ie, must be able to have a full range of motion on the pulley wheels on both sides.

Management Plan

Task	Due date	Completed	Sign
Design Brief, Specifications, and Constraints			
Research and Bibliography			
1st Freehand Solution			
2nd Freehand Solution			
Parts lists and materials			
Selection Process			
Drawing sheet preparation			
Sectional Front View			
Side View			
Isometric View			
Declaration of Authenticity			
Final Submission			

SKF 16100 Deep Groove Ball Bearing



Symbol	Measure	Description
d	10 mm	Bore diameter
D	28 mm	Outside diameter
B	8 mm	Width
d1	≈17 mm	Shoulder diameter
D2	≈24.72 mm	Recess diameter
r1,2	min.0.3 mm	Chamfer dimension

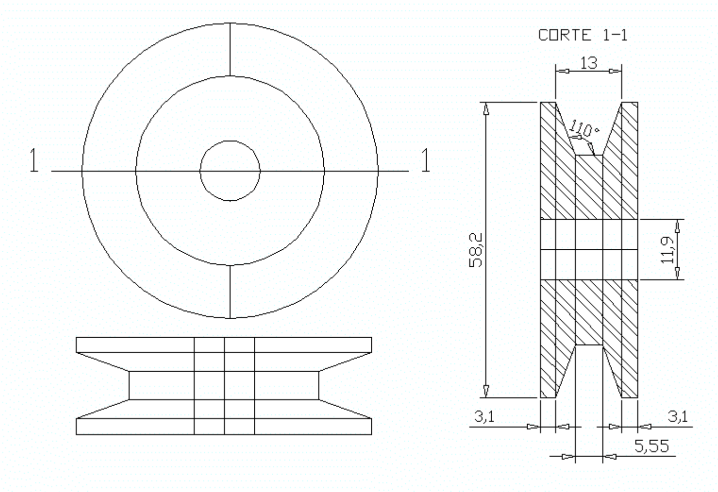
[1]

Pulley Wheels

Pulley wheels consist of a core, and an inner and outer ring. The structure of these will vary accommodate their function, such as using a belt vs using a rope, needing to carry large or medium-weight loads, and the size of the housing and shaft they are attached to.

Outer ring

The assembly requires a rope to be fitted through the pulley. A pulley with a curve recess in the outer ring would hold onto a rope well, and would prevent the rope from becoming caught in sharper curves. However, having a sharper indent causes the pulley wheel to apply pressure on the sides of the rope, which means that the rope will never slip over the pulley wheel and all friction will occur on the shaft of the pulley. For this, I believe that a pulley wheel with a sharp recess is the best fit for the assembly because it reduces friction and increases reliability.



[2] [3]

Inner Ring

The inner ring tends to be made of solid material or spurs. Some have cutouts, presumably to save on materials, especially on larger pulley wheels. I believe that having a solid inner ring is sensible for this assembly, as the pulley wheel is neither large nor thick.

[4]

Core

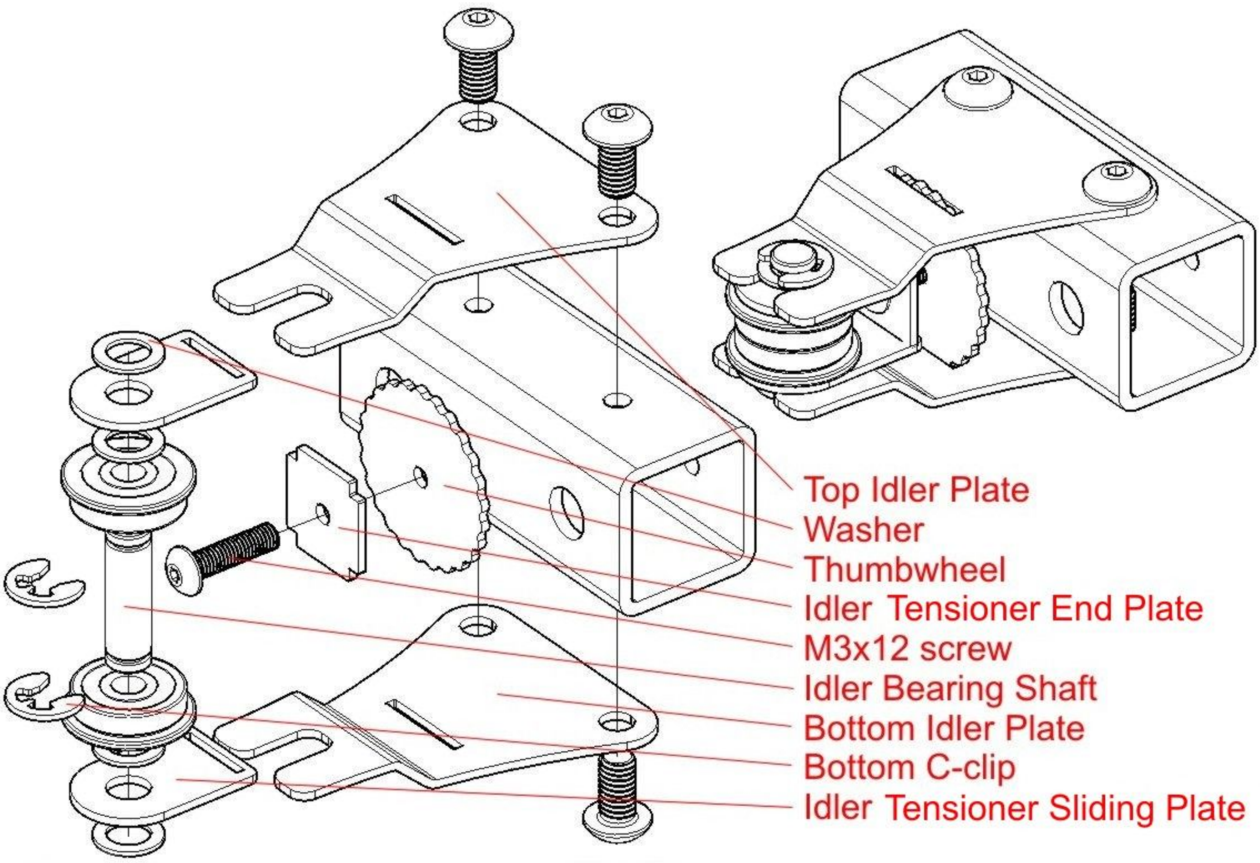
The core of a pulley can be mounted directly on a shaft, or onto a bush on a shaft. Using a key on this shaft can reduce unwanted rotation and prevent slipping. Additionally, this allows the connection of the shaft and the bearing that attaches it to the housing to reduce friction further.

Pulley Assemblies

The general pulley assembly consists of a wheel, a shaft, a block, and any special extras that it may need. I have discussed pulley wheels in the pulley wheel section, and the shaft is specified to be a smooth shank bolt. This leaves the block: the attachment point of the wheel to the surface.

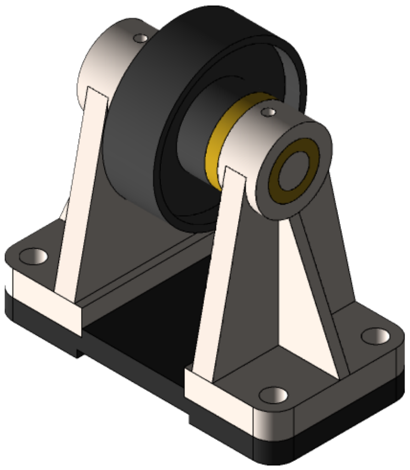
Considerations:

- The block must accommodate the rope that must pass through the pulley assembly
- Must be able to attach and reattach to a 114 × 38mm Truss
- Attachment to the truss must be secure, both from slipping down and side to side
- The rope must not rub against any component to reduce friction and prevent wear.
- Must be strong to accommodate the 120kg load capacity
- Must mount the SKF 16100 bearings securely



[5]

A pulley system like the one above is is industrial and can be disassembled easily. Additionally, it's pulley wheel mounting gives a good amount of space for a ball-bearing. Having a pulley system that can be disassembled could be a method of attaching it and re-attaching it. This specific pulley seemingly cannot be removed, and also has less optimization for low friction and load-bearing as the pulley I wish to design.



[6] [7]

This bracket mount is very sturdy and seems like a good way to mount the pulley wheel onto another structure that grips onto the truss. The rib's also work to support the load. The wide mounting points for a shaft also allow us to put a ball bearing in each side. Additionally, the wide base could work in tandem with a mounting bracket, creating a good mounting system with the use of a few bolts.

Materials

Pulleys can be made of cast iron, cast steel, wood, or plastic. In general, materials are chosen depending on the weight needed to be carried, the amount of maintenance, and how cheap they are. [8] [9]

Cast Iron

- Cheap
- Easy to manufacture
- Brittle – not good for changing loads
- Less durable

Cast Steel

- More expensive
- Highly durable
- High load capacity

Wood

- Light
- Strong
- Inexpensive

Plastic

- Used for lifting heavy things
- Cheap
- Simple to manufacture
- Less maintenance

I believe plastic is my best choice – it is lightweight, but heavy-duty. It is easy to manufacture and does not oxidise or warp due to the elements. It is also simple to manufacture and shape, and can be made strong enough to carry the load required.

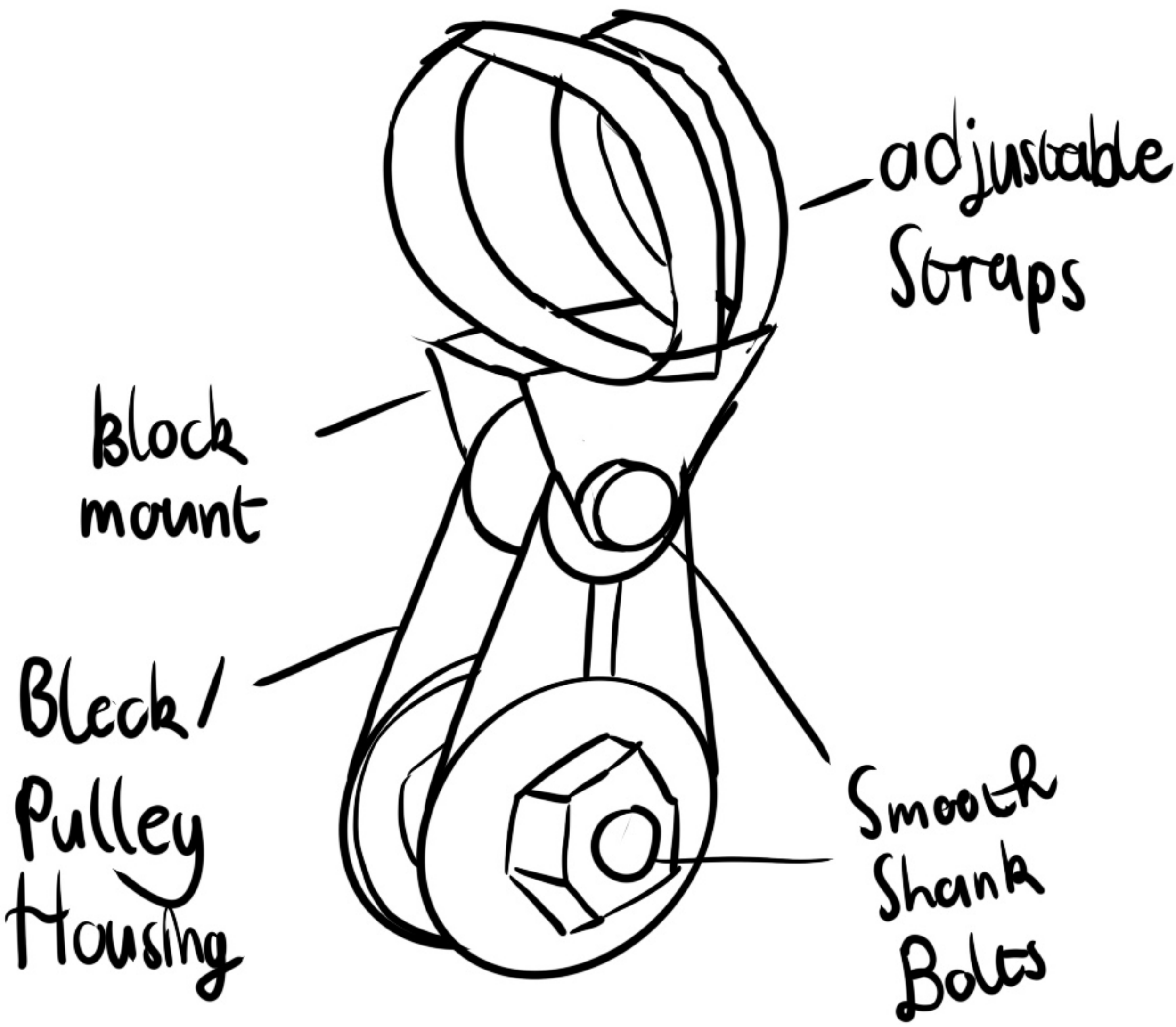
Materials	Temperature (K)	Tensile strength (MPa)	Elongation at break (%)	Modulus of elasticity (MPa)
Plastic films & paper				
Polyimide (H film)	298	18.2	44	510
	77	32.5	16	640
	4.2	34.0	8	615
Polycarbonate (Makrolon)	298	6.4	112	
	77	13.5	4.5	
	4.2	15.6	3.0	
Polyamide (Nomex)	298	8.3	21	
	77	14.5	3.5	
	4.2	15.8	3.0	
Polyethylene terephthalate (Mylar)	298	16.5	88	450
	77	26.0	9.5	870
	4.2	26.8	5.5	880
Polyvinylchloride (rigid type)	298	2.3	156	110
	77	9.5	3.6	215
	4.2	11.6	2.9	300
Polyethylene (high density)	298	2.5	525	
	77	10.5	4.3	
	4.2	13.5	3.1	
Polytetrafluoroethylene (Teflon)	298	2.0	480	
	77	4.3	6.5	145
	4.2	5.6	3.5	217
Bulk materials				
Polyimide (Vespel)	77	18.4	3.1	
Polyethylene (high density)	77	13.8	2.3	
Polyvinylchloride (rigid)	77	11.5	11.5	

[10]

Using the conversion rate $1MPa = 10,2kg.cm^{-2}$, we can see that with a cross-section of $10cm^{-2}$ we can carry 182kg with polymide, and up to 268kg with Mylar.

Concepts

Concept 1



This concept uses a pulley in a block, which may be custom-designed or a standard part. This block slots into a mount with two straps on it meant to attach it to a truss of any size, meaning that it's uses are various. The adjustable straps can be standard loading staps, and their load limit can be extremely high [11]

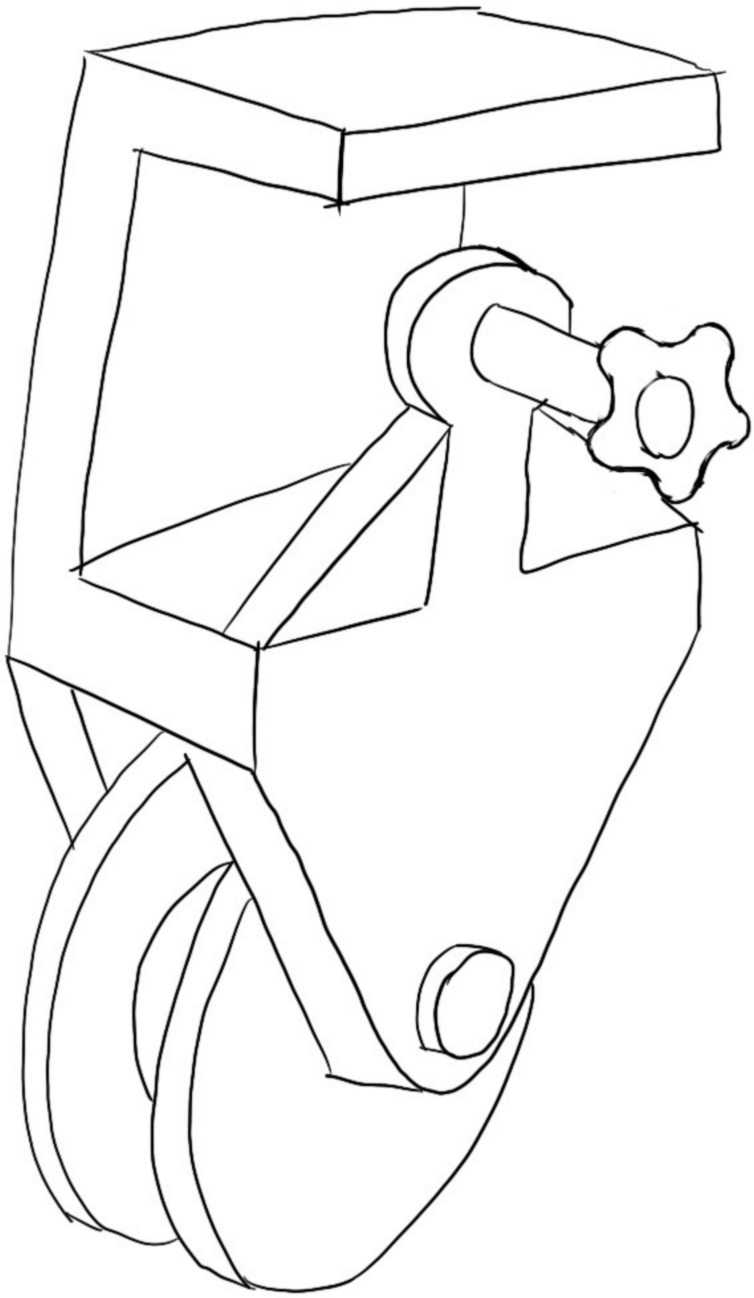
Pros:

- All standard or easy-to-manufacture parts
- Easily removable
- High load-capacity
- Inexpensive

Cons:

- Strap attachments may break
- Rope may rub against pulley housing because it is narrow
- Difficult to attach bearings within the pulley housing

Concept 2



Concept 3 uses a more grounded hanging-hook design with a clamp on one side, inspired by Mr Vermooten's pipe clamp. It's pulley wheel is in a custom housing directly attached to the overhang. Overall there are less parts in this design, and the design is better suited manufacturing compared to the previous which would require very little manufacturing. Additionally, this design is simple to put on and use, being far simpler in it's operation.The clamping mechanism ensures a secure fit with no sliding.

Pro's

- Simpler to use and manufacture

- Less parts
- Can be made of more secure materials
- No slipping

Con's

- Less standard parts - harder to repair
- More expensive - manufacturing needed

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