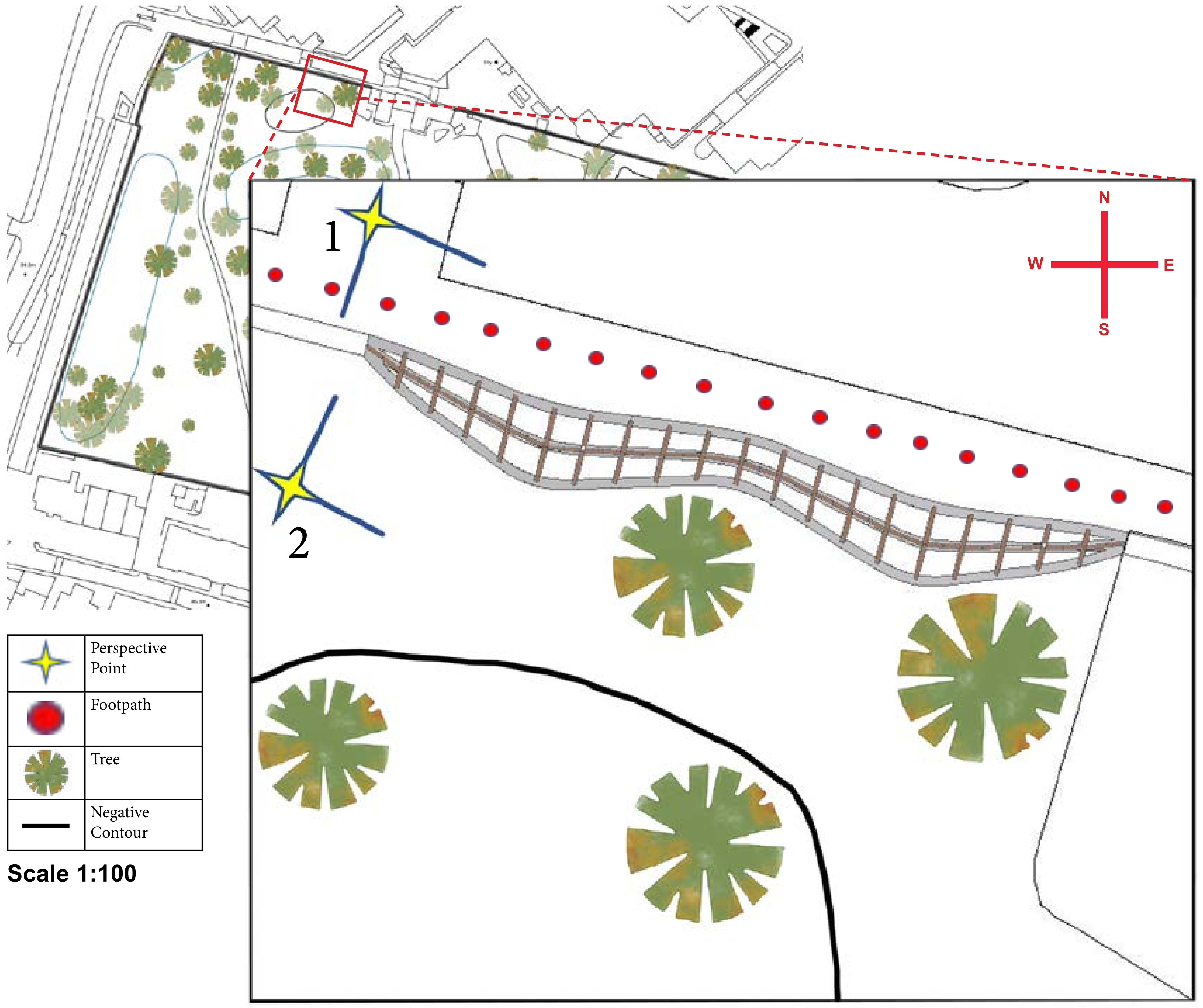
St Georges Field - Vertical Barrier G12B

Site Evaluation

The site plan below exhibits the location in which the vertical barrier would be constructed on the Northern border of St George's field, directly adjacent to the gatehouse and opposite to the University of Leeds Energy building. On its northern side, the barrier boarders the pavement of a university access road. On the southern side, there a several large tree within close proximity. As a result of the four story Leeds Energy building on one side and trees on the other, the site receives little to no direct sunlight.



Perspective 2

Perspective 1

Materials

Despite its volume, the barrier is a very lightweight structure. The primary material used to create the form, and that which is most visibly present is the pine wood of the poles. These are round poles that are machined to a consistent 100mm diameter and then pressure treated: a process by which the wood is dried and then submerged in a pressurized solution of chemical preservatives. In the interest of environmental preservation we have opted to use timber treated with a sodium silicate solution: a non-toxic alternative to traditional wood treatment chemicals. This will prolong the service life of the timber by preventing attack from fungi and insects. Pine was chosen because as a fast growing softwood it is a more sustainable option. We will ensure the Pine is FSC and PEFC approved - guaranteeing it is harvested from sustain-ably managed forests.

At the tops and bottoms of the poles, the connection points are made from 5mm steel plate that is galvanized after the components are fabricated. Galvanized carbon steel was chosen over stainless steel because it is significantly cheaper whilst still being resistant to corrosion.

For the cables that run the length of the barrier, stainless steel cables were chosen because of their more appealing appearance over galvanized steel. 10mm was chosen as the diameter to provide suitable visual weight for these elements.

In the soil beds that are built into the concrete base of the barrier Ivy will be planted and encouraged to grown on the central poles of the of the barrier and the cables that pass through them. Ivy was chosen for its fast growing nature and ability to thrive in the shady environment of the proposed site.

Costing

Material	Cost	Unit	Number of Units	Total Cost (£)(2 s.f)
100mm round pressure treated pine	£17.10	/m	105	1,800
5mm steel plate	£124.98	/m^2	11.15	1,400
Fabrication of connection points	£145.81	/m^2	11.15	1,600
Galvanising steel plates	£1.00	/kg	438.195	440
10mm 7x19 Stainless Steel Wire Rope	£5.74	/m	160	920
Climbing plant	£2.10	/m	160	330
Concrete	£75	/m^3	24	1,800
Manual labour	£200	/day/worker	8 days, 15 workers	24,000
			Total cost of barrier	= £32,290

Design Process and Precedents

Two of our precedent designs for the barrier can be seen below, conveying the evolution of our design. From the beginning of the design process, photo-sketch montage was used in order to ensure our design work was not detached from context of the proposed site. On the left is a concept that was designed to be made from the same sandstone as the gatehouse and chapel, mirroring their clean lines and solid appearance. On the right is one of a series of wooden truss designs with steel wires to fill the gaps and allow plants to grow on the barrier. Building on these ideas, we established our preferred attributes from each proposal and were able to devise a plan for our final barrier design. Our main objectives were to allow passers by sight into the field and to reflect the natural characteristics of the field in the materials used. After selecting a design, physical modeling was used to develop it further and allow visualization of the concept in space. Evidence of this modeling can be seen under the modeling heading of this sheet.

Proposal Justification

Stemming from the initial proposal of our vertical barrier, which was to reflect the natural ambiance of St George's field, alongside our precedent suggestions, we sought for our design to incorporate timber members, connected via steel plate connection points, with apertures in the design, sanctioning sight into the field. Steel wire ropes were integrated into the design between the vertical timber members, along these, climbing plants would be grown, re-establishing the 'natural' theme of the barrier, whilst disallowing pedestrians to have the ability to enter the field via the openings. The timber members vary in height producing a sinusoidal effect in the height of the barrier, and from a birds-eye-view.

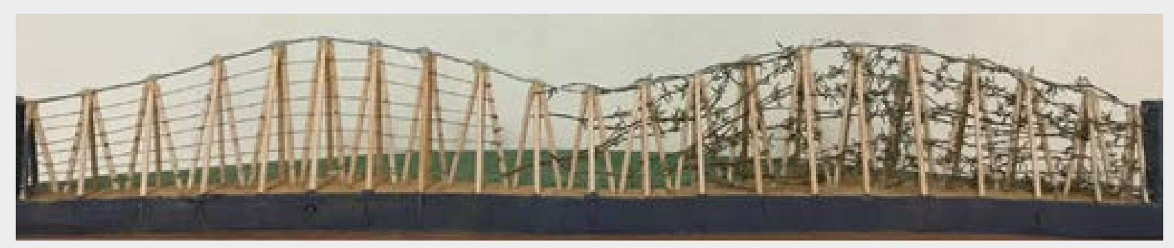
Maintenance

As the timber has been treated with sodium silicate, a solution that effecitly becomes glass after heat treatment, it is largely impervious to water and hence will require little maintenance.

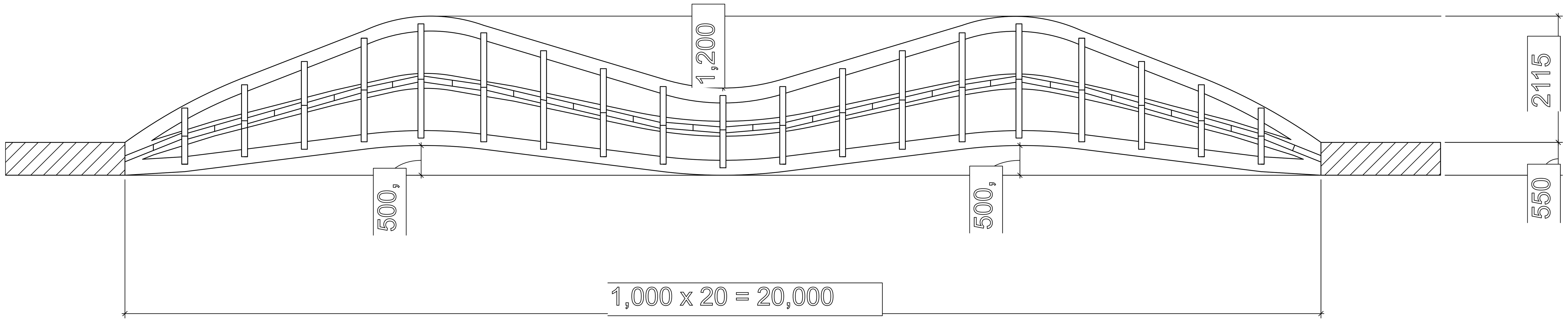
Galvanized steel is resilient to weathering for a prolonged period and can last almost 60 years maintenance free; however, preventative cleaning can be performed on an annual basis to ensure that corrosion of the steel is minimized.

The climbing plants and soil bed will be the main concern for the maintenance of the appearnace of this barrier. Ivy is generally fast growing and will require relatively frequent attention to ensure the growth of the plants is limited to the central timber members that carry the steel cables. In addition weeds may need to be periodically removed from the soil beds. If the plants are not controlled and maintained, they will obscure the form of the barrier and withhold the ability to see into the field via the gaps in the barrier.

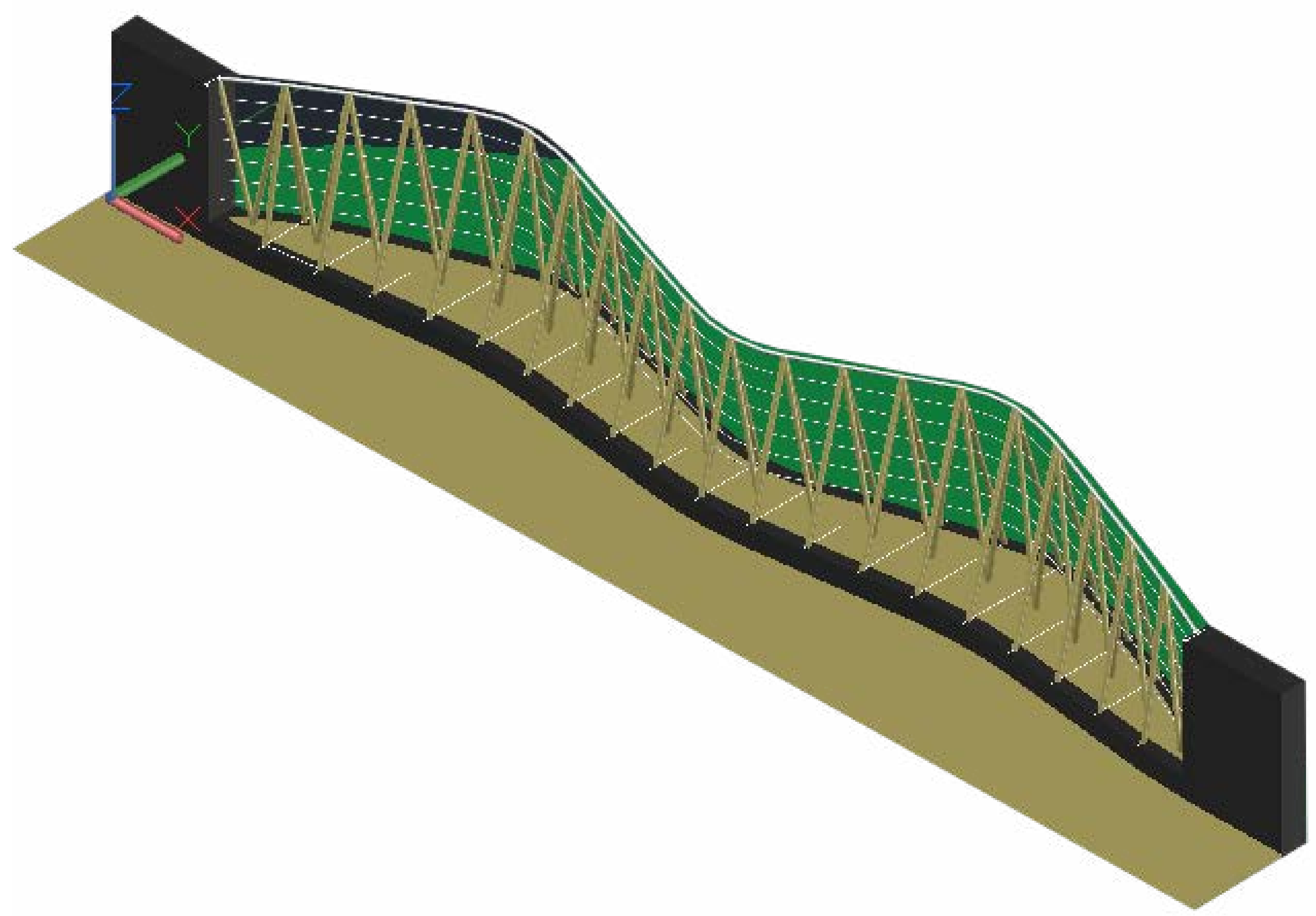
Modeling



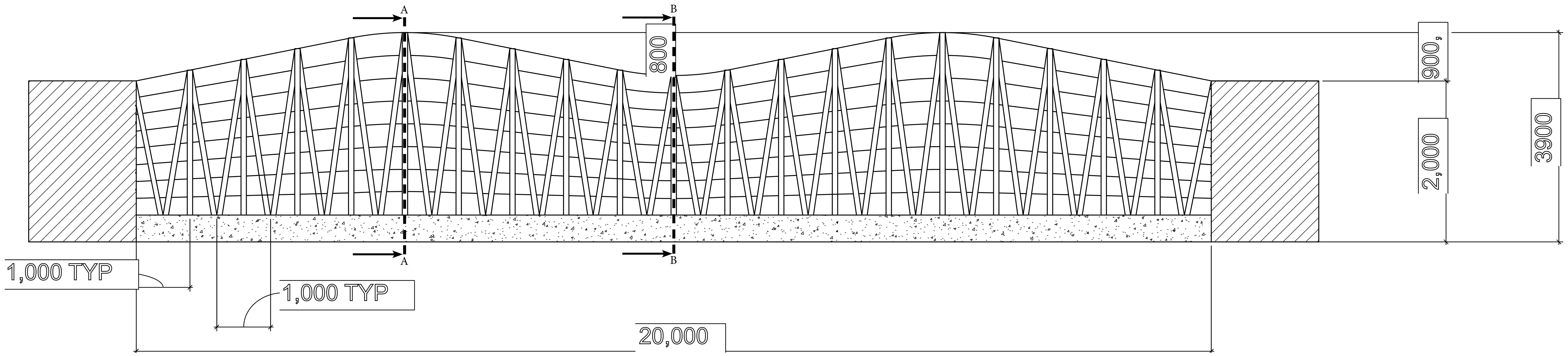
PLAN VIEW (1:50)



3D Model



ELEVATION: FACING FIELD (1:50)



Construction Method

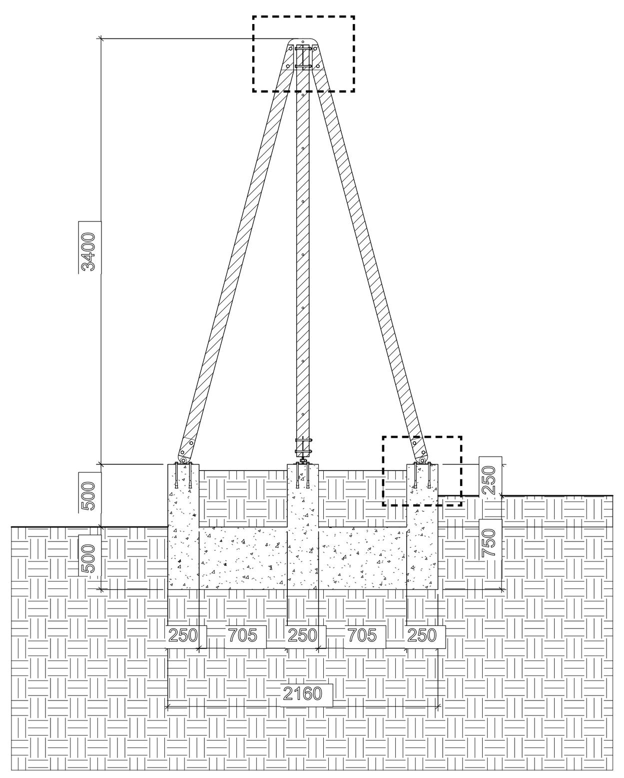
Prior to construction, the round timber poles are cut to the lengths and angles required for each position. In addition, they have slits cut in the ends to accommodate the connection points as shown in Section A:A Detail 1 and 2. Holes on the central poles for the cables are also pre-drilled. The steel plate for the connection points is machined to shape and welding carried out to join the perpendicular plates as shown in Detail 1, and the vertical half round pieces to the base plate as per detail 2. After fabrication the components are galvanized.

After clearing the remains of the old wall, the trench for the foundation is dug to a depth of 0.5m. Since the foundation follow the shape of the wall, the trench dug will be roughly the area shown by the plan view. Wooden form-work is then constructed in the exact shape of the base, using the edge of the existing wall a datum for measurements. Initially, the form work will take the shape of the outer edges only, and will rise 1.2m from the base of the trench. Concrete is then poured until a depth of 0.5m is achieved (level with the pavement). Once this is set, form-work for the flower bed channels can be constructed. After thorough surface preparation to ensure a good bond, concrete is then poured into this form-work to a depth of 0.5m, making the total depth 1m. Once set, the form-work is removed and then flower bed channels are filled with soil.

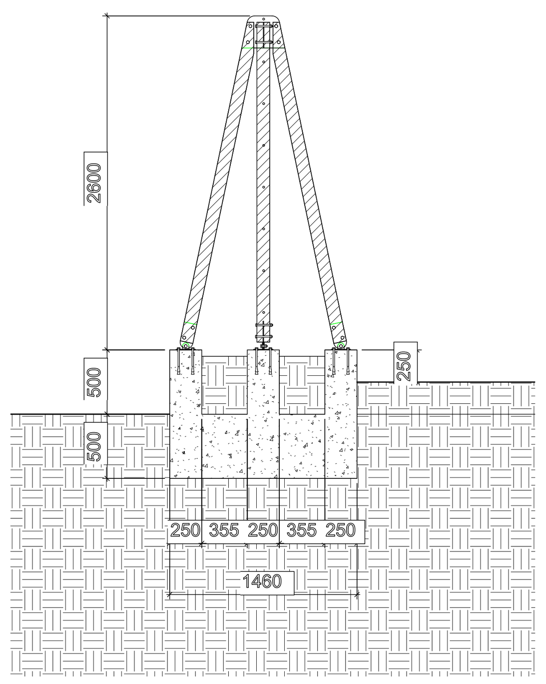
With the foundation and lower wall constructed, the base connection points are fitted to the concrete in the required positions using M12 expansion bolts as shown in Section A:A Detail 2. The steel plates are then positioned in the slits in the ends of the timbers, drilled and bolted. The poles can then be attached to the base, and then attached to the top connection point in conjunction with three other poles (four per top connection point).

Once all poles are erected, the stainless steel cables can be passed through the holes in the central poles and connected to studs which are glued into the side of the existing wall. Connection it achieved using bottle screws which are then adjusted to give a slight tension, and locked in position.

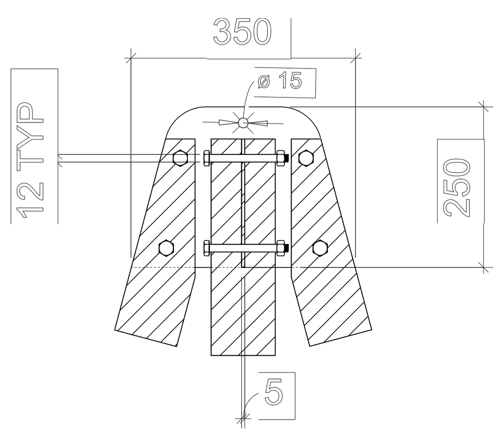
SECTION A:A (1:50)



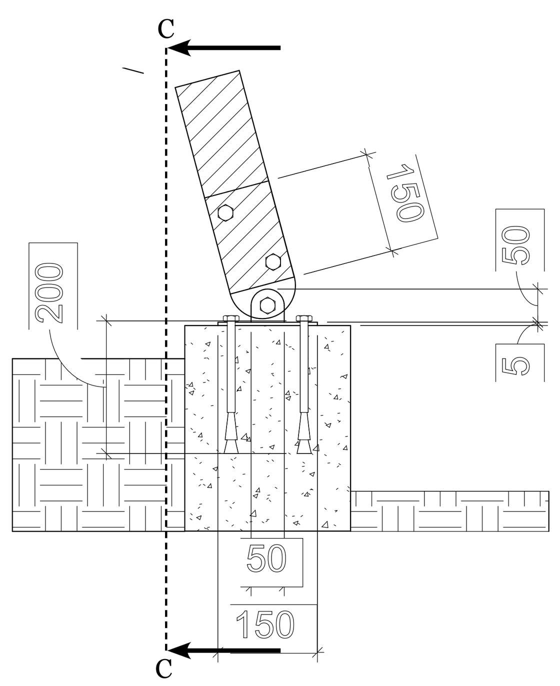
SECTION B:B (1:50)



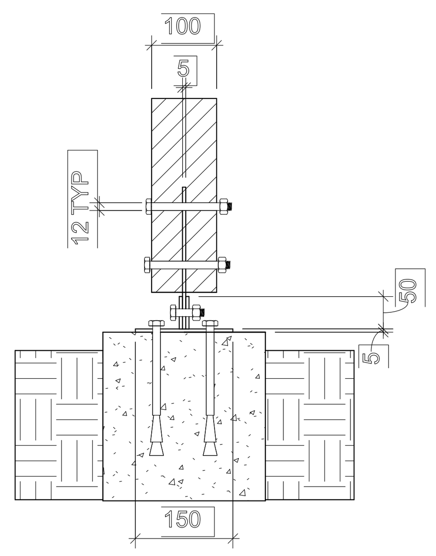
DETAIL 1 (1:10)



DETAIL 2 (1:10)



DETAIL 2 - Section C:C (1:10)



Foundation Design

Safe Bearing Capacity of ground up to 1m depth = 50kN/m2

Wind load applied = 1.2kN/m2

Stress on ground = self-weight of barrier and foundation + wind load

Calculations for each meter of the barrier have determined that the maximum stress will occur at the widest section of the barrier (Section A:A). Hence, only the calculations for this section will be demonstrated here.

Per Meter of barrier there are four timbers, four base connection points and one top connection point.

Densities: Concrete = 24kN/m3 Pressure treated pine = 5.7kN/m3 5mm Steel Plate = 0.385 kN/m^2

Timbers (100mm Diameter Poles): W/meter = 0.61kN
Steel (5mm Plate Throughout): W/meter = 0.133kN

Concrete: W/meter = 51.84kN
Total weight of barrier: W = 52.58kN

Wind load = ((0.1 x 3 x 3.4)+(0.5x1)) x 1.2 = 1.82kN

Total stress under the foundation:
$\sigma = P/A +/- M/Z$

Pressure, P = Weight = 52.58kN

Area, A (assuming flat sides) = 2.16 m^2

Moment, M = wind load x lever arm
= 1.82 x (3.9/ 2) = 3.55kNm

Z = bd^2/6 = (1 x 2.16^2)/6 = 0.78

$\sigma_{(B:B)}$ = 52.58/2.16 + 3.55/0.78 =28.9kN/m2
$\sigma_{(B:B)}$ =52.58/2.16 – 3.55/0.78 = 19.8kN/m2
In both cases, $\sigma < 50$kN/m2

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