APOLLO SALES LTD
SITE SCAFFOLD STEP
DESIGN CHECK CALCULATIONS

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R0197/001

CALCULATION SHEET	Project :	Apollo Site Tread		ALAN WHITE DESIGN
	Element :	Brief		
	Job Number : R0197	By : anw	Date:Feb13	
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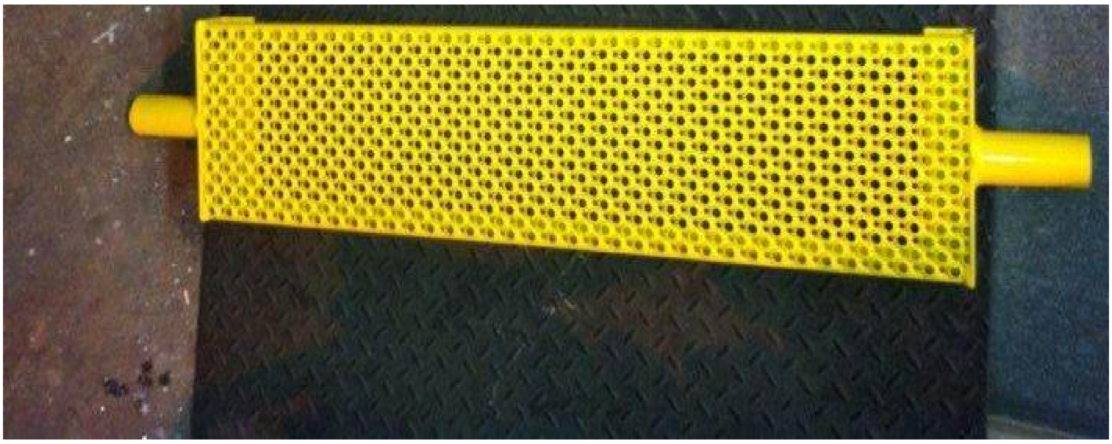
Brief

To carry out a design check on the Apollo Site Tread scaffold step
to the relevant Standards and Codes.

Layout

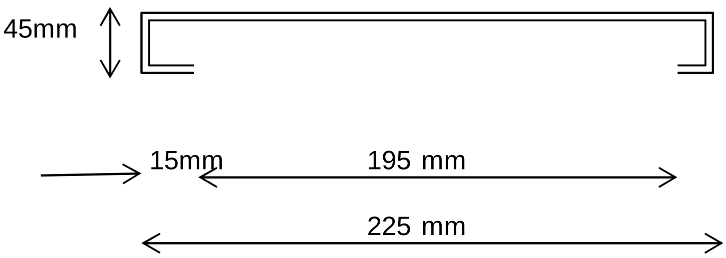


The step varies in length, supplied up to 1.5m wide tread
taking into account the connection the span is taken as 1.6m

The step is 225mm wide with a non slip grating.

Section

From BS 5395 Stairs Ladders and walkways the min going is 225mm



Loading

BS EN 12811-1 Cl6.2.4 Access routes

For stairways built for access to a working scaffold, each tread and landing shall
be designed to support the more unfavourable of:
either
a) a single load of 1,5 kN in the most unfavourable position, assumed to be
uniformly distributed over an area of 200 mm x 200 mm or over the actual width
if it is less than 200 mm,
or
b) an uniformly distributed load of 1,0 kN/m2.

The structure of the stairways shall be capable of supporting a uniformly distributed
load of 1,0 kN/m2 on all treads and landings within a height of 10 m.

Factor of safety

From BS EN 12811-1

1.1.1.1 Partial safety factors for actions, gF

Except where stated otherwise, the partial safety factors, gF, shall be taken as follows:

Ultimate limit state

γ_F **= 1,5 for all permanent and variable loads**

γ_F **= 1,0 for accidental loads**

Serviceability limit state

γ_F **= 1,0**

10.3.2.2 Partial safety factors for resistance gM

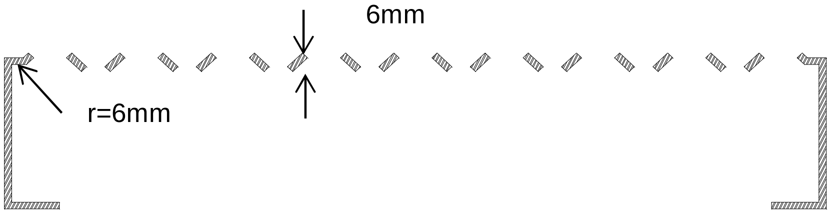
For the calculation of the design values of the resistances of steel or aluminium components the partial safety factor, . For components

γ_M**=1,1**

of other materials the partial safety factor, gM, is to be taken from relevant standards.

Section properties

From autocad massprop using the section as shown below
This is conservative as the section chosen is the minimum



$A=$ 441 mm2
$I_x=$ 123982 mm4
$I_y=$ 3691175 mm4
$r_x=$ 16.8 mm
$r_y=$ 91.5 mm
$W_{el,x}=$ 4129 mm3
$W_{el,y}=$ 32810 mm3

Slenderness $C/t=$ 213/6 $\quad C=$ 225-2*6
$=$ 213mm
$t=$ 6mm
$=$ 35.50

Section is class so plastic design allowable but elastic design chosen

Material is mild steel fy=275N/mm2

Moment capacity

From BS EN 1993-1-1- 6.2.5

$M_{c,Rd}= W_{el}f_y/\gamma_{M0}$ $\quad W_{el}=$ 4.13cm3
$f_y=$ 275N/mm2
$\gamma_{M0}=$ 1.1

$=$ 4.13*275/1100
$=$ **1.03** kNm

Shear capacity From BS EN 1993-1-1- 6.2.6

$V_{c,Rd}= A_v(f_y/\text{sqrt}(3))/\gamma_{M0}$

Av= 2*45*2
$=$ 180mm2
$f_y=$ 275N/mm2

$=$ 180*(275/sqrt(3))/1100
$=$ **25.98 kN**

Lateral Torsional Buckling

From BS EN 1993-1-1- 6.3.2.1

As bending is about minor axis LTB verification is not required.

Loading

As before

UDL on stair	w=	1.00	kN/m2
and point load	W=	1.50	kN on 200mm by 200mm

Moment

so for UDL on 225mm wide stair with span of 1.6m

M_{Ed}= γ.w.B.L^2/8 γ= 1.5

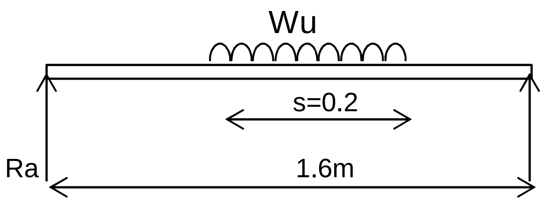
w= 1kN/m2
B= 0.225m
L= 1.6m

= 1.5*1*0.225*1.6^2/8
= **0.14 kNm**

for a point load of 4kN over a width of 200mm

Wu= γW γ= 1.5

= 1.5*1.5
= 2.25 kN



Ra= Wu/2 Wu= 2.25kN
= 2.25/2
= 1.13

M_{Ed}= Ra.L/2-γ.Wu.s/16

s= 0.2m
Wu= 2.25kN
B= 0.225m
L= 1.6m

= 1.13*1.6/2-2*2.25*0.2/16
= **0.85 kNm**

from previous calculations

$M_{c,Rd}$= **1.03 kNm**
> **0.85** **ok**

Shear

so for UDL on 225mm wide stair with span of 1.6m

V_{Ed}= γ.w.B.L/2 γ= 1.5

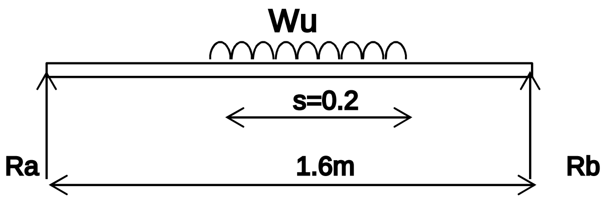
w= 1kN/m2
B= 0.225m
L= 1.6m

= 1.5*1*0.225*1.6/2
= 0.27 kN

for a point load of 4kN over a width of 200mm

Wu= γW γ= 1.5

= 1.5*1.5
= 2.25 kN



Ra= Wu/2 Wu= 2.25kN
= 2.25/2
= 1.13

V_{Ed}= Ra
= **1.13 kN**

from previous calculations

$M_{c,Rd}$= **25.98 kN**
> **1.13** **ok**

Deflection

for central point load of 1.5kN

d= $WL^3/48EI$ W= 1.5kN
L= 1.6m
E= 205kN/mm2
I= 123982mm4

= 1500*1600^3/(48*205E3*123982)
= **5.04** **mm**

From BS EN 12811-1 the max deflection is

d= L/100 L= 1600mm
= 1600/100
= **16.00 mm**
> **5.04** **ok**

Rotation

If the loading was eccentric, ie at the step edge the moment applied to the support couplers would be

M= Wu.la **Wu= 2.25kN**
la= 0.225/2
= 0.11m

= 2.25*0.11
= 0.248 kNm

This is conservative as the load is spread over a patch not a point.

this is resisted by two couplers so the twisting moment is

M= 0.124 kNm

From BS EN 12811-1 the resistance to rotation of a double coupler is

Mr= 0.130 kNm
> 0.124 ok

If the load is considerd as a patch 200mm wide on a 225mm wide step then the eccentricity

la= 225/2-200/2
= 12.50 mm

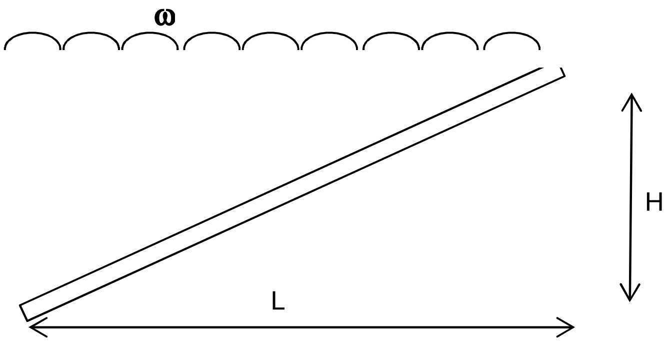
and M= Wu.la
= 2.25*0.0125
= 0.03 kNm
<< 0.13 ok

Length of stringer

From BS EN 12811-1, the load on the stringer is :

The structure of the stairways shall be capable of supporting a uniformly distributed load of 1,0 kN/m2 on all treads and landings within a height of 10 m.

so the stringer will carry the load as shown below



where
for one stringer w= 1.0kN/m2*1.6m/2
= 1*1.6/2
= **0.80 kN/m unfactored**

and L= length between stringer supports
H= height varies with angle between 30 and 55 deg

taking allowable values from TG20 as

Moment M= 1.1 kNm
Axial P= kN for 8m

Angle ^{o}	Moment kNm	Axial kN	Combined	Length m
30	0.96	1.33	1.00	2.88
35	0.93	1.55	1.00	2.76
40	0.90	1.76	1.00	2.62
45	0.85	1.97	1.00	2.46
50	0.81	2.17	1.00	2.28
55	0.75	2.37	1.00	2.07

Above table found by Excel Goal seeking

Summary

The scaffold step has been checked for the required loading
and found to be adequate for a maximum width of 1.5m.

Loading from BS EN 12811-1 Cl6.2.4 Access routes

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either
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The stringer which supports the steps requires to be supported by standards at a spacing as shown in the table below dependant on the angle of the stair.

Angle Degrees	Standard Spacing m
30	2.88
35	2.76
40	2.62
45	2.46
50	2.28
55	2.07