# Five Star CONSULTANTS

INNOVATION-INTEGRITY-INGENUITY

## FINAL YEAR STUDENTS DESIGN PROJECT

**06 December 2017**

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# Capstone Design

- UNIVERSITY OF JOHANNESBURG CIVIL ENGINEERING CAPSTONE DESIGN SUPPORTED BY Futran System SA, Podcar Alliance University of San Jose
- ENGINEERING OF THE FUTRAN PODCAR
- Capstone Design is a 28 credit Design module that runs in the 2nd semester from the month of August to Mid-November.
- It is a Design module for Only Civil Engineering Students.The Capstone is supported by Two weeks lectures on CAD drawing and PROKON
- It is coordinated by a faculty member (primary client) and convened by Consulting firm (Infraconsult). Mr Jansen Monroe (cc) is the convenor .

# Capstone Design cont..

- It is convened by Infraconsult and Four consultants from Civil Engineering consulting companies
- Capstone designs problems are formulated to cover all the sub disciplines of Materials , Structural Engineering, Pavement Design and Transportation Engineering, Geotechnical Engineering , Water Resources and Municipal Engineering , with basic Knowledge of Green Technology, Micro Electronics, etc.
- Our last two years capstone design was on the Development of Major Support Infrastructure for the proposed Extension of the Gauteng Province Medium Speed Train (Gautrain).
- This year the topic is the Design of Major Support infrastructure for the Futran Model Suspended Mono Rail in Gauteng Province.

# Contents

1. Design Objective
2. Route Determination
3. Technical Components
4. Market Analysis
5. Green Technology
6. Visual Simulation

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# 1. Design Objective

- Design a suspended monorail transportation network system to service the Sandton and Alexandra regions in Gauteng, South Africa.

MILOTEK innovating transportation

FUTRAN PODCARS

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# What the system offers

- Not necessarily the solution to traffic congestion.
- Increase the green rating of Johannesburg.
- Increased freedom in travelling throughout Johannesburg.

# Factors Considered

- Land availability
- Demand
- Accessibility
- Traffic congestion
- Existing transportation systems

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# 2. Route Determination

## Sandton Site Visit

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# Alexandra Site Visit

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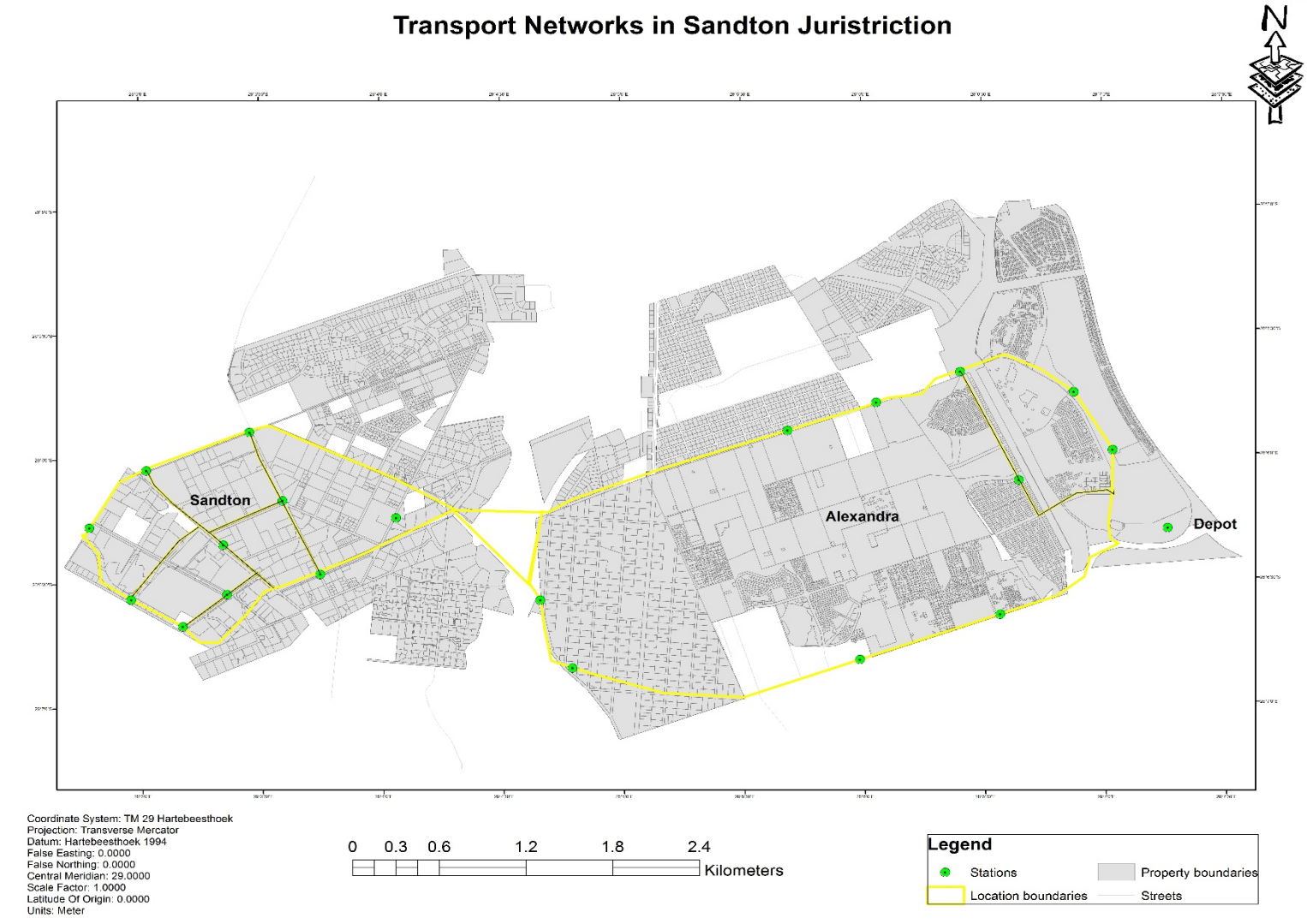
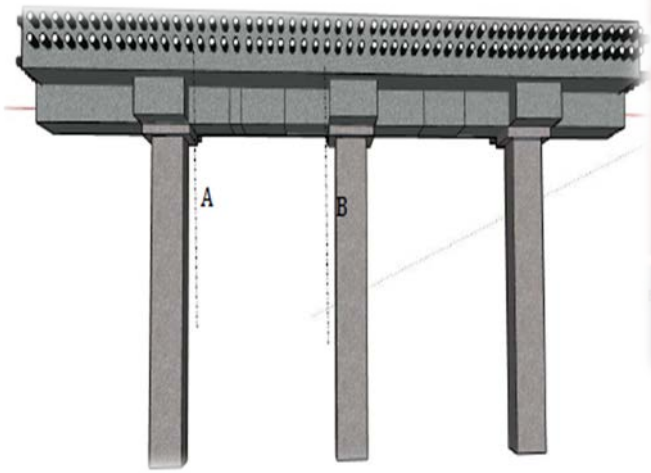
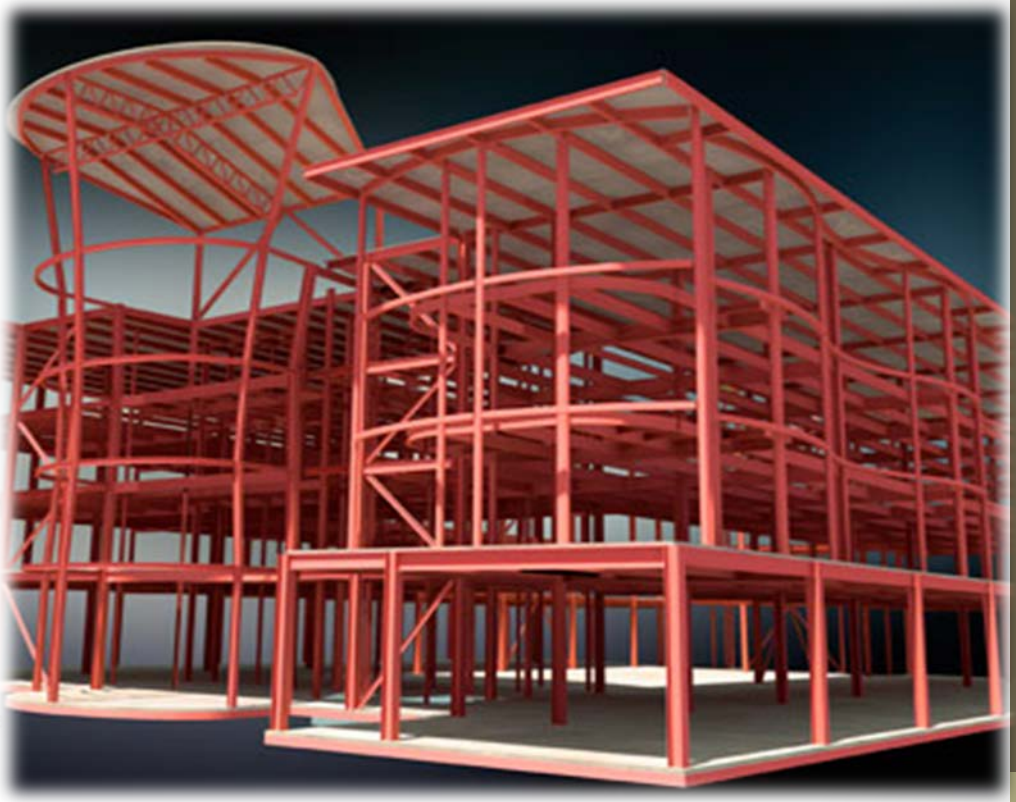
# Final Route


Transport Networks in Sandton Juristriction
N
Sandton
Alexandra
Depot
Coordinate System: TM 29 Hartebeesthoek
Projection: Transverse Mercator
Datum: Hartebeesthoek 1994
False Easting: 0.0000
False Northing: 0.0000
Central Meridian: 29.0000
Scale Factor: 1.0000
Latitude Of Origin: 0.0000
Units: Meter
0 0.3 0.6 1.2 1.8 2.4
Kilometers
Legend
Stations
Property boundaries
Location boundaries
Streets

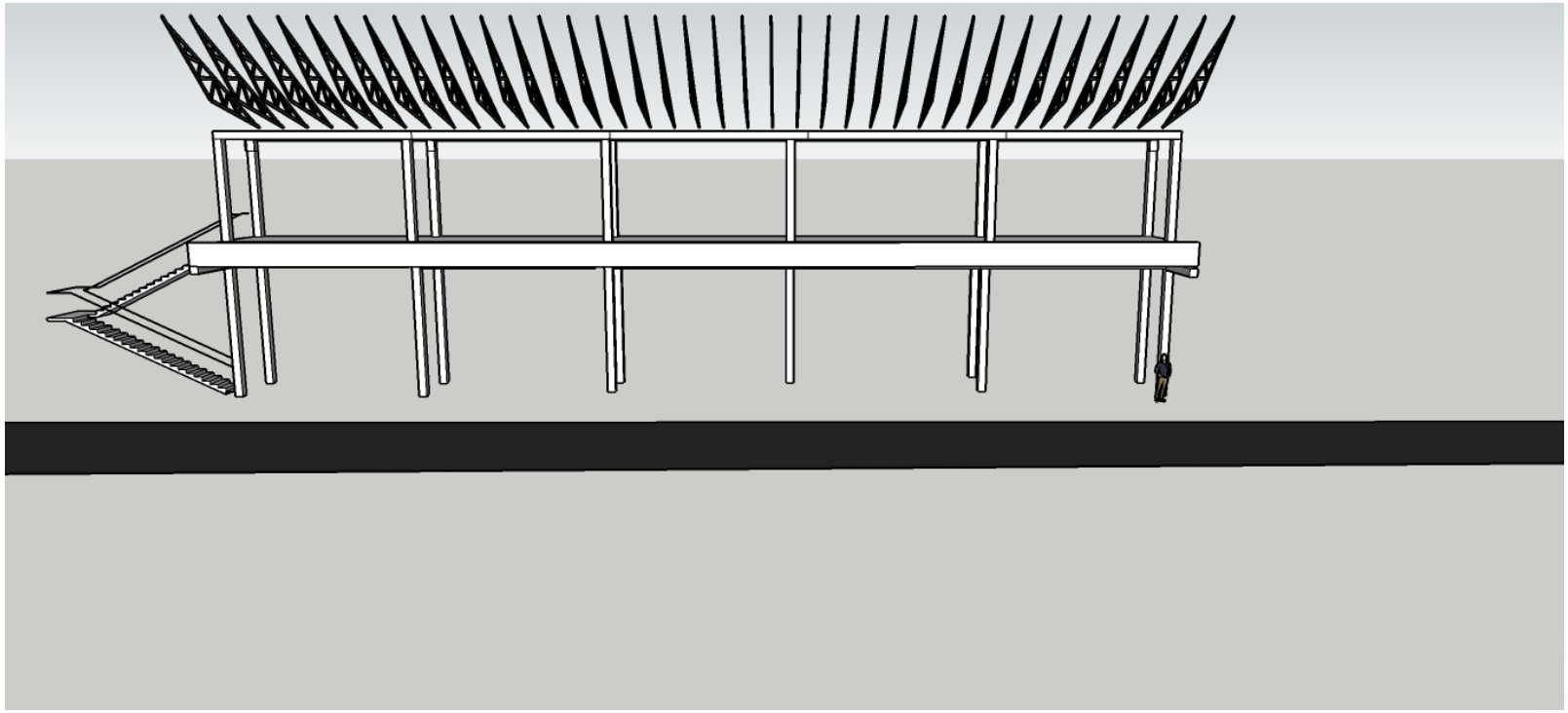
# 3. Technical Components

## 3.1 Structural Components



# 3-5 Door Station



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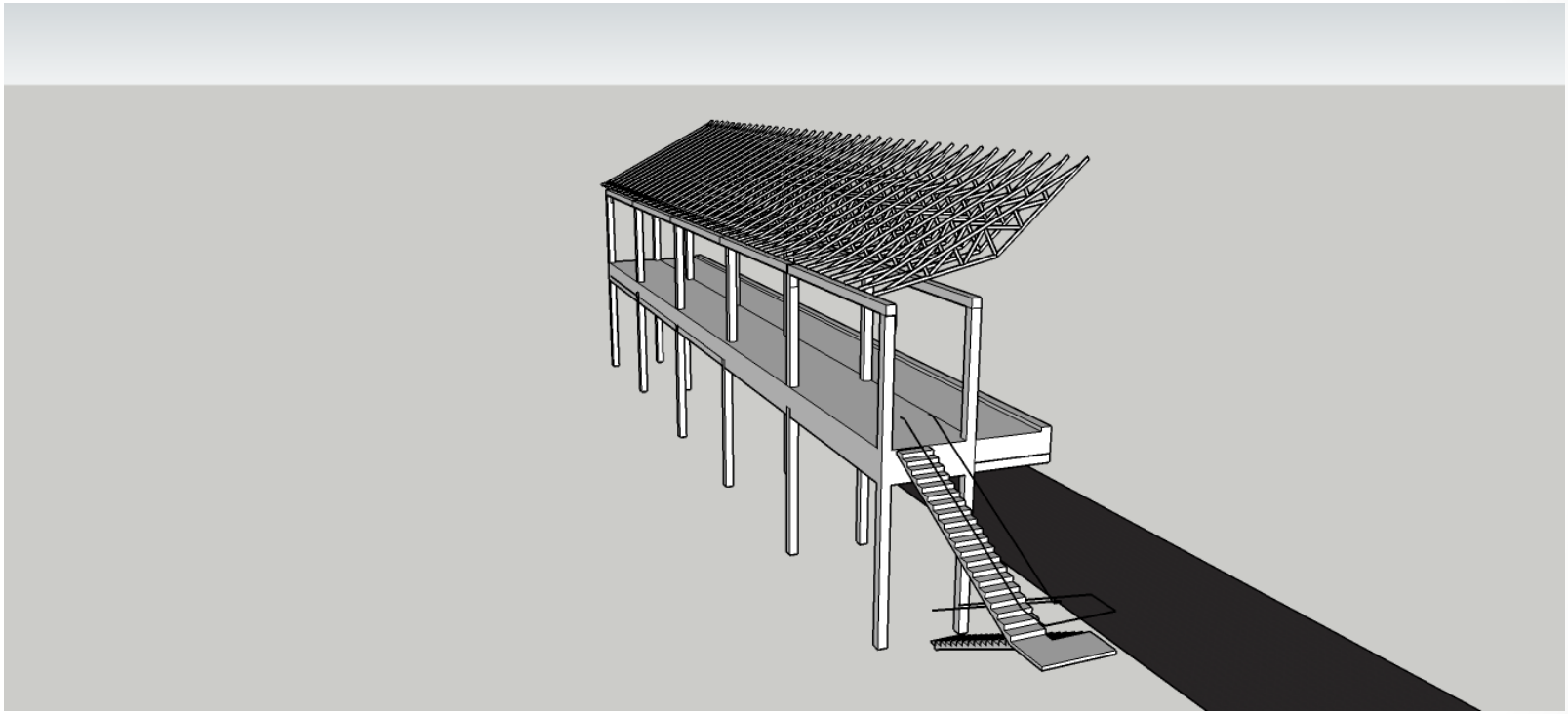
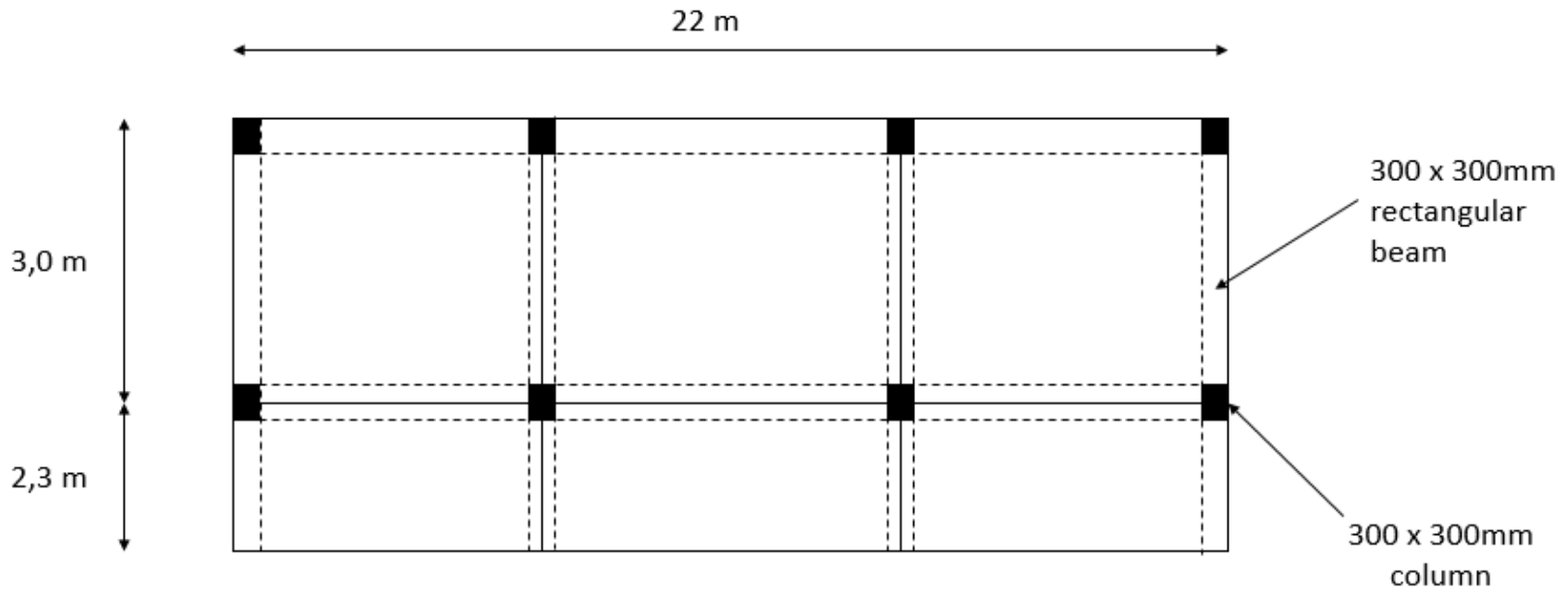


# 3- Door Station Elements

| COMPONENT | SPECIFICATIONS |
|---|---|
| Number of Floors | 2 |
| Floor Area | 145 $m^2$ |
| Columns | 300mm x300mm |
| Floor Slab | 350mm |
| Roof Beam | Rectangular (500mm x 300mm) |
| Floor Beam | 550mm x 300mm |
| Roof Sheeting | IBR 686 Corrugated Steel Sheeting (0.8mm) |
| Roof Truss | Inverted ( 80mm x 80 mm x 6mm Equal angle sections) |
| Foundation | Pilled Foundation, 15 Piles ( 500mm diameter, 10m Length) |

# 3-Door Station Floor Plan

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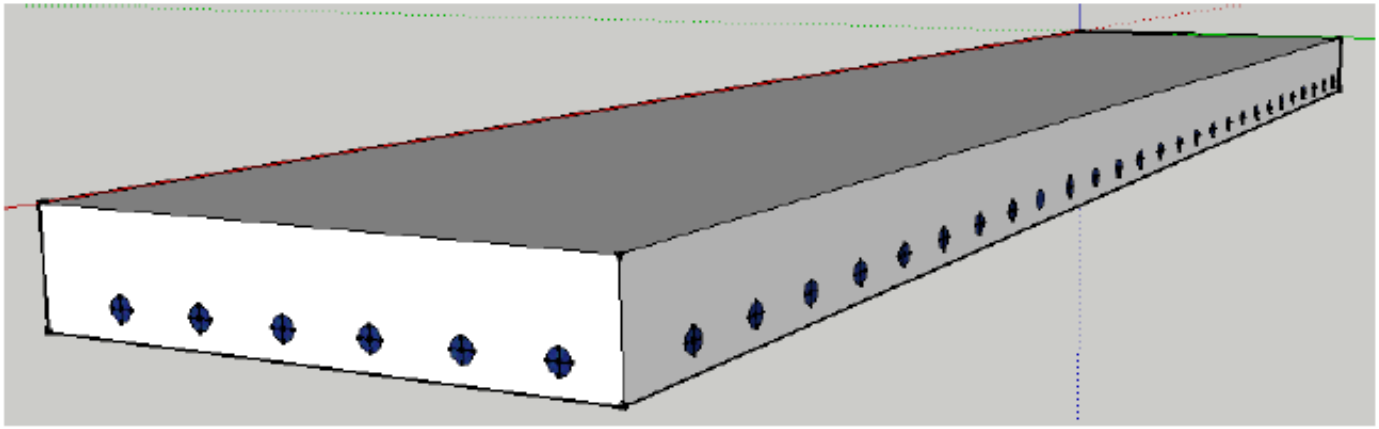
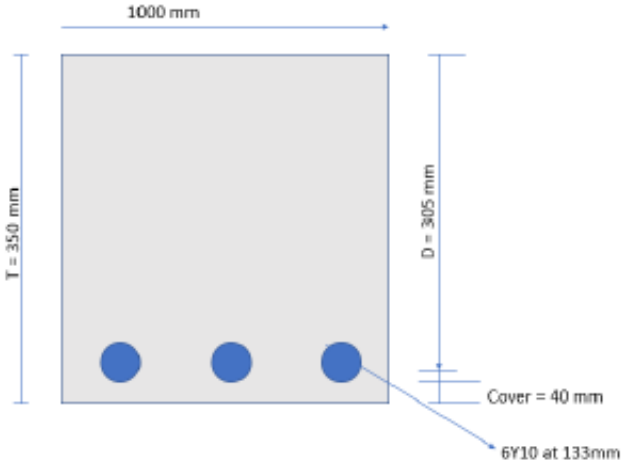
# 3-Door Station Slab Design

**SLAB DESIGN**



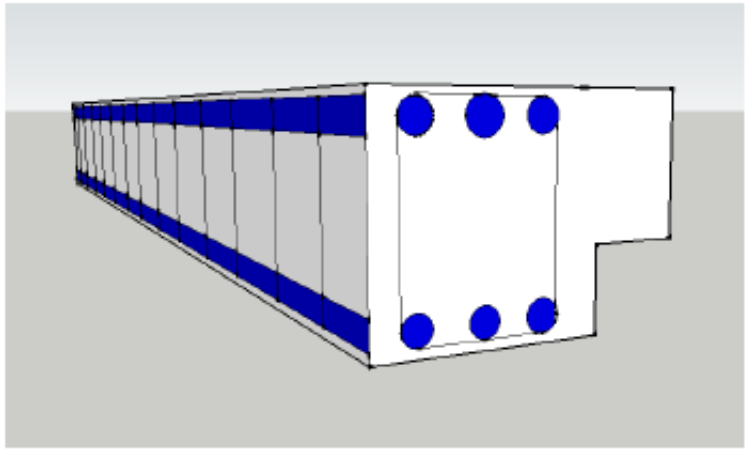
**Cross section:**

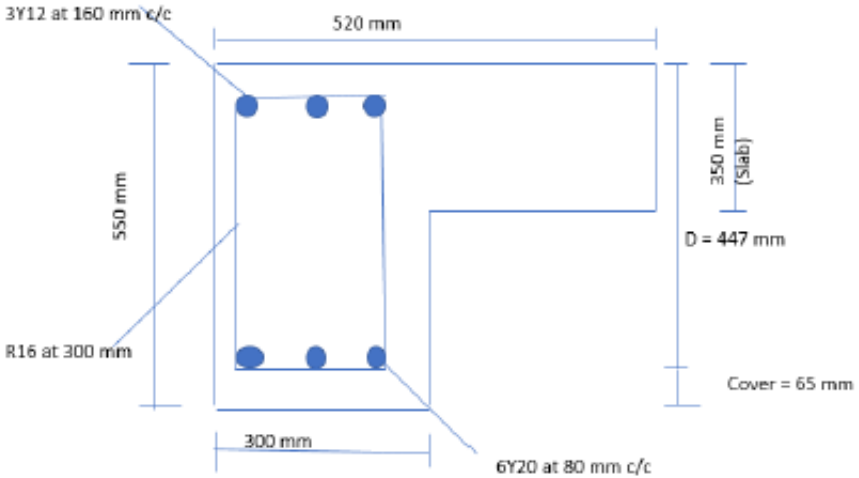



| | |
|---|---|
| Project: Monorail Transport system | Civil Design OWS4B21 |
| Designer: Mofokeng M.T 201214015 | Date: 31 October 2017 |

# 3-Door Station Beam Design

**L-BEAM DESIGN**






| | |
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# Depot Station Elements

| COMPONENT | SPECIFICATIONS |
|---|---|
| Number of Floors | 2 |
| Floor Area | 460 $m^2$ |
| Columns | 350mm x 350mm |
| Roof Slab | 300mm |
| Floor Slab | 300mm |
| Roof Beam | Rectangular (525mm x 350mm) |
| Floor Beam | Rectangular (350mm x 350 mm) |
| Footings | 220mm x 3000mm x 500mm |

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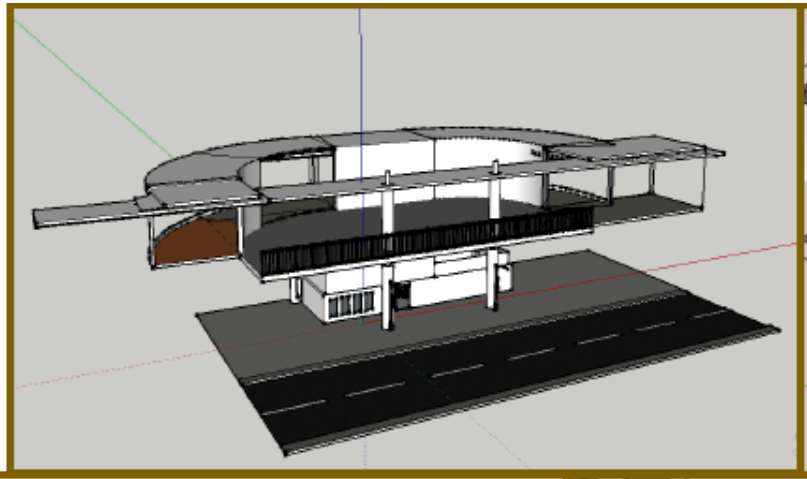
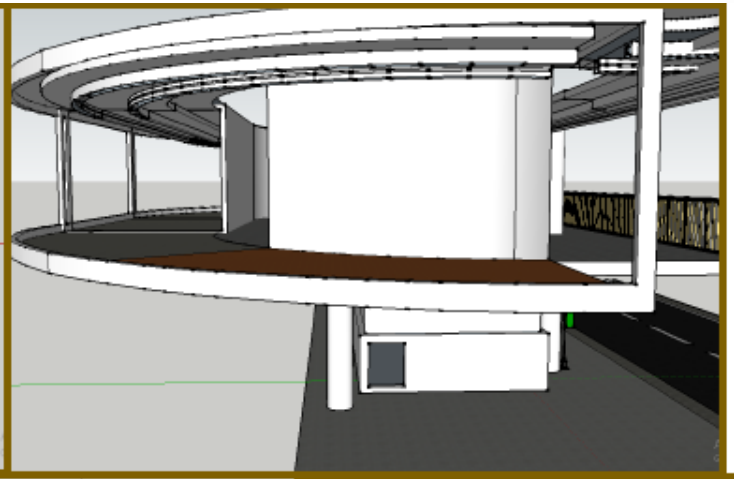
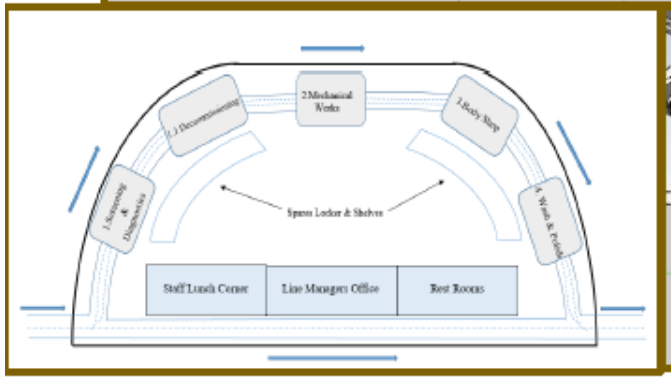
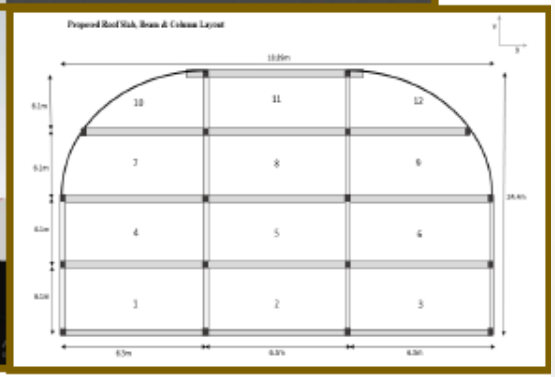
# Depot Station Layout

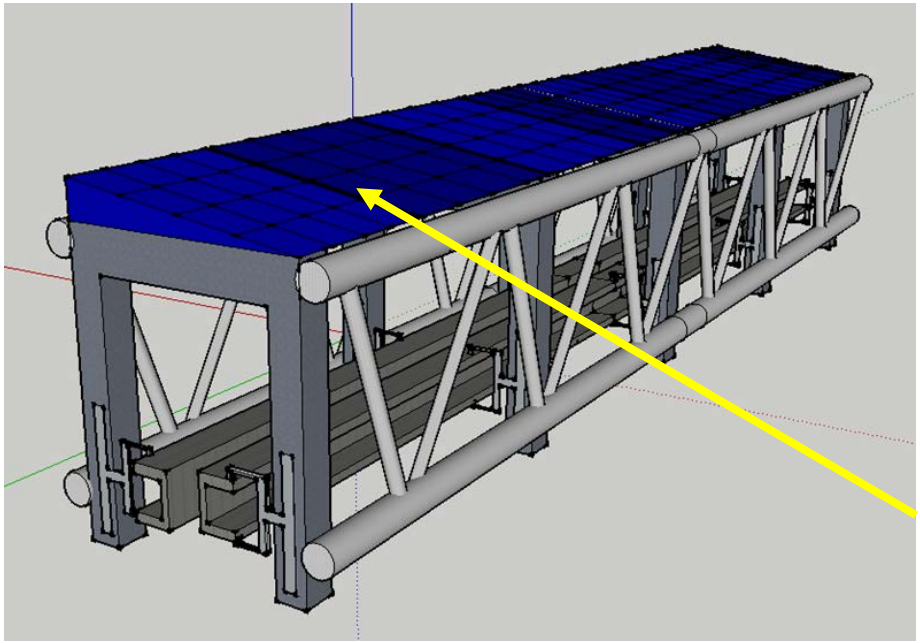








# Track Analysis



Track: Warren Truss (economical and simple to design)

Beam: 300x100x46kg/m Flanged channel

Solar panels

1.4Kw per 9meter span of Track

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# Track analysis

Alternative truss design

Truss: Pratt Truss

Beam: 533x210x122 kg/m I-section

Solar panels

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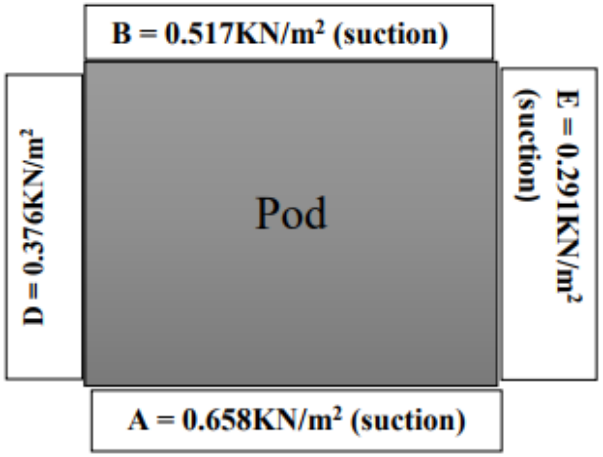
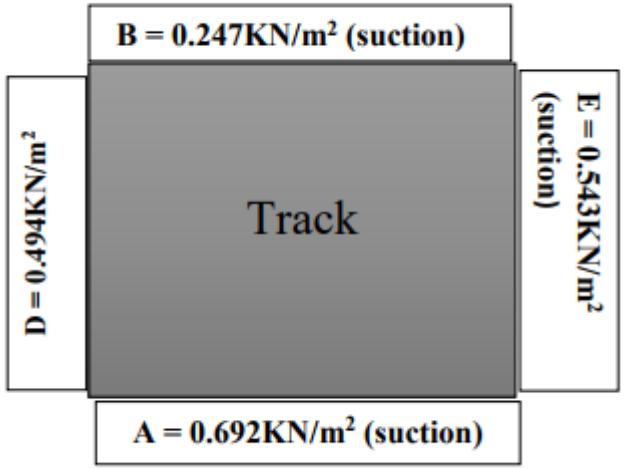
# Wind pressures




Height above ground =7.2 m
Pod width = 2.2 m
Pod length = 4.4 m

Height above ground =8.2 m
Track width =1 m
track length =3 m

Angle of contact = 0 degrees for both

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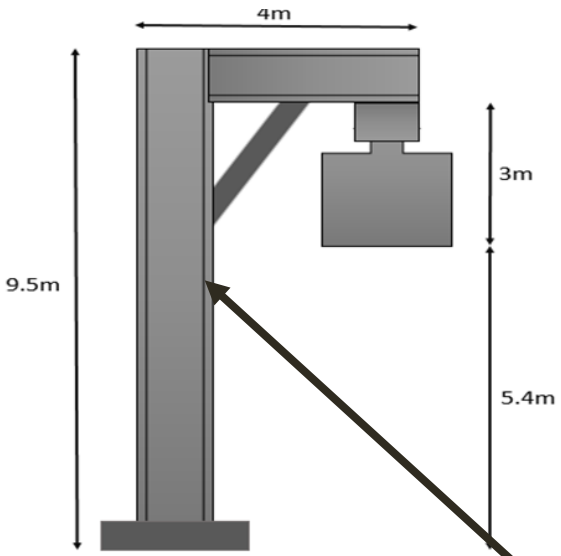
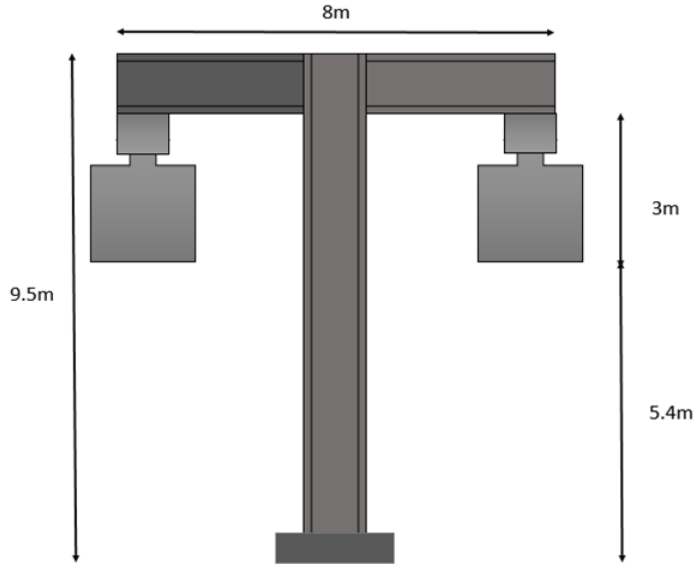
# Track Column Analysis




Column design along the path




Column design at the station

**Critical column designed for**

Column selection:
254x254x107kg/m H-section
Beam selection:
406x178x67kg/m I - section

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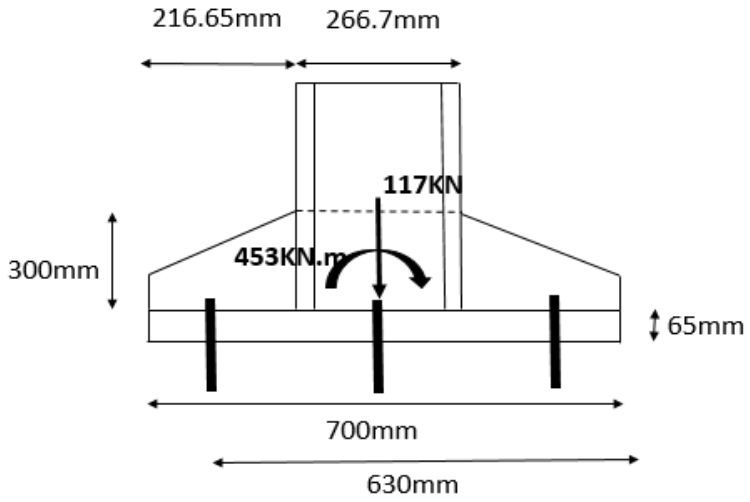
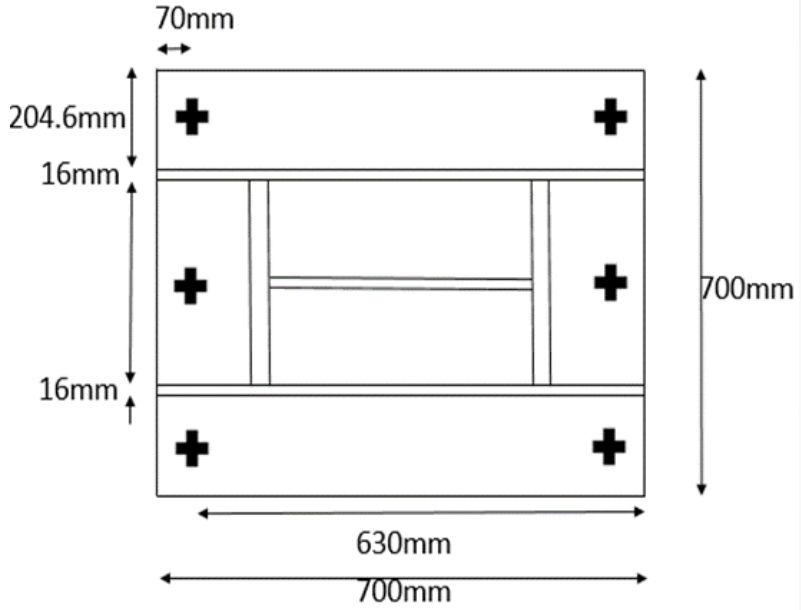
# Base-Plate Analysis




Base plate: Side-View




Base plate: Top - View

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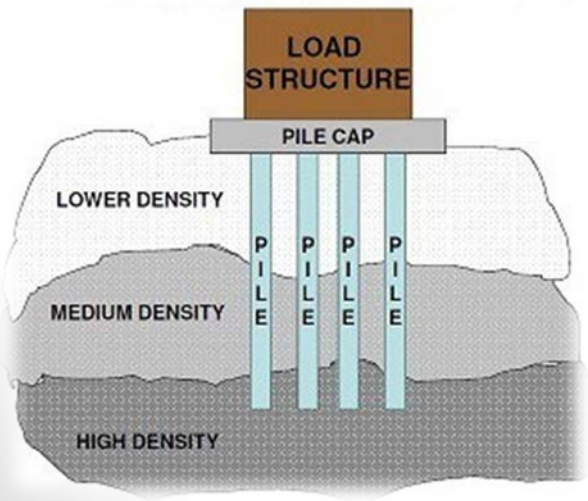
# 3.2 Geotechnical Components



# Track Loadings on Foundation

| Foundation Loadings | Units |
|---|---|
| H-steel Section (self-weight) | 9.7 KN |
| Gusset Plate | 1.63 KN |
| Base Plate | 2.87 KN |
| Holding Down Bolts | Negligible |
| Column Base Dead Load | 14.18 KN |
| Applied Loading | 117 KN |
| Applied Moments | 453 KN.m |
| **Total** | **131.18 KN** |

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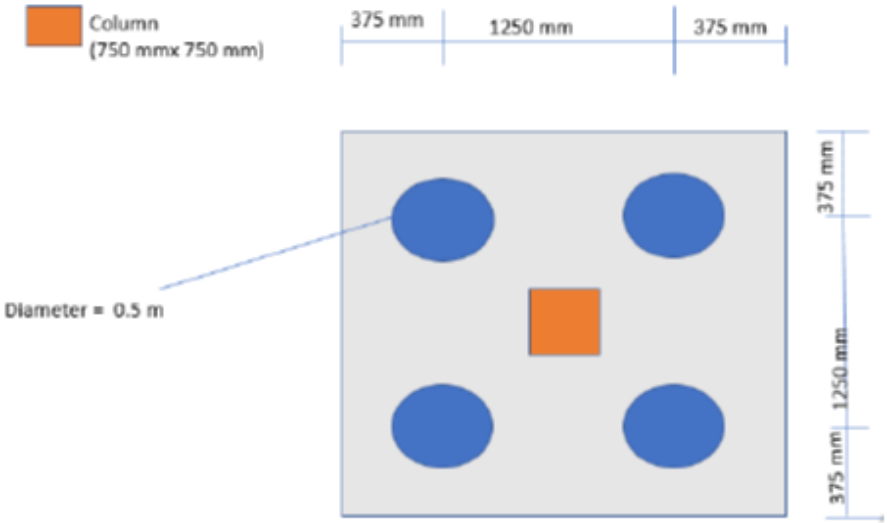
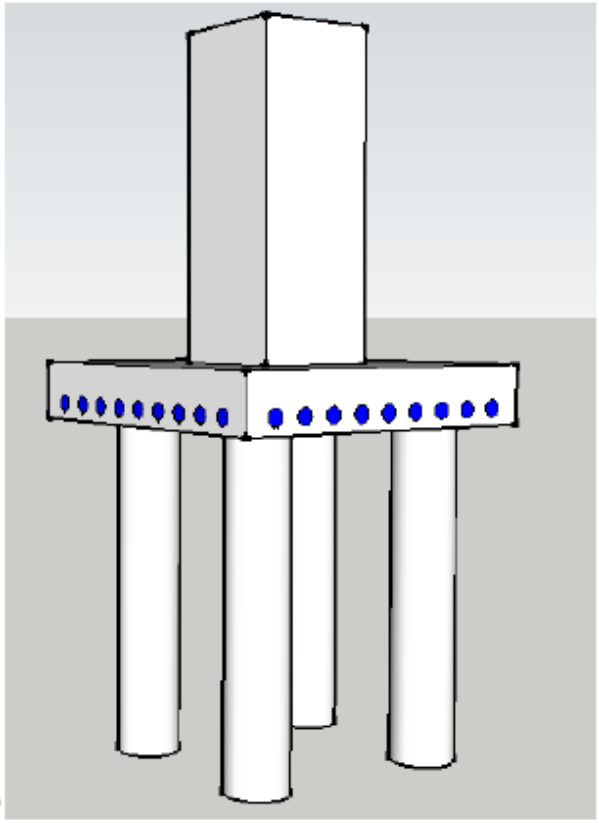
# Track Foundation Design



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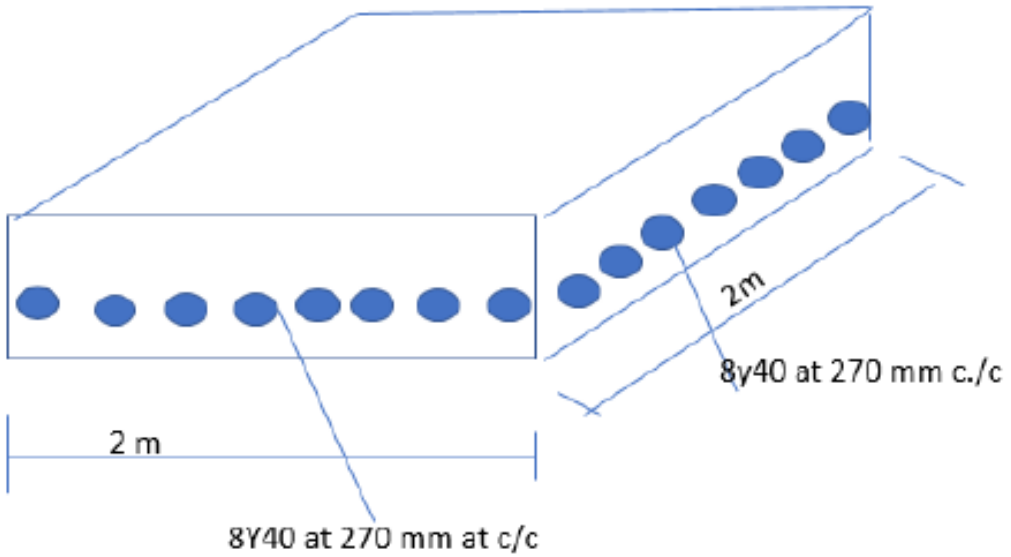
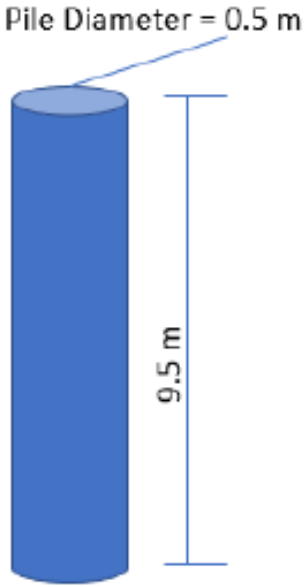
# Track Foundation Design




| | |
|---|---|
| Project: Monorail Transport system | Civil Design OWS4B21 |
| Designer: Mofokeng M.T 201214015 | Date: 31 October 2017 |

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# 4. Market Analysis

| Region | Sandton | Alexandra |
|---|---|---|
| Population | 220 000 people | 180 000 people |
| Daily commuter train market | 496 255 people | |
| Number of pods | 1047 | |
| Maximum number of occupants per pod | 12 people | |
| Number of people per day | 52599 | |
| Cost | 10 US cents per km per person | |
| Number of stations | 10 | 11 |
| Total length from Alex to Sandton | 21 km | |

# 5. Green Technology

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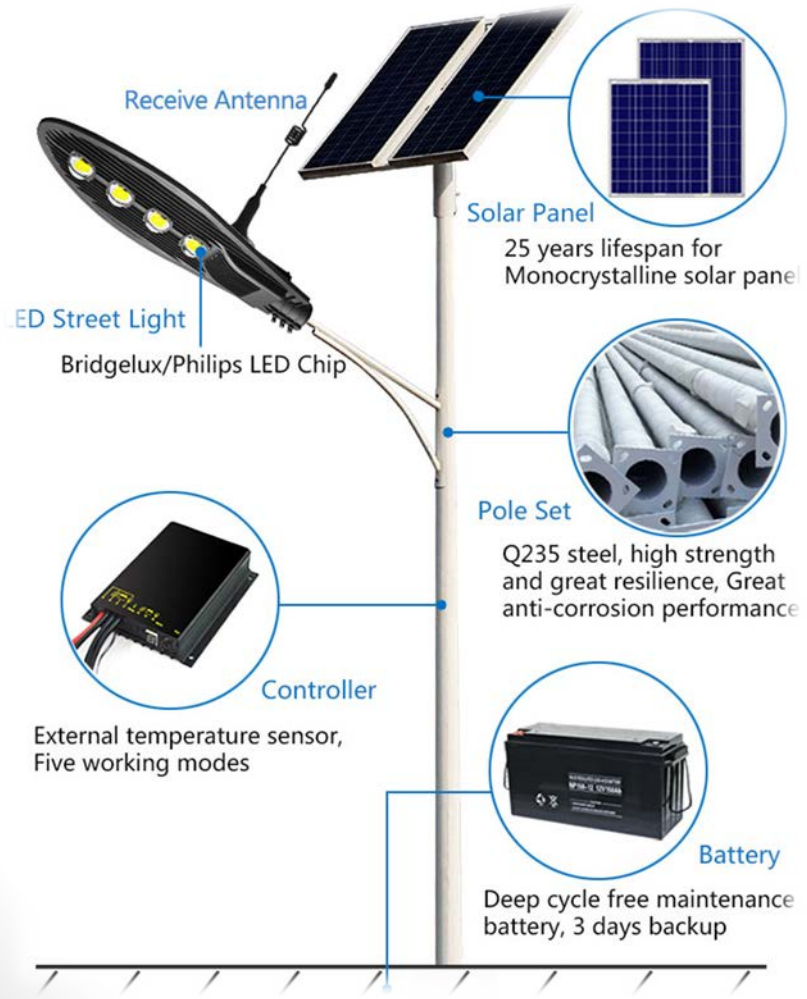
# Solar Energy

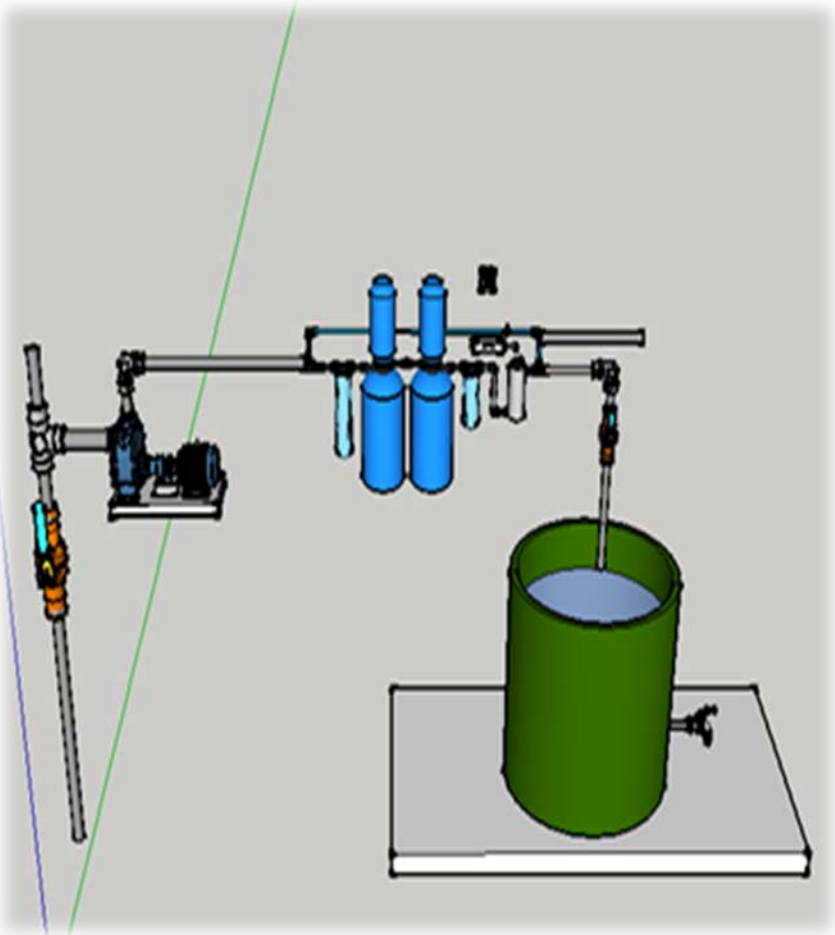



- Incorporated into the already existing solar panels on the track
- Wireless
- 3-5 days backup
- Automatic on/off, intelligent time control and dimmable mode.
- Zero energy cost

# Solar panels

| Total area of station | 204 $m^2$ |
|---|---|
| Area of a single panel | 1.4 $m^2$ |
| Total number of panels | 125 panels |
| Energy generated per day | 34.76 KW |
| Possible Energy to be utilized for | Elevator |
| | Water Treatment |
| | Lightning system |
| | Sliding doors |
| | Appliances |

# Rain Water Harvesting System



- 2500L Tank
- GAC & Sand filter
- Chlorinators

**Use**

- Watering vegetation at station
- Wash Pods & Clean Station
- Toilet flushing
- Can be used for drinking but further purification is recommended

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# Green Cement

- The term ‘green cement’ refers to cement production that does not release a large amount of emissions into the environment (Khan, 2010)
- Green cements are becoming a necessity currently because the current cement production produces a high amount of emissions in the atmosphere
- Calcination and Pyro-processing are the largest $CO_2$ producers during cement production
- Calcination is the process in which $CaO_3$ (limestone) is subjected to high temperatures to produce CaO (lime)

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# Eskom Fly Ash

- Eskom consumes approximately 120 million tons of coal per annum producing approximately 36 million tons of fly ash per annum (www.eskom.com)
- Only 1.2 million tons of fly ash is sold to the cement industry
- The rest of the fly ash is stacked on huge dumps of ash dams and rehabilitated
- Instead of stacking the fly ash more fly ash should be used in the construction industry to ensure sustainable development

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# Eskom's Rehabilitation Program

Figure 1: Current fly ash rehabilitation on power station site

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# 6. CONSOLIDATED DESIGN & VISUAL SIMULATION

DESIGN 3.mp4

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