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Executive Summary

We were appointed to advise on the foundation size for two sculptures. Our calculations check (1) the foundation size for equilibrium under horizontal loading and (2) the fixings to foundation by comparison to a proprietary product (appended).

DESIGN
The foundation is to be mass concrete C25/30 or greater (due to fixings). Gross dimensions 1000 x 1000 x 500mm (H) but for the “top section” which is the upper 150mm, it only needs to be 480 x 480 (centred) or 480mm diameter (centred). The remainder of the “bottom section” can be concealed by top soil and grass (Figure 2). If there is a construction joint between top and bottom section the casting face must be rough (Eurocode defines this as 3mm of roughness every 40mm)

Unfortunately the existing foundation will need to be broken out and rebuilt. It cannot be economically extended as it is too shallow.

KEY ASSUMPTIONS
Dimensions:- taken as most onerous from each sculpture (Figure 3).

Load Cases:- include (1) wind, (2) two adults climbing on the structure and (3) from Eurocode 1 for “horizontal loads on parapets and partition walls acting as barriers”.

Specifically we have used the load case for “footways or pavements greater than 1.5m wide adjacent to sunken areas”. We speculate that this load is for say a mobility scooter crashing off a path into the sculpture.

Arguably this load case is not mandatory as the sculpture is not a partition wall so we believe some judgement is allowed. The width of the path varies so we have used the modal width (i.e. what we believe is the most common) as the best approximation of people flows. A more onerous load case which was 200% could have been used but was deemed in our judgement as unreasonable.

The Client wishes to conceal the foundation as much as possible. Therefore the “top section” has been made as small as possible governed by the requirements of the fixings (concrete break-out). An allowance of 150mm has been made for top soil and grass. Then below this the size of the “bottom section” is governed by the equilibrium checks.

Figure 1: Kaleidoscope (left) to be installed in Regent's Place and Teleidoscope (right) in Cumberland Market

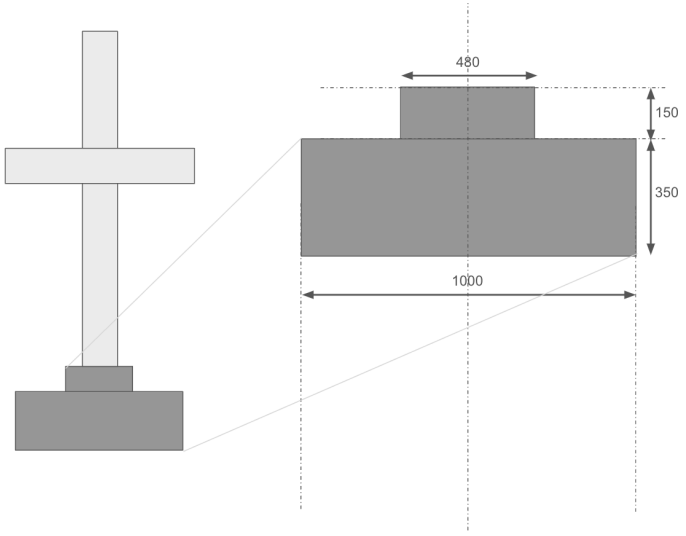

Figure 2: Foundation to be 1000 x 1000 x 500mm (H) but for the top 150mm it can be 480 x 480 or 480mm diameter. Use C25/30

Introduction

USAGE
This document has been produced for Your exclusive use for the purposes and at the address specified above and should not be used in whole or in part by any third parties without written permission from 99 Structural Engineers Ltd.

INFORMATION YOU PROVIDED
You provided us the following information by email on Thu 20 Mar, 14:57
- The weight and gross dimensions of the sculptures (Figure 3)
- The baseplate size and fixing details (Figure 4)
- The location of the Kaleidoscope (Figure 5)
- An aspiration that the foundation is not visible.

SERVICES INCLUDED
Our Services include:
- wind calculation for local site conditions
- check on foundation size for equilibrium under lateral loading
- calculation of required Hilti fixing into concrete as a comparison
- calculations for Building Control

SERVICES EXCLUDED
Services by AN Other to include:
- temporary works
- fire protection
- RC detailing
- fixings
- waterproofing

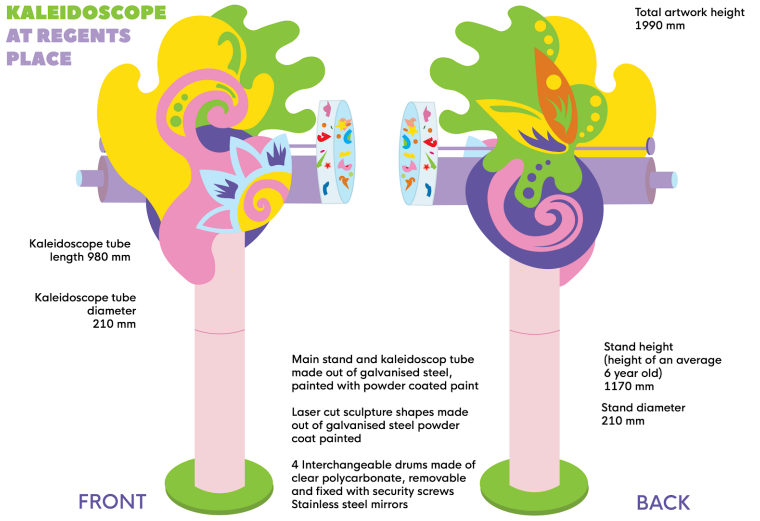

Figure 3: Kaleidoscope is 1990mm tall and weighs 115kg. Teleidoscope is shorter and heavier but wider 1127mm wide.

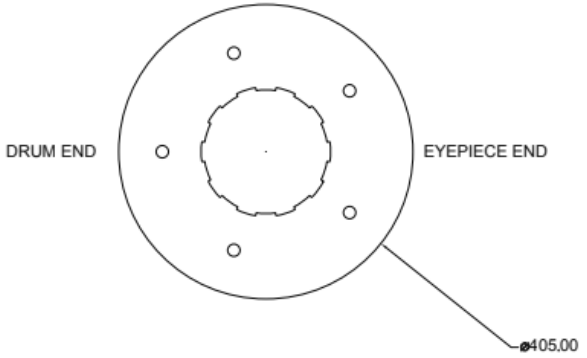

Figure 4: Kaleidoscope baseplate is 8mm plate, 405mm diameter. Fixings into foundation are M16 stainless steel, 200mm long

Wind Loading

The wind loads are calculated to BS EN 1991.

Wind Calculation - Lateral Wind Forces on Sculpture
location = London
L_shore = 40 km
A_alt = 47.0 m
c_alt = 1.047
v_b,map = 21.4 m/s
v_b,0 = v_b,map x c_alt = 22.4 m/s ..fundamental basic wind velocity

Roof Type = flat
eaves type = sharp
L_building = 1,000mm
W_building = 1,000mm
H_eaves = 2,000mm
h_building = 2,000mm

c_dir = 1.00 ..225° clockwise from North
c_prob = [(1 - K x ln(-ln(1-p)))/(1 - K x ln(-ln(0.98)))]^n = 1.0 ..probability factor
v_b = c_dir * c_season * v_b,0 * c_prob = 22.4m/s ..basic wind speed
q_b = 0.5 x ρ_air x v_b^2 = 0.308kN/m^2 ..basic velocity pressure
location = Town
z = 49,000mm

c_e(z) = 2.80 ..exposure factor
from [BS EN 1991-1-4:2005+A1:2010 UK NA Figure NA.7]

c_e,T = 0.83 ..exposure correction factor
from [BS EN 1991-1-4:2005+A1:2010 UK NA Figure NA.8]

Wind Force on Sculpture (modelled as Panel)
c_pe (zone D) = 0.80
c_pe (zone E) = -0.70

c_size = 1.00 ..size factor
from [BS EN 1991-1-4:2005+A1:2010 UK NA Table NA.3]

c_dynamic = 1.00 ..dynamic factor
from [BS EN 1991-1-4:2005+A1:2010 UK NA Figure NA.8]

q_p = c_exposure x c_e,T x q_b = 0.72 kN/m^2 ..peak velocity pressure
p = 1.07kN/m2 ..

A_ref = 1.13m^2 ..reference area
F_w = 1.21kN ..resultant wind force

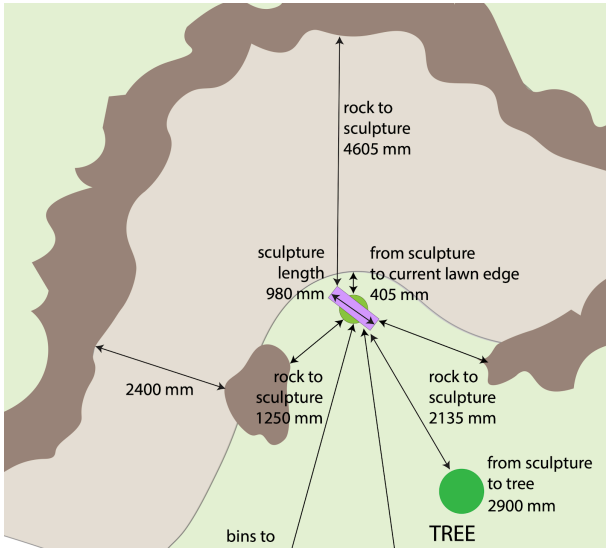

Figure 5: Kaleidoscope will be installed next to a footpath of typical width less than 3m. Teleidoscope assumed similar.

Horizontal Loading

To UK National Annex to BS EN 1991-1:2002 location is:
• Category C “Areas where people may congregate”
• C5 Areas susceptible to large crowds
• (ix) Footways or pavements greater than 1.5m wide adjacent to sunken areas (Table NA.8 “Horizontal loads on partition walls and parapets”)

THEREFORE design for 1.5 kN/m.

NOTE have not used category (x) as although the footpath varies in width the majority of the footpath seems to be less than 3m width so it would be a poor approximation for what the flow of people is likely to be like.

Regarding height of action (from BS EN 1991-1-1:2002 section 6.4 Horizontal loads on parapets and partition walls acting as barriers):
• Characteristic value of line load “acting at the height of the partition wall or parapets but not higher than 1.2m”
• Kaleidoscope and Teleidoscope are both set about 1.2m above ground level

THEREFORE load assumed to act at 1.2m above ground level.

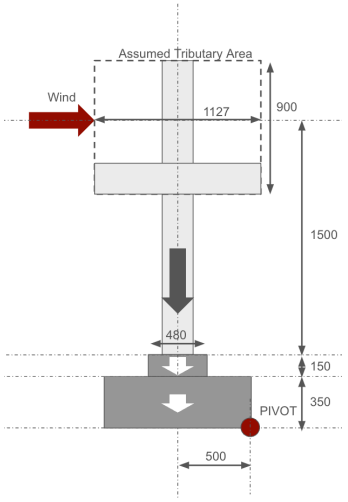

Figure 6: Loading Diagram for Wind Force (red arrow) about Pivot Point (red circle)

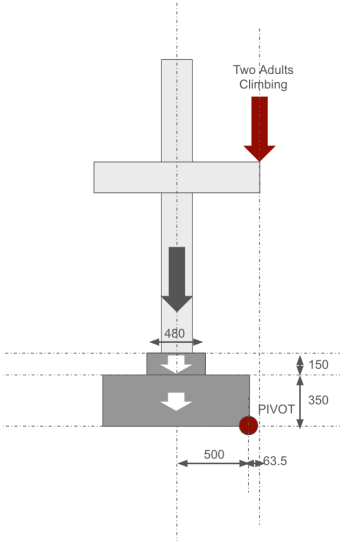

Figure 7: Loading Diagram for People Climbing (red arrow) about Pivot Point (red circle)

Foundation Size based on Equilibrium Load Combinations

Three load cases are considered of which the Eurocode Horizontal Load governs.

WIND LOAD - Overturning Check about Foundation (Figure 6)

Unfavourable Load Cases
0kM, Eurocode-Wind
L = 2.000m (lever-arm)
IL = 1.21kN
ULS = 1.82kN

...M_unfavourable = 3.6kNm

BY INSPECTION wind loading case does not govern

PEOPLE CLIMBING - Overturning Check about Foundation (Figure 7)

Unfavourable Load Cases
0kM, Two Persons Climbing
L = 0.064m (lever-arm)
IL = 1.80kN
ULS = 2.70kN

...M_unfavourable = 0.2kNm

BY INSPECTION people climbing does not govern

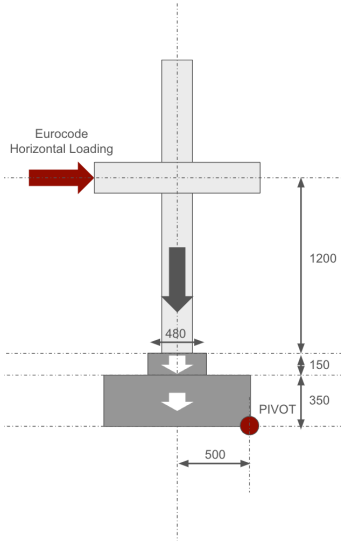

Figure 8: Loading Diagram for Horizontal Load (red arrow) about Pivot Point (red circle)

HORIZONTAL LOAD - Overturning Check about Foundation (Figure 8)

Unfavourable Load Cases
0kM, Eurocode-Horizontal
L = 1.700m (lever-arm)
IL = 1.69kN
ULS = 2.54kN
...M_unfavourable = 4.3kNm

Favourable Load Cases
0kM, Kaleidoscope-Gravity
L = 0.500m
DL = 1.13kN
ULS = 1.02kN

0kM, Foundation-Gravity
L = 0.500m
DL = 0.86kN
ULS = 0.78kN

: 0kM, Foundation-Gravity
L = 0.500m
DL = 8.75kN
ULS = 7.88kN
...M_favourable = 4.8kNm

M_unfavourable = 4.3kNm
M_favourable = 4.8kNm
...PASS (overturning) = 1.122 > 1.00 FOS required

FOUNDATION works if bottom section is 1000 x 1000 x 500 (H)

with top section 480 x 480 x 150 (H)