466.

Inflatables

Introduction

It has come to the attention of the industry that there are a number of issues associated with the implementation of BS EN 14960 - 2013 and that further and better information has become available. In particular there appears to be some uncertainty regarding the number and location of anchor points. The intention of this bulletin is to clarify a number of points and update the industry.

Definition

The information contained within this TB is to be applied to the inspection of inflatable (bouncy) devices. These are defined as a structure relying on a continuous supply of air to maintain its shape, on or in which users bounce and/or slide.

Such devices as “Last man standing” or “Dash and Grab,” although based around an inflatable element, fall into the definition of “other inflatables” and are an amusement device and require full PUI. This TB does not apply to these types of devices.

BS EN 14960 – 2013

Calculation of ground anchors

The formula for the calculation of the number of ground anchors is given in Annex A. The force is calculated for each face of the device, for ease of reference:

F=Cw ρ/(2) V^2 A

Where F = Force (in Newtons)

Cw = wind coefficient (or shape coefficient)

ρ = density of air

V = maximum wind speed

A = area of exposed surface (or projected area)

Using the following values

Cw = 1.5

ρ = 1.24 kg/m3

V = 11.1 m/s

The number of anchor points required on this side = F/1600 1.5 Rounded up as necessary.

Where 1.5 is a safety factor

This assumes that the ground anchor (or equivalent ballast) will provide an anchorage force of 1600N. As per clause 4.2.1.

Note corner anchors count 50% on each side.

Interpretation

Many bouncy castles have an open side to allow access and egress. It would appear that this has been interpreted to mean that the area of the step only is the exposed area. This would lead to a situation where no anchors would be required on the front face. Similarly, with slides it has been assumed that there is no front face and therefore the front edge has not been secured correctly. To be clear, in order to calculate the number of anchors required on any one side of the structure, the calculation of the area of the exposed surface includes all parts of the inflatable structure exposed to the wind in the direction normal to the side under consideration, even if they are not directly attached to the side under consideration.

It is understood that anchor points on an edge used for access/egress could become an additional hazard, but arrangements will need to be made to protect these. This could be by either fixing them under the front edge (EN 14960 fig 8) or by adding some protection in the form of an “apron” of impact attenuating material. The design of any anchor points that are protected and thus possibly hidden will need to consider access for regular inspection, especially if the device is maintained at the same location for a number of days.

See worked examples 1 and 2. In undertaking these worked examples the projected area has been equated to the overall size of the side, for ease of calculation, but also to enhance the factor of safety.

It is possible that, for limited widths of inflatables no anchors will be required along the front edge and that two corner anchors are sufficient. See worked example 3. It is understood that typically the “corner” anchors could be positioned about 300mm from the actual corner but these will still provide 50% support to each side, as per the foot note in Annex A of BS 14960.

Distribution

It can be seen from the examples that the distribution or the position of the anchors along any one side can be improved by spacing the anchors at equal distances along the side.

High level anchor points

It is recognised that high level anchor points can be very effective in securing inflatables. In particular they are very useful against overturning. However, depending where on the device these are secured then the force in the tether could easily exceed the force recommended in the standard. Should the designer decide that they wish to take account of high-level anchors then they will have to undertake the appropriate calculations to demonstrate the forces in these anchor points; the guy lines and the ground anchor will have to be designed to correspond to the actual forces. However, if the simple rule in BS 14960 is to be used, then the resistance force of high-level anchors should not exceed 1600 N. BS EN 14960 - 2013 sets out in paragraph 4.2.1 that the ground stakes or ballast should be designed to withstand force of 1600 N, and therefore the value assigned to any high-level anchor point should not exceed this value.

Anchor points on hard standing surfaces

Where an inflatable is to be operated in an area where the surface is hard standing and one on which ground anchors cannot be used, then it will be necessary to provide ballast with the equivalent mass to the force provided by a ground anchor. That is the mass of the ballast should be equivalent to 1600 N. For ease, this equates to a mass of 160kg at each ground anchor point. A way of providing this mass might be by using water; again for ease this equates to 160 litres of water.

Domes

It has been found that the internal pressure within a dome can have a significant affect on the ground anchors. It appears that over inflation can lead to the dome becoming more of a spherical shape resulting in the edges of the floor lifting and producing an uplift force in the ground anchors. The internal pressure should be given in the O&M Manual. IBs should check to confirm this.
IBs undertaking an in-service inspection of these types of inflatable domes should assure themselves that there is a means of monitoring and regulating the internal pressure.

In-service inspection

It is normally outside of the scope of an in-service inspection for an IB to comment on the number of anchor points. However, given the present state of confusion over the number and location of anchor points it would seem sensible to undertake a review of the present stock of inflatables. As such, when carrying out any future inflatable in-service inspections, the IB should first try to determine from the O&M Manual (or any other relevant documentation or reports, if available) what the manufacturer recommends for the number of anchor points. If this is not possible then the IB will have to verify the correct number of anchor points themselves. If they are competent to do so they can undertake the calculation set out above. Alternatively, they or the device owner should arrange for another suitably competent IB or Consultant to carry out this work. If it is found, or the IB believes, that the inflatable does not have the correct number of anchor points or finds they are

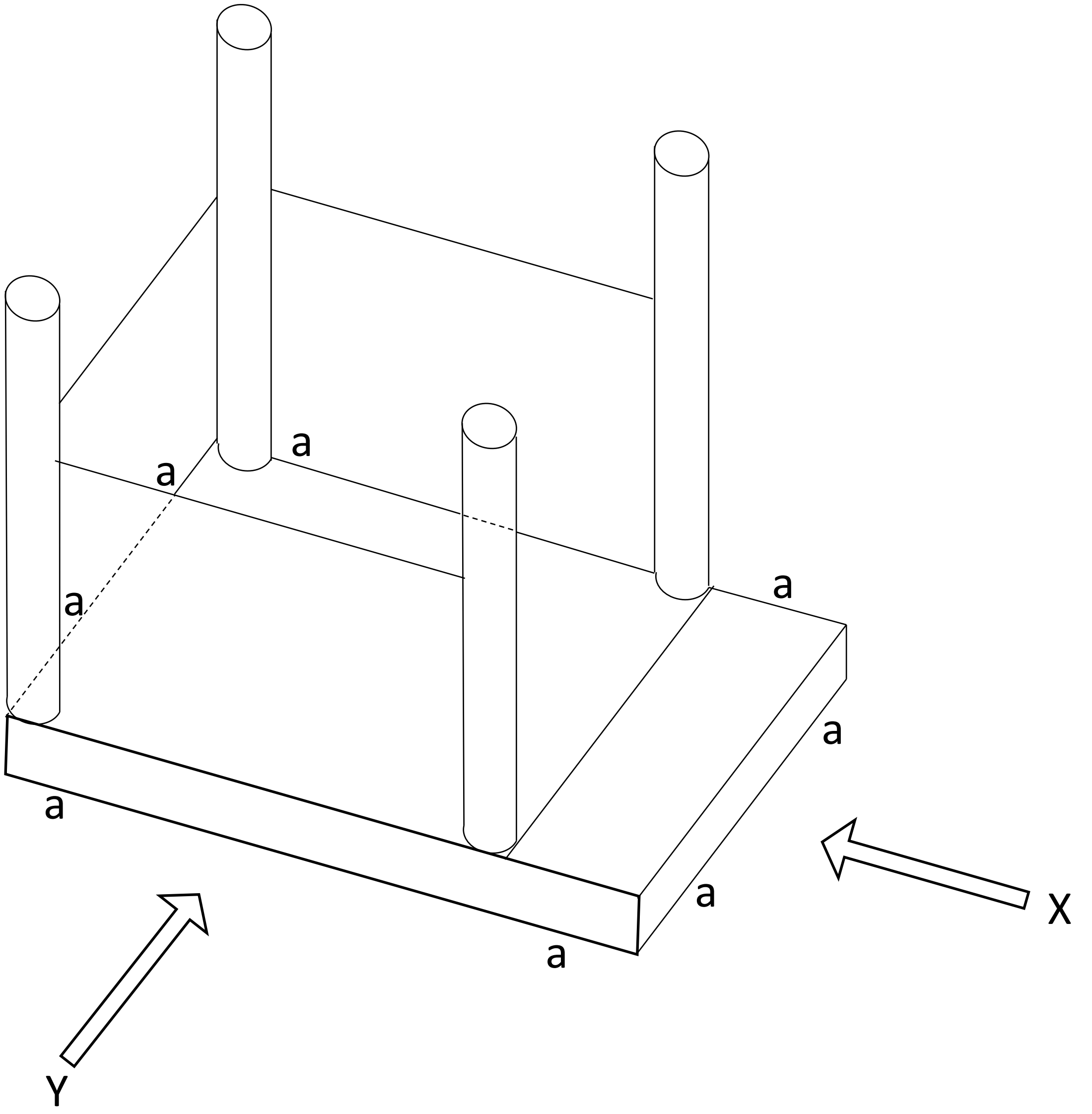
distributed incorrectly, then he should inform the controller. The controller will then have to refer the device to the original manufacturer/designer who will advise the controller of the modifications that are required. The IB, if they are competent to do so, will have to review this modification and confirm that the new arrangement is in compliance with BS EN 14960 - 2013. Again, if they do not consider they are competent to do this work, they or the device owner should arrange for another suitably competent IB or Consultant to carry out this work.
In addition, as part of the in-service inspection, it is expected that the IB will check that the correct number and type of ground anchors are available. It is understood that many inspections are undertaken at the premises of the controller, during the closed season when the device is not in use. Often the device will be just inflated and only partially pegged down. This is acceptable, but as stated above the IB will have to be presented with the correct number of ground anchors of the correct type and should note this in their report.

Wind speed

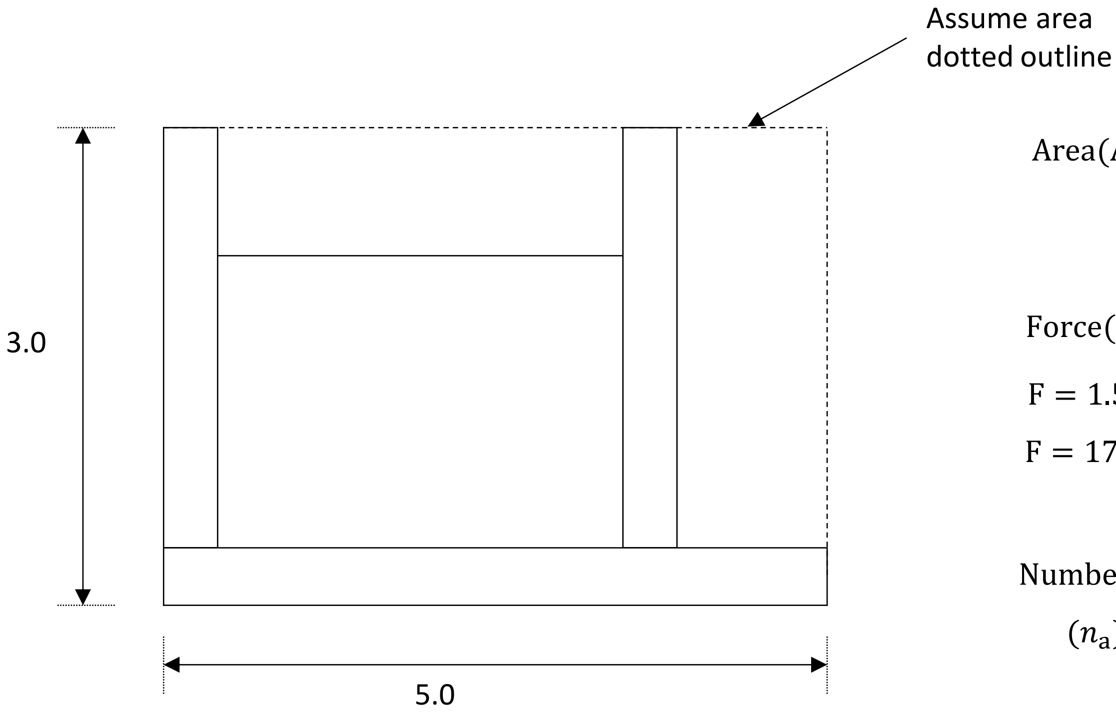
Controllers are reminded that these devices are extremely sensitive to small changes in wind speed. Also, that the location of the device with respect to other buildings or objects can affect the wind that the device is subject to. It is therefore recommended that a suitable anemometer should be used to monitor the wind speed throughout operating hours. It is recommended that the operator records the readings from the anemometer. Where necessary, the anemometer should be regularly calibrated or checked to ensure that it is reading correctly.

Worked Example 1:

Typical Bouncy Castle



Direction Y

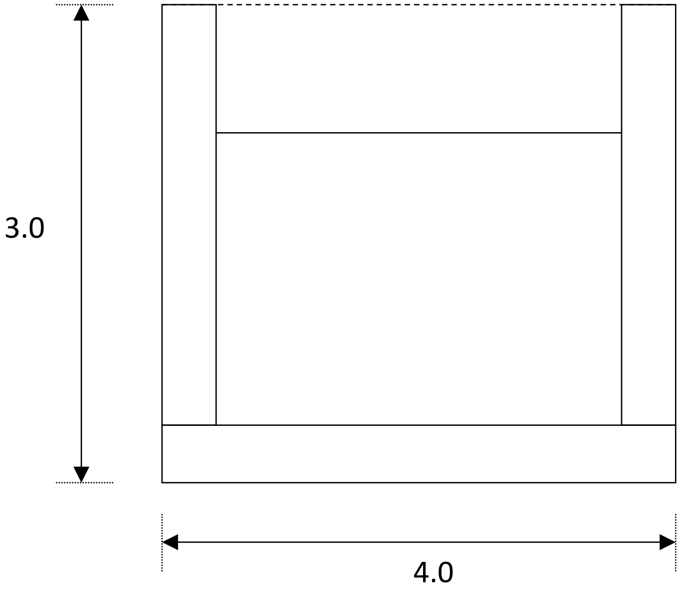


$$\text{Area(A)} = l \times w$$
$$\text{A} = 3 \times 5$$
$$\text{A} = 15\ \text{m}^2$$

$$\text{Force(F)} = \text{C}_w \frac{\rho}{2} v^2 \text{A}$$
$$\text{F} = 1.5 \times \frac{1.24}{2} 11.1^2 \times 15$$
$$\text{F} = 1718\ \text{N}$$

Number of Anchor Points
$$(n_\text{a}) = \frac{\text{F}}{1600} \times 1.5$$
$$n_\text{a} = \frac{1718}{1600} \times 1.5$$
$$n_\text{a} = 1.6$$
$$\text{Round Up } n_\text{a} = 2$$

Direction X



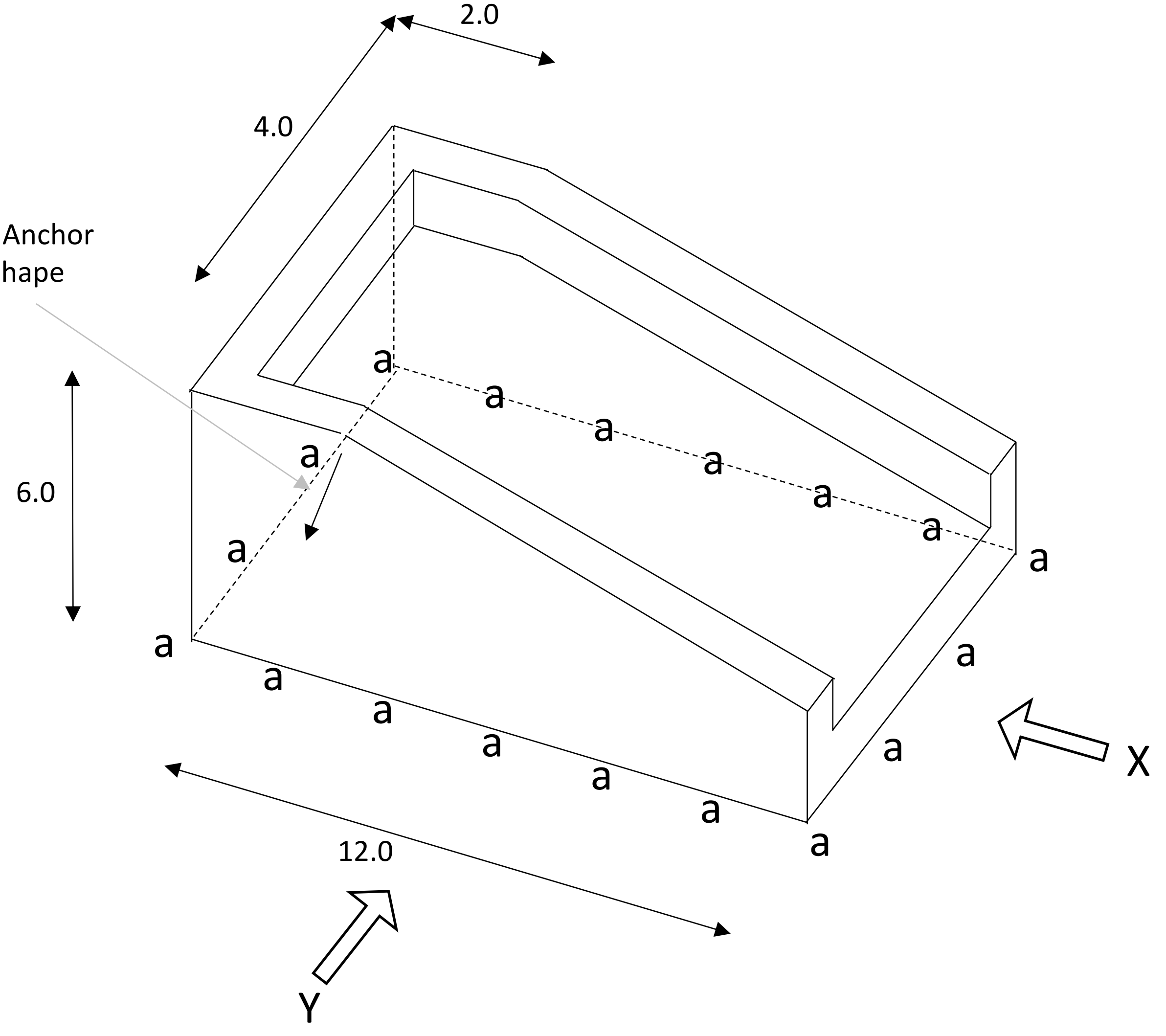
$$\text{Area(A)} = l \times w$$
$$\text{A} = 3 \times 4$$
$$\text{A} = 12\ \text{m}^2$$

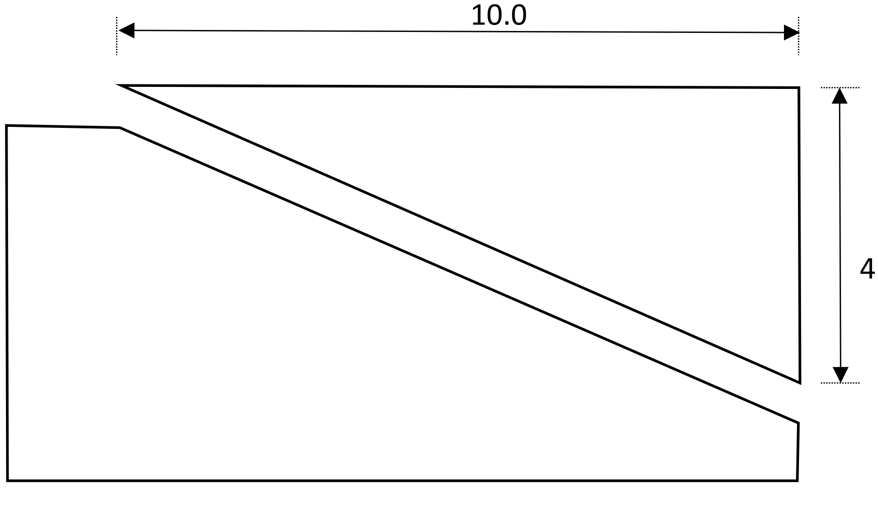
$$\text{Force(F)} = \text{C}_w \frac{\rho}{2} v^2 \text{A}$$
$$\text{F} = 1.5 \times \frac{1.24}{2} 11.1^2 \times 12$$
$$\text{F} = 1375\ \text{N}$$

Number of Anchor Points
$$(n_\text{a}) = \frac{\text{F}}{1600} \times 1.5$$
$$n_\text{a} = \frac{1375}{1600} \times 1.5$$
$$n_\text{a} = 1.28$$
$$\text{Round Up } n_\text{a} = 2$$

Worked Example 2:

SLIDE





Direction Y

$$\text{Area}(A) = l \times w$$

$$A = 6 \times 12 \ - \left(\frac{10 \times 4}{2}\right)$$
$$A = 52 \text{ m}^2$$

$$\text{Force}(F) = C_w \frac{\rho}{2} v^2 A$$
$$F = 1.5 \times \frac{1.24}{2} 11.1^2 \times 52$$
$$F = 5958 \text{ N}$$

$$\text{Number of Anchor Points } (n_a) = \frac{F}{1600} \times 1.5$$

$$n_a = \frac{5958}{1600} \times 1.5$$

$$n_a = 5.5$$

$$\text{Round Up } n_a = 6$$

Direction X

$$\text{Area}(A) = l \times w$$

$$A = 6 \times 4$$
$$A = 24 \text{ m}^2$$

$$\text{Force}(F) = C_w \frac{\rho}{2} v^2 A$$
$$F = 1.5 \times \frac{1.24}{2} 11.1^2 \times 24$$
$$F = 2750 \text{ N}$$

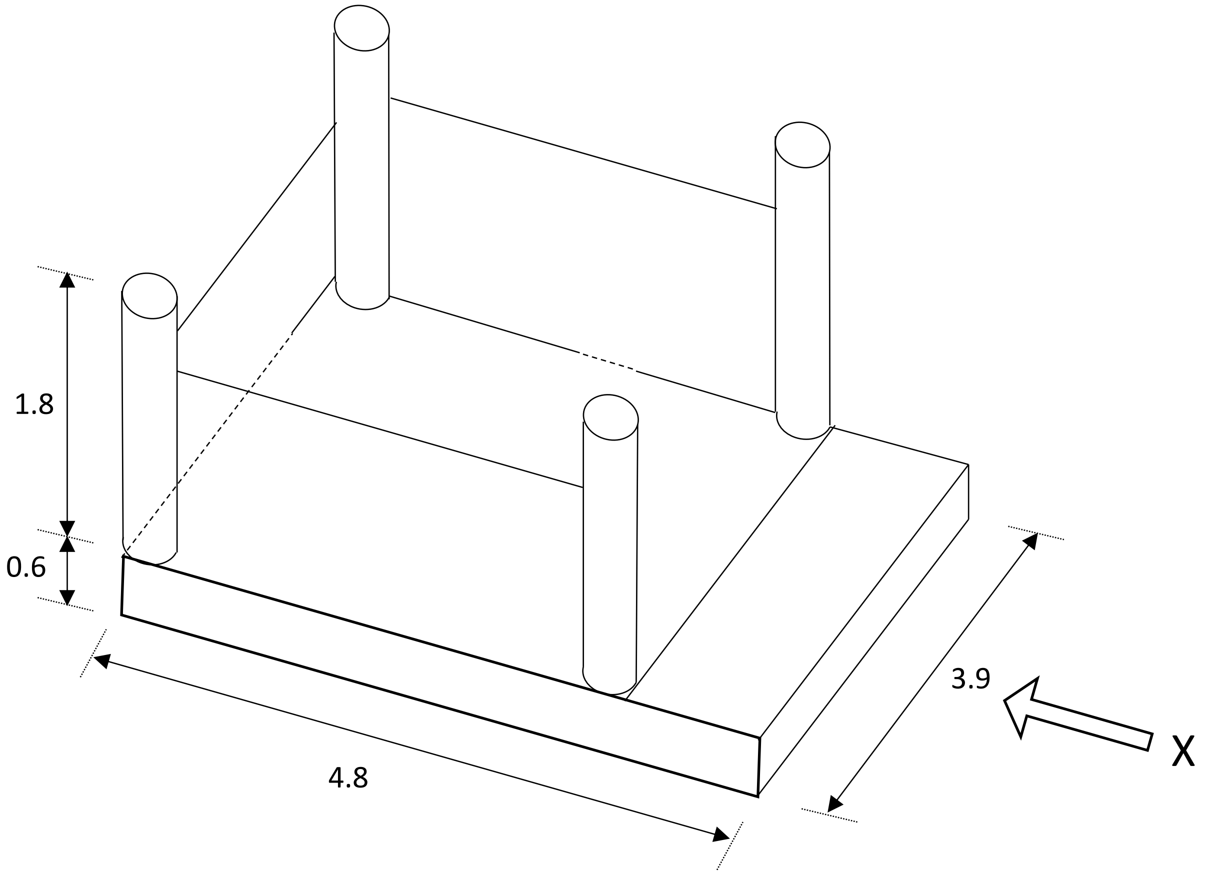
$$\text{Number of Anchor Points } (n_a) = \frac{F}{1600} \times 1.5$$

$$n_a = \frac{2750}{1600} \times 1.5$$

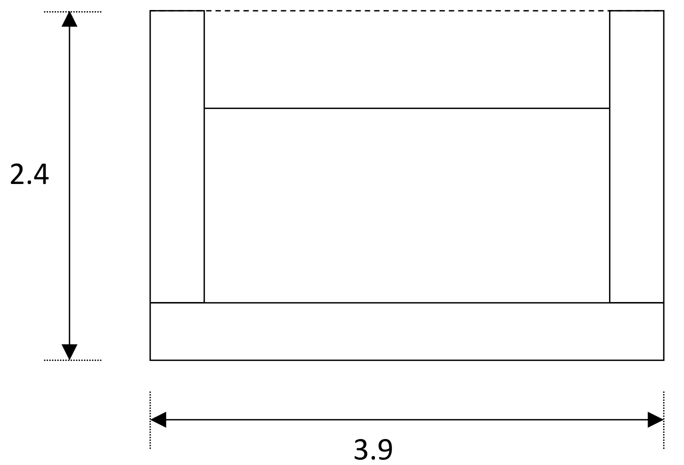
$$n_a = 2.5$$

$$\text{Round Up } n_a = 3$$

Worked Example 3:



Wind in ‘x’ direction



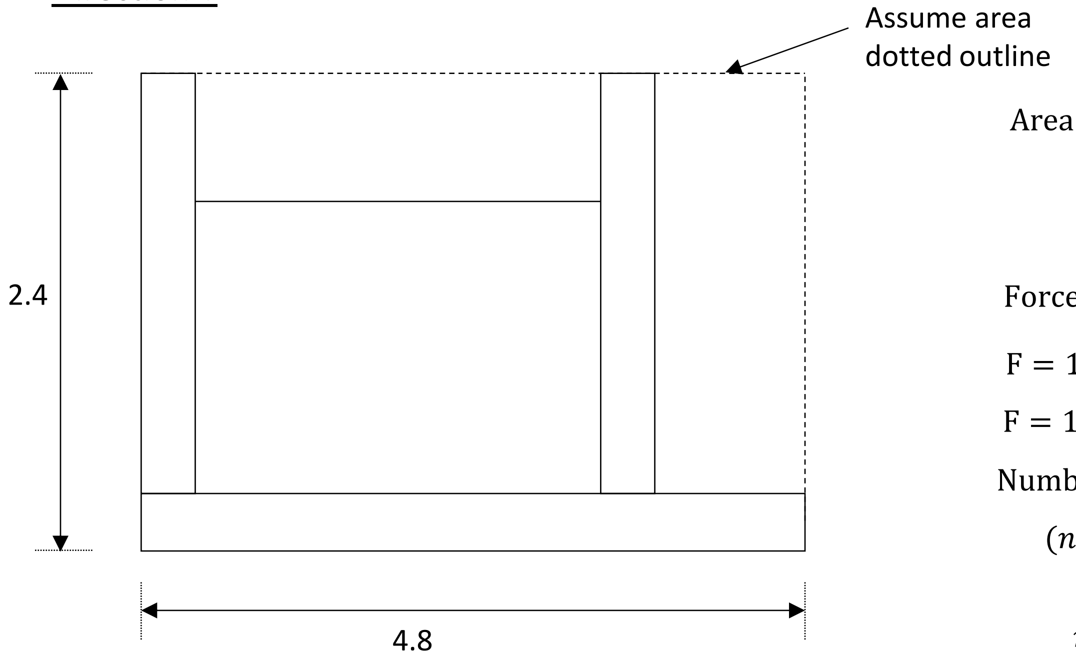
$$\text{Area}(A) = l \times w$$
$$A = 2.4 \times 3.9$$
$$A = 9.36\ \text{m}^2$$

$$\text{Force}(F) = C_w \frac{\rho}{2} v^2 A$$
$$F = 1.5 \times \frac{1.24}{2} 11.1^2 \times 9.36$$
$$F = 1072\ \text{N}$$

Number of Anchor Points

$$(n_a) = \frac{F}{1600} \times 1.5$$
$$n_a = \frac{1072}{1600} \times 1.5$$
$$n_a = 1.0$$
$$\text{Round Up } n_a = 1$$

<u>Direction Y</u>



$$\text{Area}(A) = l \times w$$
$$A = 2.4 \times 4.8$$
$$A = 11.52\ \text{m}^2$$

$$\text{Force}(F) = C_w \frac{\rho}{2} v^2 A$$
$$F = 1.5 \times \frac{1.24}{2} 11.1^2 \times 11.2$$
$$F = 1283.4\ \text{N}$$

Number of Anchor Points

$$(n_a) = \frac{F}{1600} \times 1.5$$
$$n_a = \frac{1718}{1600} \times 1.5$$
$$n_a = 1.2$$
$$\text{Round Up } n_a = 2$$