

Crash Resistance Fence



PMU

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3. Brainstorming
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Introduction

Security parameters have become commonly used around the world to protect the surroundings of sensitive and strategic buildings.

Crash Resistant Fence is designed to protect the environment that it surrounds; whether it is employees, visitors or building functions and services to protect from unauthorized vehicles from penetrating the strategic and sensitive building structures.



Objective

The main objective of this design is designing a Crash Resistance Fence that meets (ASTM F2656 M50-PI USA) standards for K12 rating, however it is important that it can be manufactured in the Kingdom of Saudi Arabia. Also it is important that this design is cost effective and can withstand the Kingdom harsh environment.



Objective

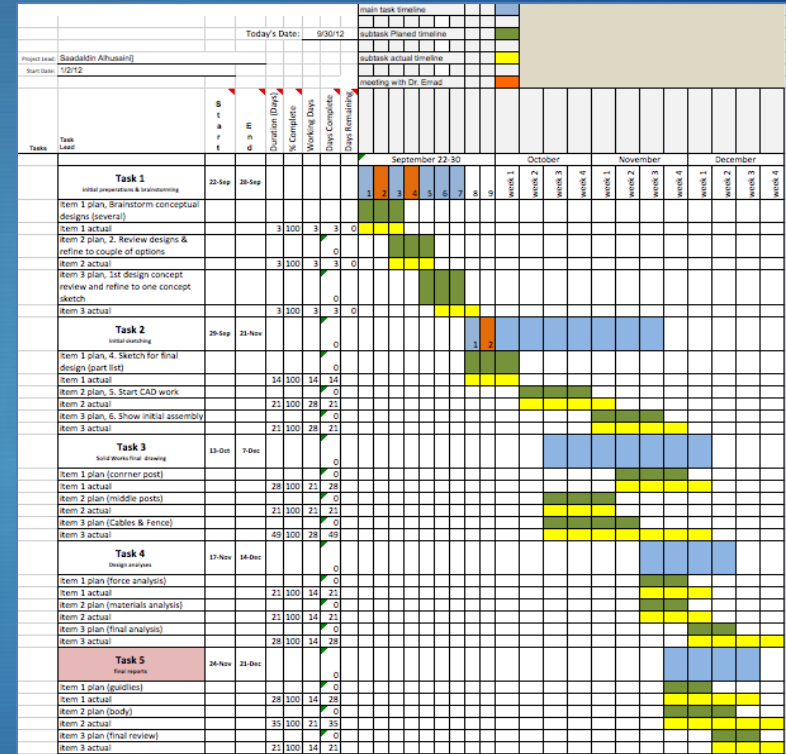
Requirements:

1. Must prevent a medium size truck weighing 6800kg \pm 140kg moving at maximum forward speed of 80km/h from entering the restricted zone.
2. Maximum penetrating distance is 1 m.
3. Contain simple installation procedures.



Brainstorming

The team initiated a timeline and project scope in order to form project boundaries. A Gantt chart was created to track project progress.

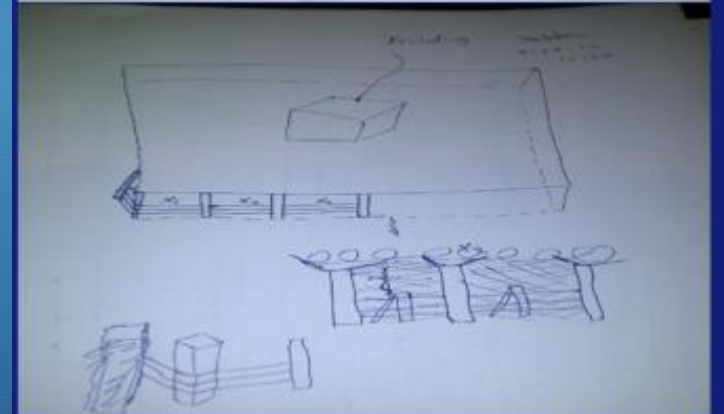
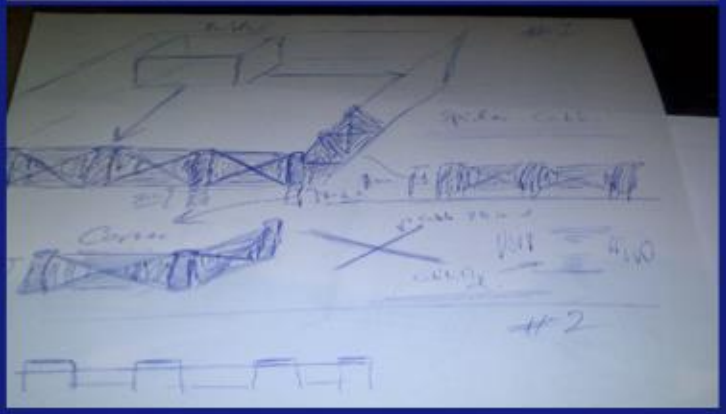
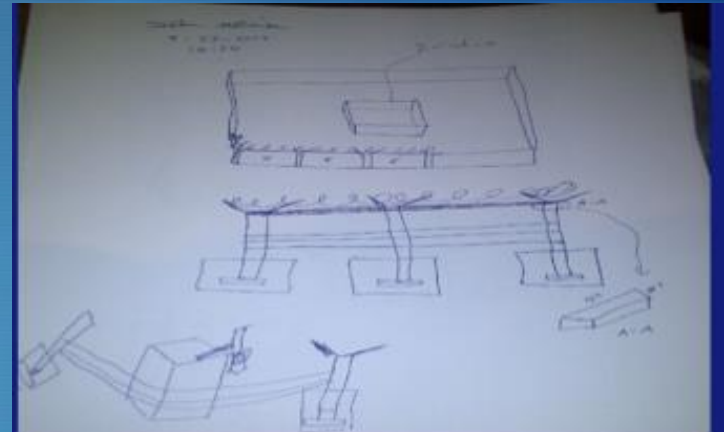
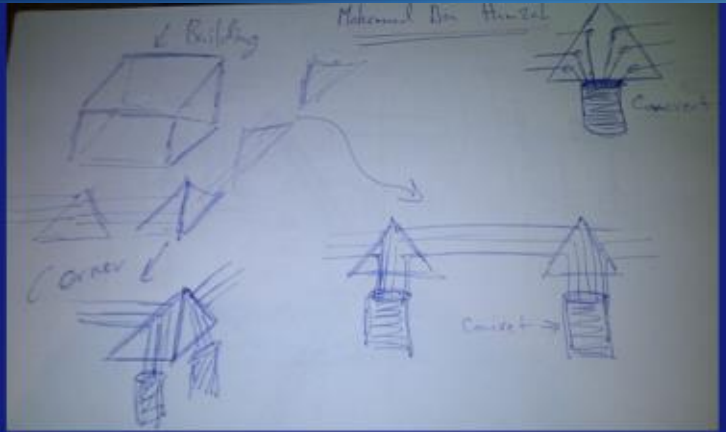


Brainstorming

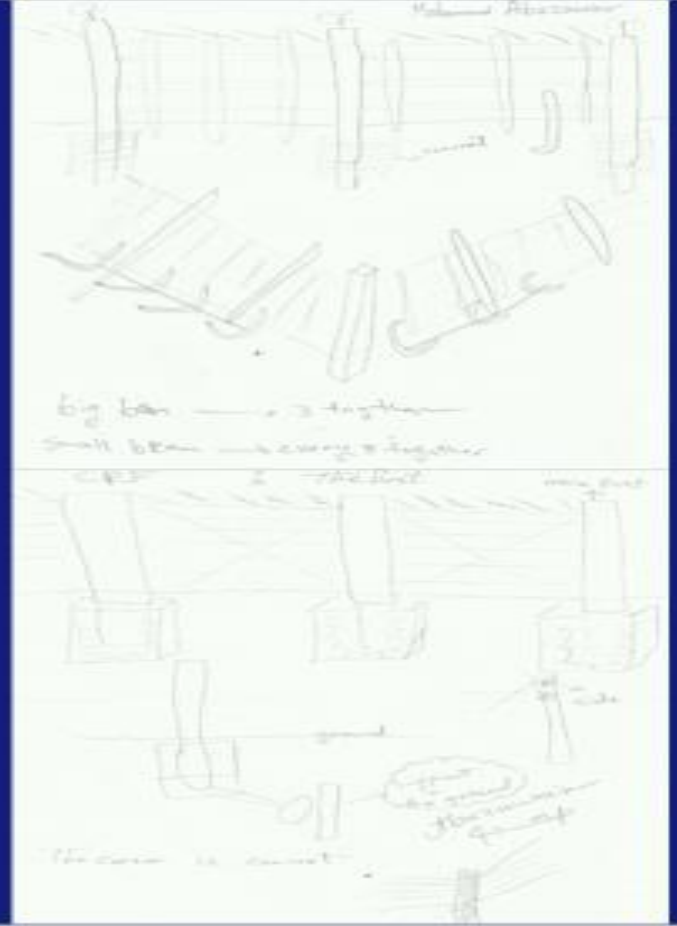
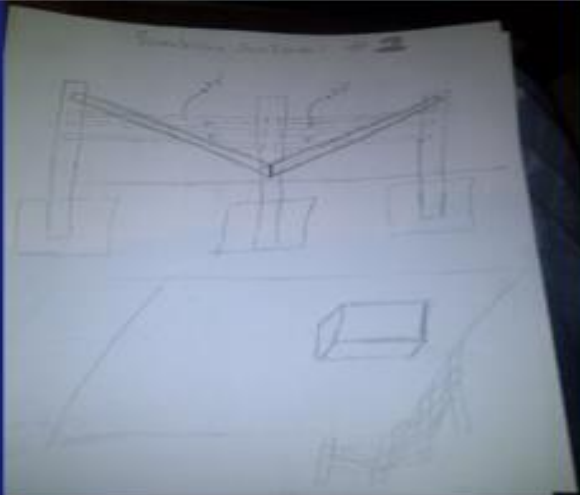
The team gathered and formed number of conceptual sketches which at a later stage refined into two main sketches. After conducting the force analysis on the two sketches resulted into consolidating both sketches into one main sketch



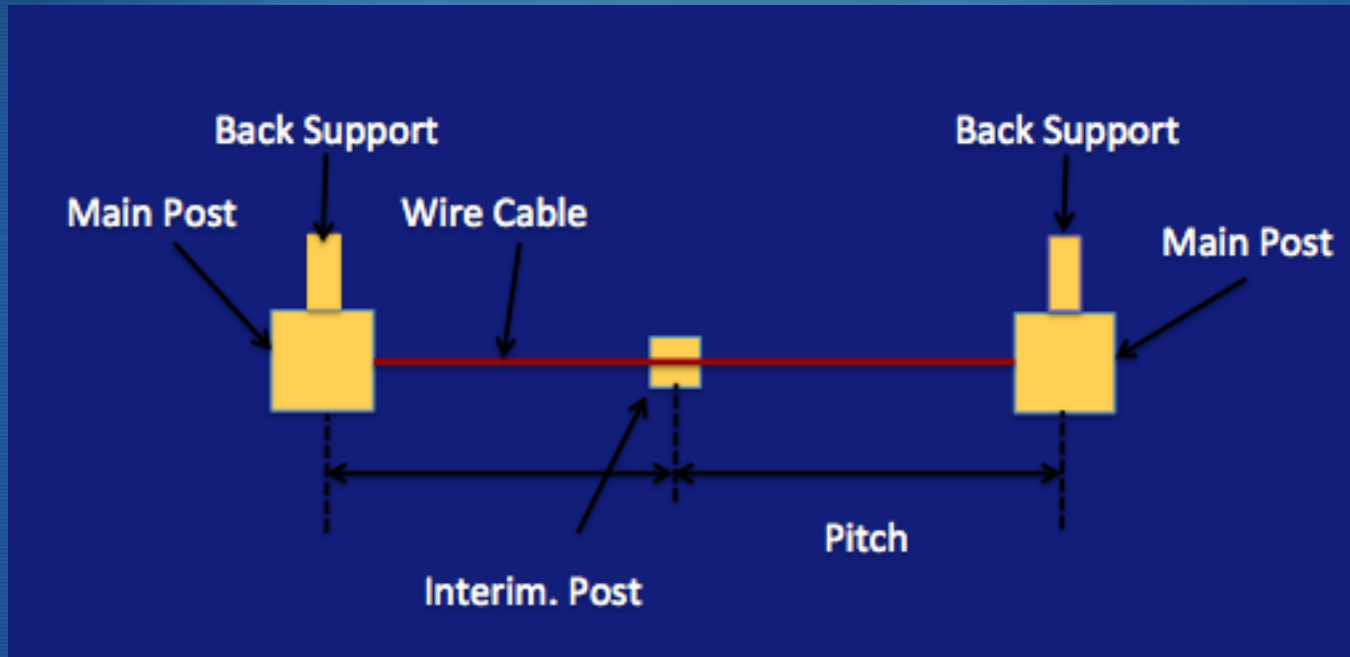
Initial Sketching



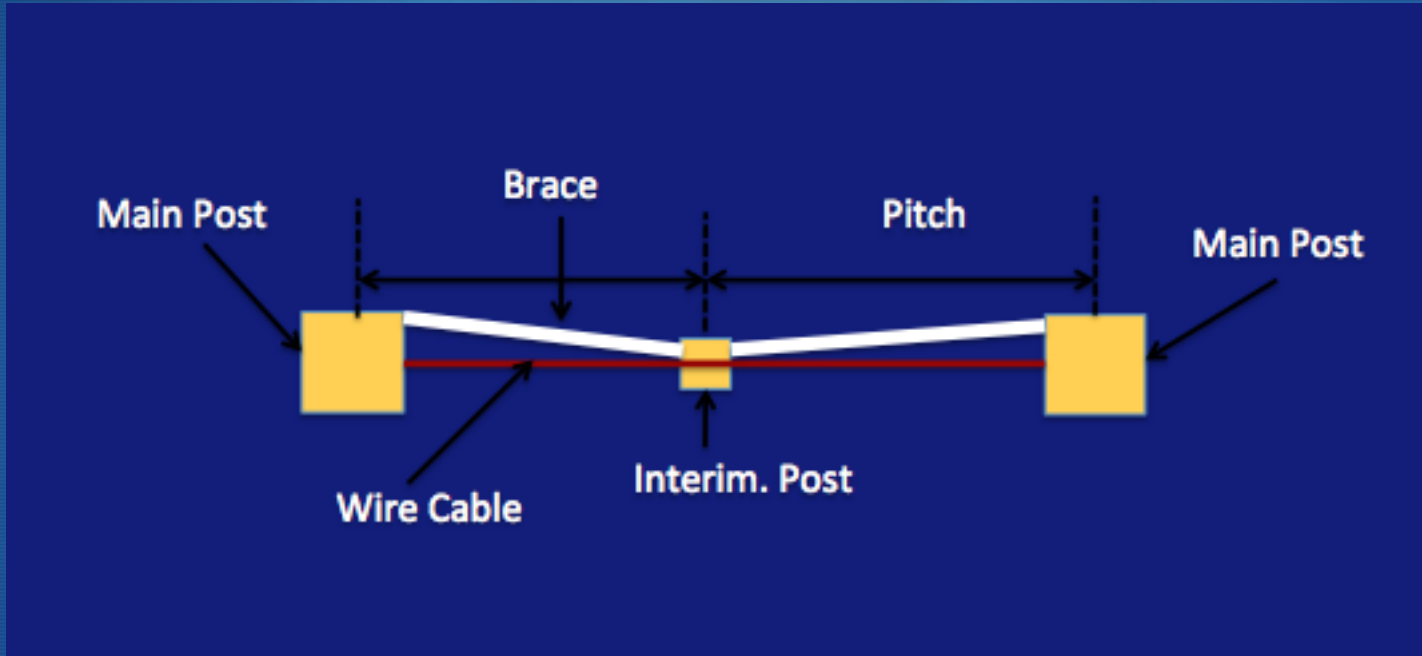
Initial Sketching



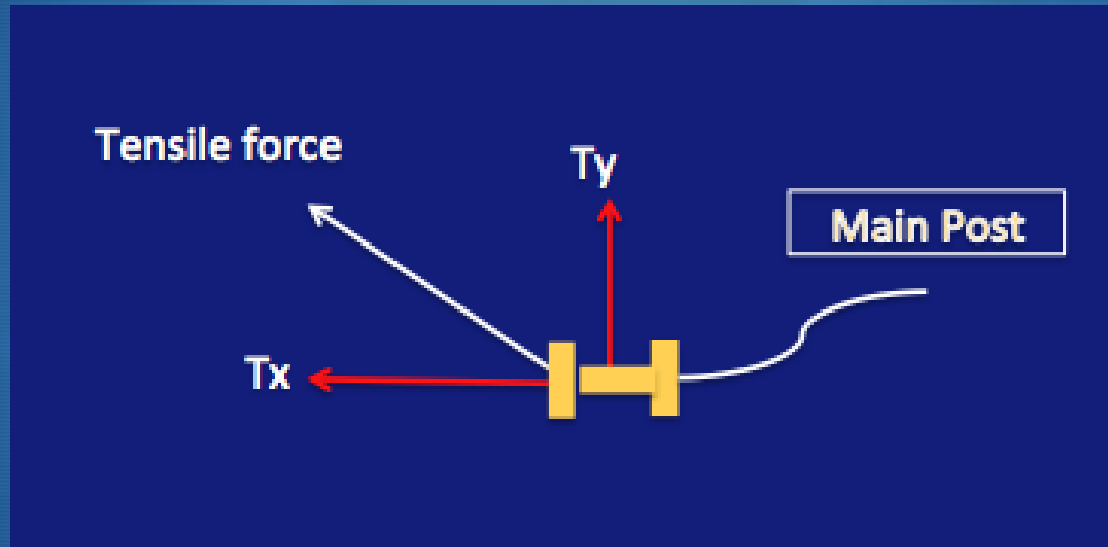
Initial Sketching



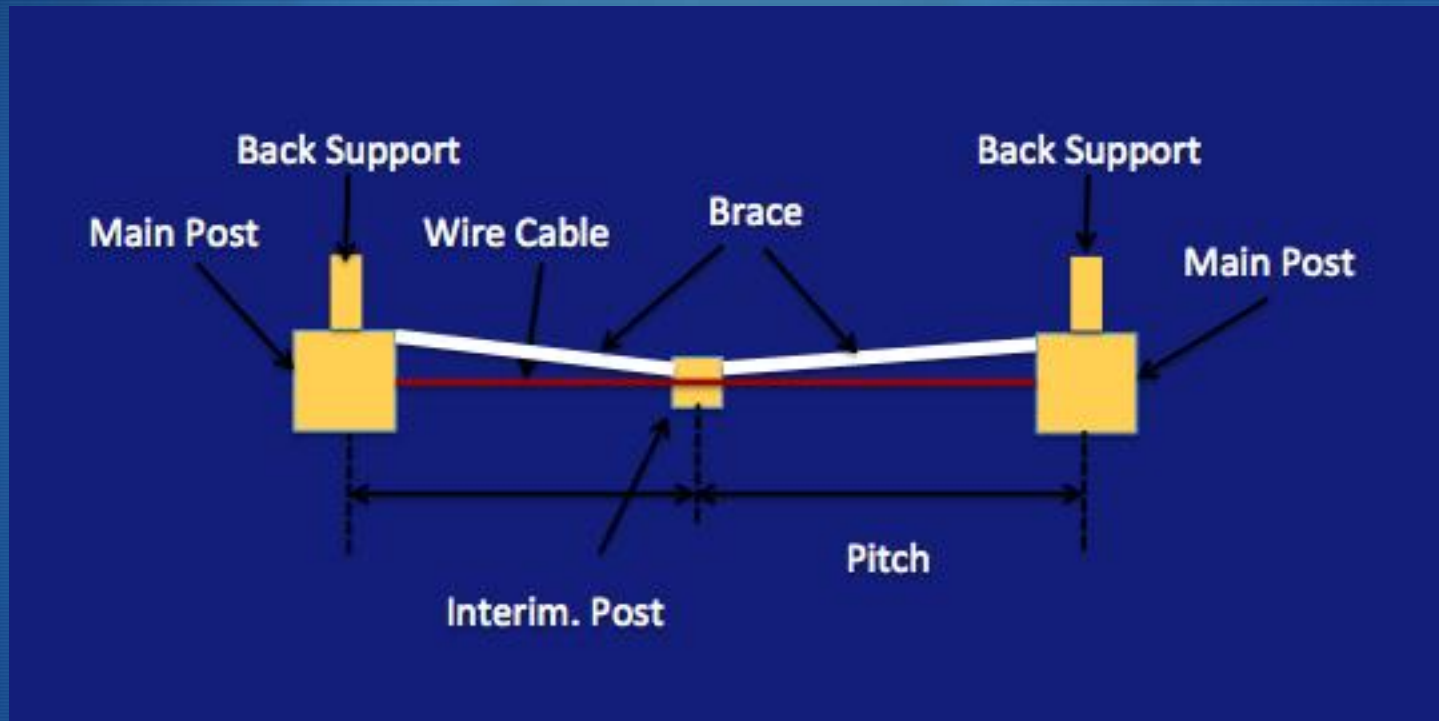
Initial Sketching



Initial Sketching



Combining Ideas



Force Analysis

Given data: K12 rating

Mass of the truck = 6800kg ± 140kg

Truck speed = 80km/h

Penetration distance = 1m

$$F_{imp} = \frac{\frac{1}{2} \text{ Mass} * (\text{Velocity})^2}{\text{distance of penetration}}$$



Force Analysis

If the main beam is to be impacted at zero degrees, the impact force is:

At 50km/h

$$F_{imp} = \frac{0.5 * 7000kg * 13.9^2 m/s}{1m} = 0.7 MN$$

At 80km/h

$$F_{imp} = \frac{0.5 * 7000kg * 22.22^2 m/s}{1m} = 1.7 MN$$



Force Analysis

If the impact is in the area between the two main posts, the impact force is:

$$T_y = F_{imp} * \cos 45$$

$$T_x = F_{impl} * \sin 45$$

At 50km/h

$$T_y = 0.7MN * \cos 45 = 0.5 MN$$

$$T_x = 0.7MN * \sin 45 = 0.5 MN$$

At 80 km/h

$$T_y = 1.7MN * \cos 45 = 1.2 MN$$

$$T_x = 1.7MN * \sin 45 = 1.52MN$$



Force Analysis

Running the impact force analysis based on:

90km/h

$$F_{imp} = \frac{0.5 * 7000 * 25^2}{1} = 2.2 \text{ MN}$$

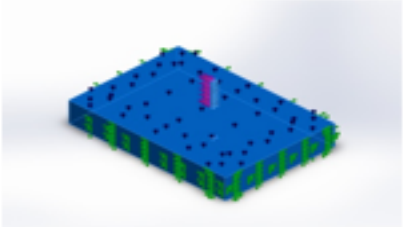
$$T_y = 2.2 \text{ MN} * \cos 45 = 1.6 \text{ MN}$$

$$T_x = 2.2 \text{ MN} * \sin 45 = 1.6 \text{ MN}$$



Force Analysis

Material Properties

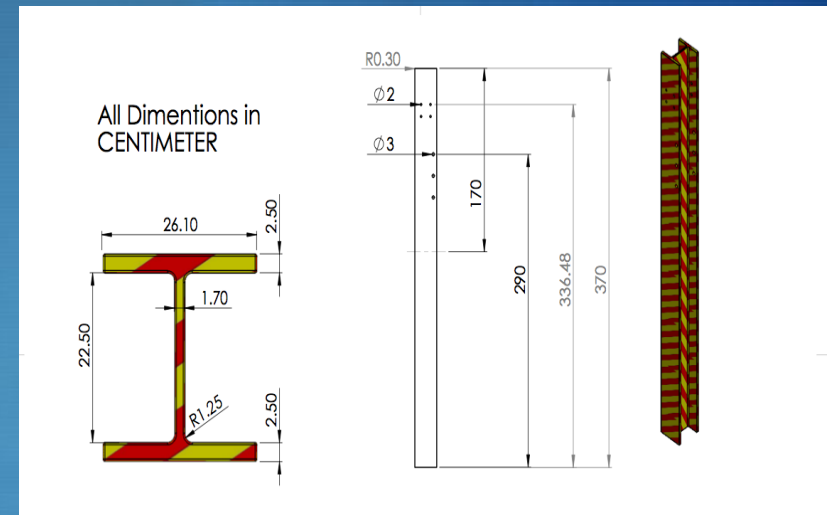
Model Reference	Properties	Components
	<p>Name: AISI 1010 Steel, hot rolled bar</p> <p>Model type: Linear Elastic Isotropic</p> <p>Default failure criterion: Max von Mises Stress</p> <p>Yield strength: 1.8e+008 N/m²</p> <p>Tensile strength: 3.25e+008 N/m²</p> <p>Elastic modulus: 2e+011 N/m²</p> <p>Poisson's ratio: 0.29</p> <p>Mass density: 7870 kg/m³</p> <p>Shear modulus: 8e+010 N/m²</p> <p>Thermal expansion coefficient: 1.22e-005 /Kelvin</p>	<p>SolidBody.1(Cut-Extrude2[2])(Main Post-2),</p> <p>SolidBody.2(Cut-Extrude2[1])(Main Post-2),</p> <p>SolidBody.1(Boss-Extrude1)(test analysis-1-1)</p>
Curve Data:N/A		

$$\sigma = \frac{2.2 \text{ MN}}{0.016875} = 130.4 \text{ Mpa}$$

$$\text{Safety Factor} = \frac{3.25 \cdot 10^8}{130.4 \cdot 10^6} = 2.49$$

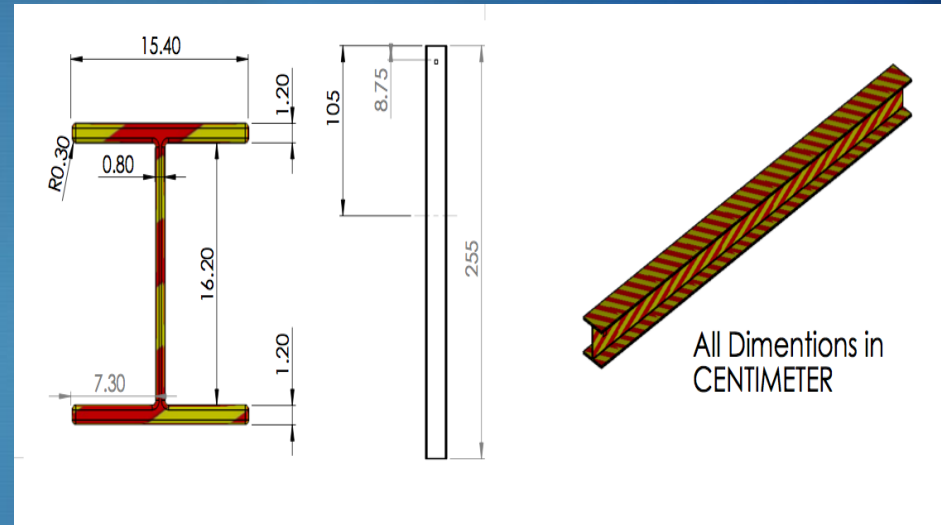
SolidWork Drawings

Main post: the main post is made of AISI 1010 steel, hot rolled. It is considered one of the most important parts of the system. Its function is to connect the cables between fence segments. It also provides connections for the braces and the chain link wire fence assembly. It carries a huge amount of load during impact and for this it is supported by back supports to enhance its strength.



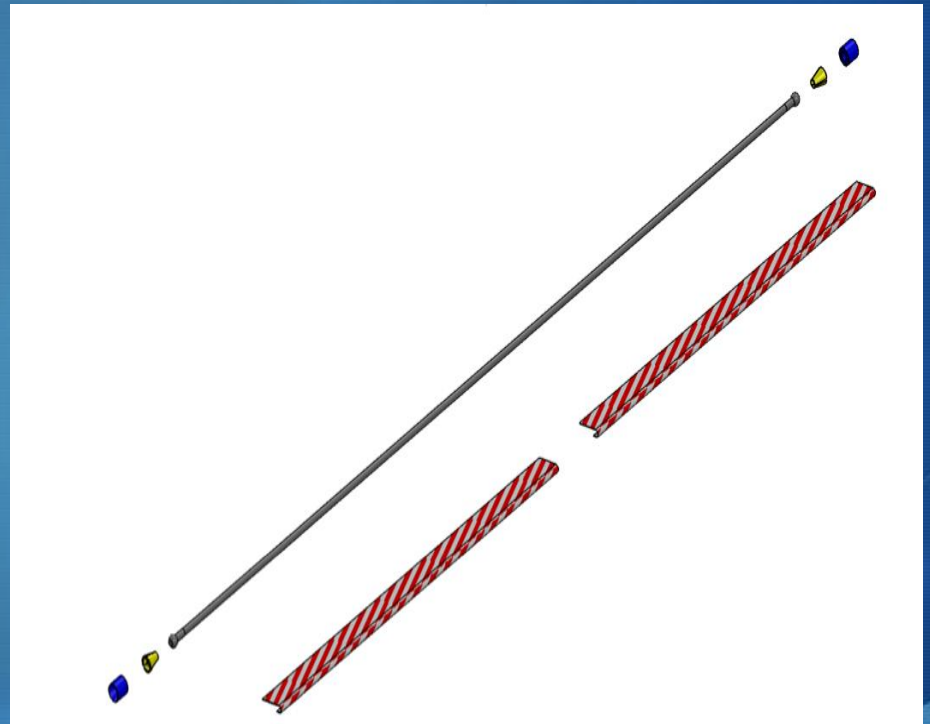
SolidWork Drawings

Intermediate post: main post is made of AISI 1010 steel, hot rolled. This part is designed to provide the system with additional strength and support. It provides connections for the braces and helps support the cables and prevent sagging.



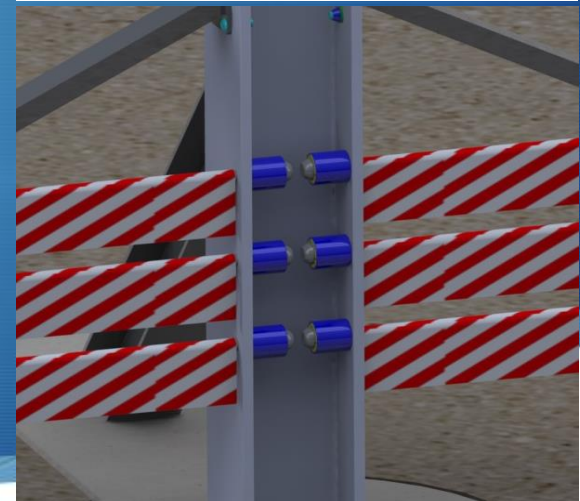
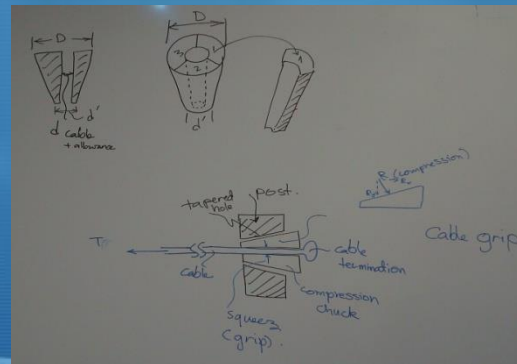
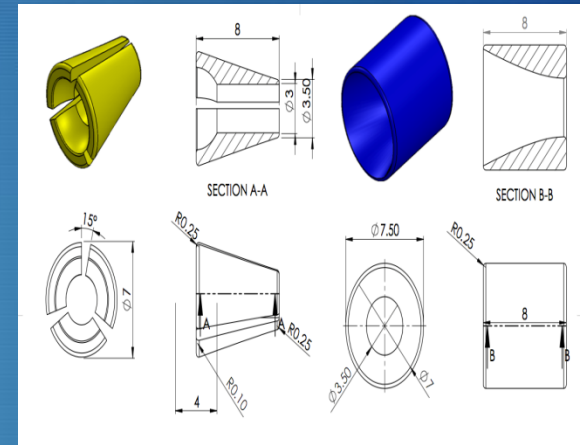
SolidWork Drawings

Cable assembly: the cable is made of galvanized steel. Its function is to help distribute the impact force between the two main posts. It also localizes the reaction force on the vehicle to intensify the damage. The cable glad provides a visual mean of the security system.



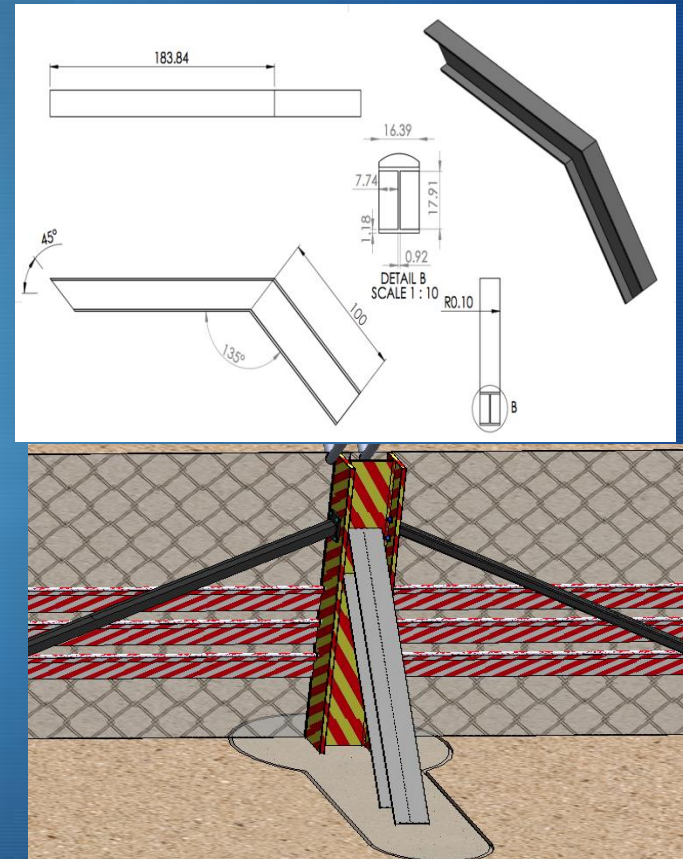
SolidWorks Drawings

Cable grip system: Cable grip is made of galvanized steel. It provides positive clamping of the cable and prevents cable slippage during impact. Because of its geometry the force to hold the cable in place increases as the tension on the cable increases.



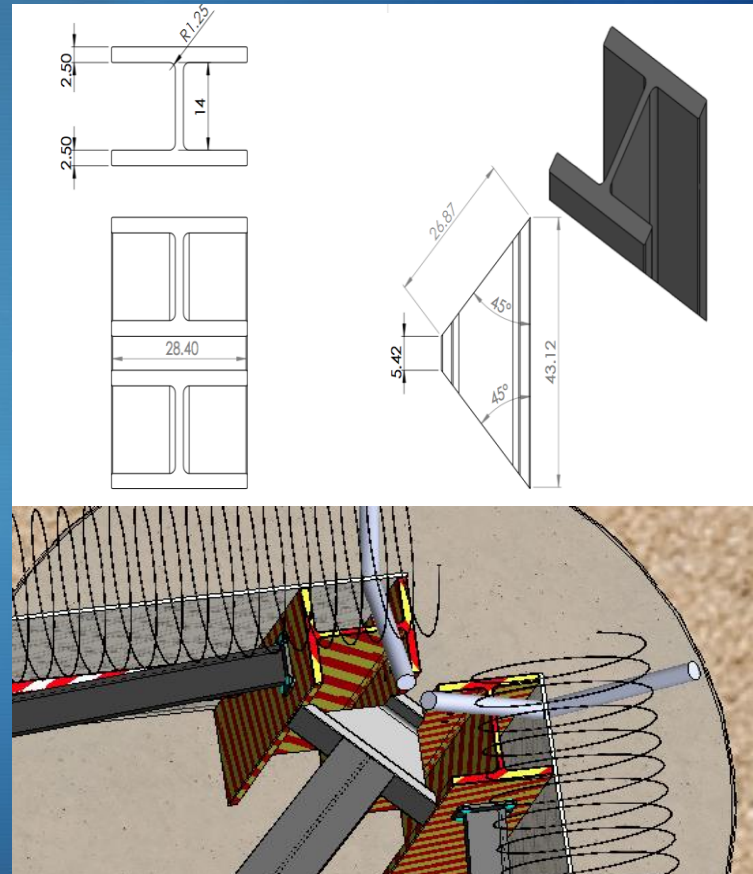
SolidWork Drawings

Back support: the back support is made of AISI 1010 steel, hot rolled. The main function of the back support is to provide additional strength to the main posts in the Y direction during impact.



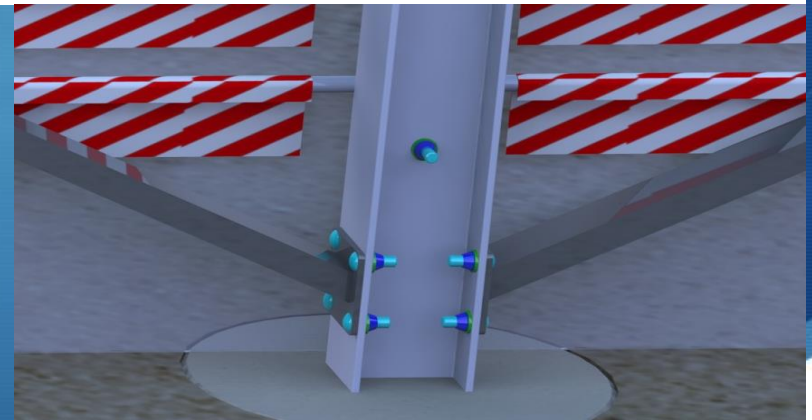
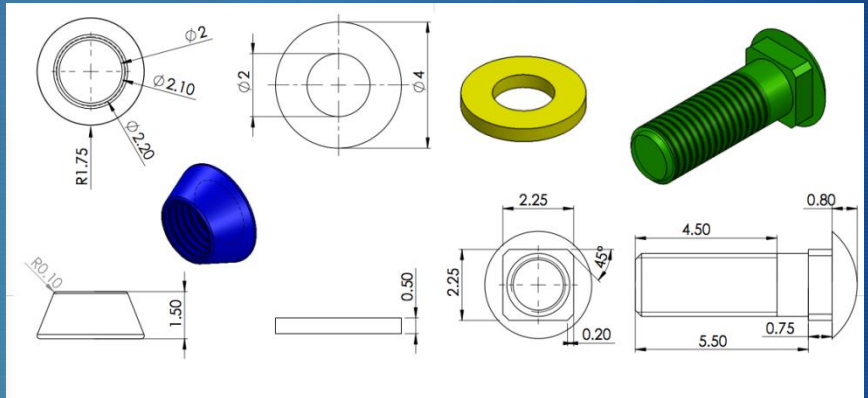
SolidWork Drawings

Corner filler: the filler is made of AISI 1010 steel, hot rolled. Its function is to provide connection between the two corner posts with a single back support. It also transmits the force from the corner posts to the single back support.



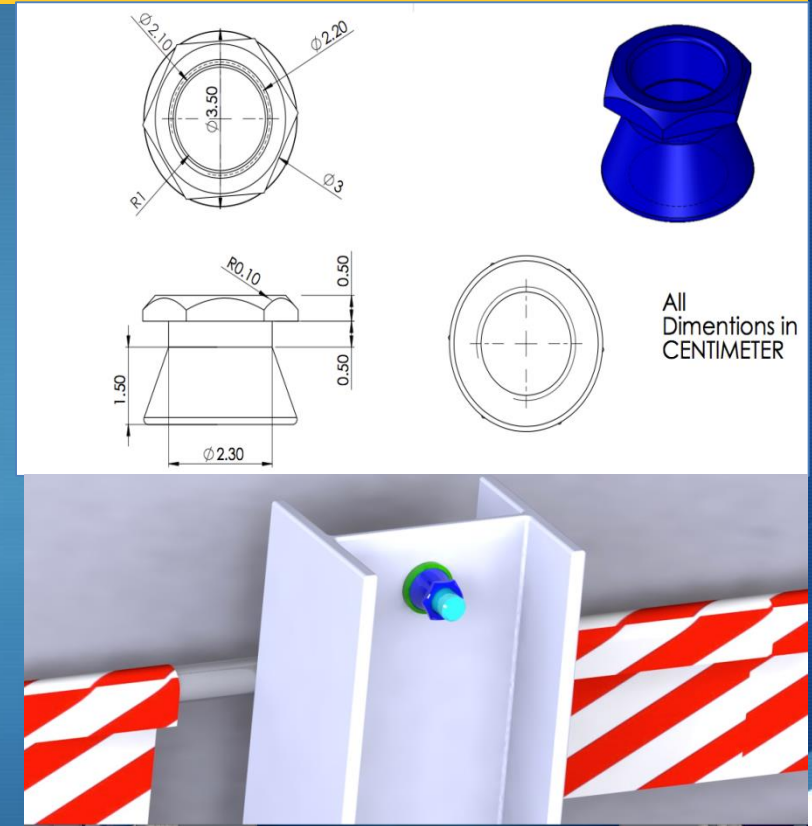
SolidWork Drawings

Anti-Tamper system: the anti-tamper system consists of a carriage bolt, washer, and a cone nut. The function of this system is to provide regular parts' connections, but most importantly is to prevent easy dismantling of the system. The removal of this system cannot be done using regular hand tools, but requires special cutting tools.

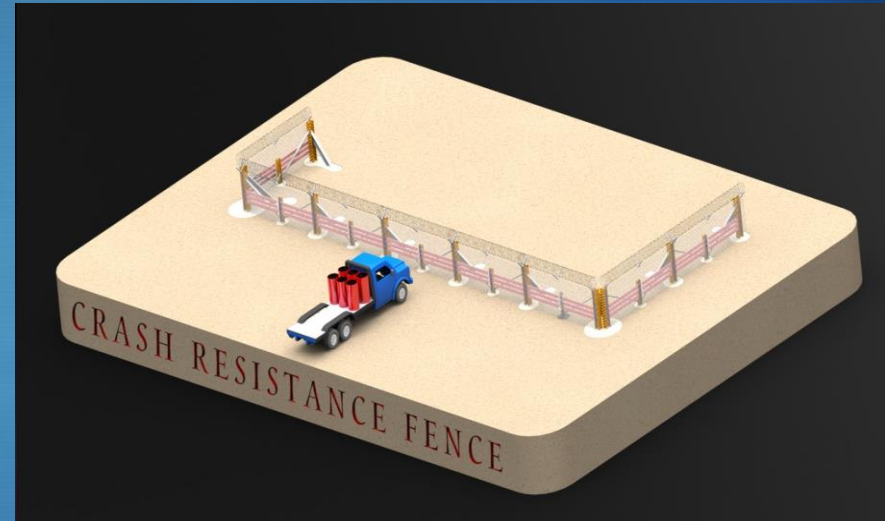
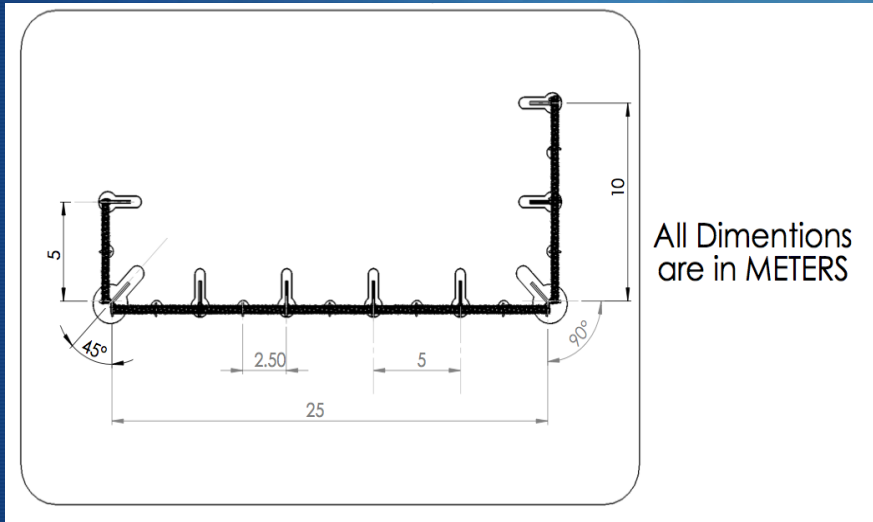


SolidWork Drawings

Anti-Tampered cone nut: this nut is part of the anti-tampered system. It comes with a hex type head to allow for installation. The hex head will break off at specified torque in order to prevent removal of the nut using traditional hand tools.



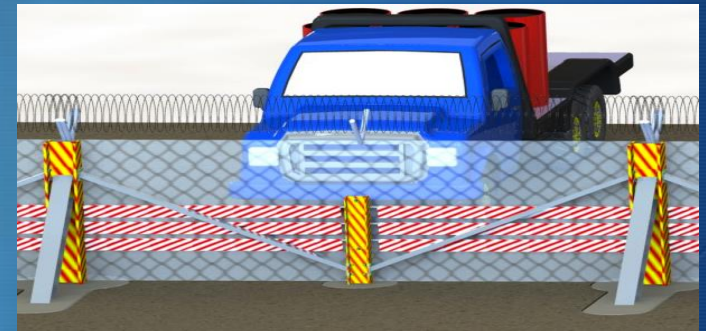
Final Drawing



Cost Estimations

Cost estimation of side section major parts:

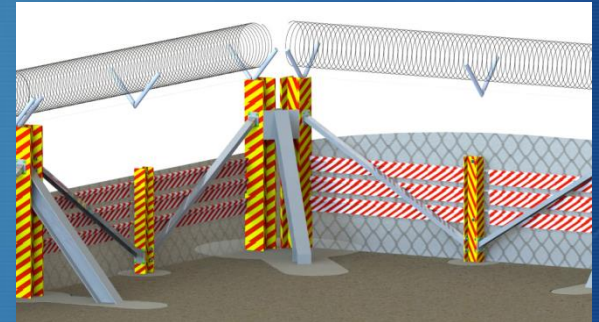
Item	Part	Unit price	Quantity required	Total cost
1	W10, 12mtr	1093.00 SR	8 meters	728.70 SR
2	W8, 12mtr	1802.00 SR	6 meters	901.00 SR
3	W6, 12mtr	1802.00 SR	3 meters	450.50 SR
4	Concrete	230.00 SR	8.5 Cubic meters	1955.00 SR
			Total	4035.20 SR



Cost Estimations

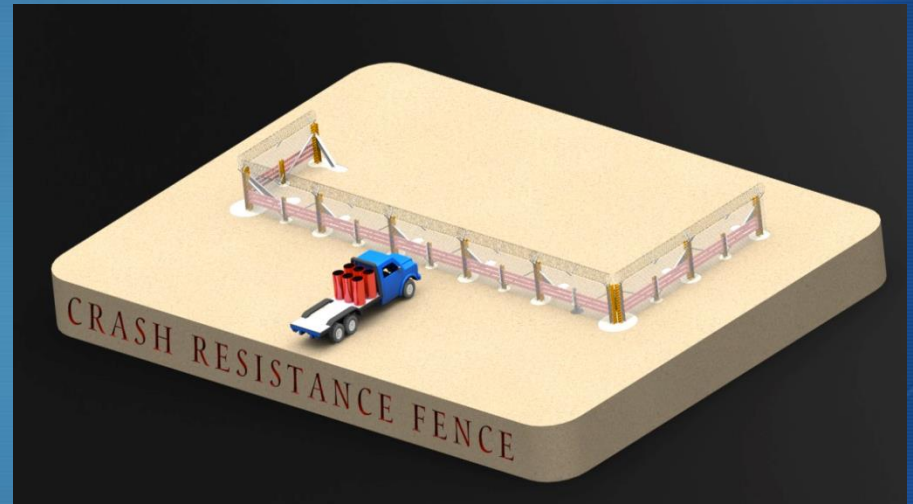
Cost estimation for corner section major parts:

Item	Part	Unit price	Quantity required	Total cost
1	W10, 12mtr	1093.00 SR	16 meters	1457.30 SR
2	W8, 12mtr	1802.00 SR	9 meters	1351.50 SR
3	W6, 12mtr	1802.00 SR	6 meters	901.00 SR
4	Concrete	230.00 SR	18 Cubic meters	4140.00 SR
			Total	7849.80 SR



Summary

The Crash Resistance Team feels confident that the design meets and exceeds ASTM F2656 M50-PI USA for K12 rating standards. It is possible that this design can be manufactured in the kingdom and can withstand its harsh environment.



Crash Resistance Fence

Thank You

