APOLLO SALES LTD
PUBLIC ACCESS SCAFFOLD STEP
DESIGN CHECK CALCULATIONS

Alan N White B.Sc., M.Eng., C.Eng., M.I.C.E., M.I.H.T.

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Somerset House
11 Somerset Place
GLASGOW G3 7JT
Tel:0141 354 6579
Fax:0141 354 6549

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Brief

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

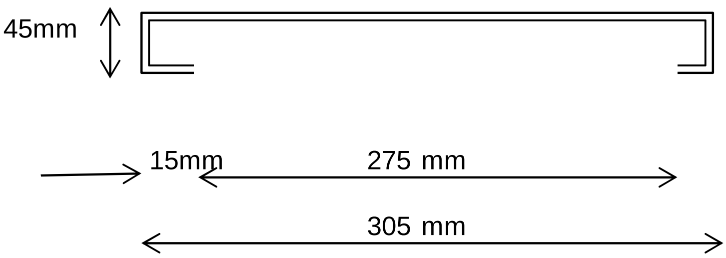
Layout

The step varies in length, supplied up to 1.5m wide tread

The step is 305mm wide with a non slip grating, non-see through grating.

Section

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



Loading

BS EN 1991-1-1 Table NA.3

UDL	w=	3.00 kN/m2
Point load	W=	4.00 kN
on 200 by 200mm		

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

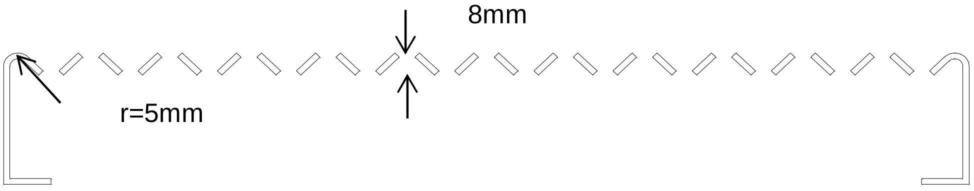
For the calculation of the design values of the resistances of steel or aluminium components the partial safety factor, . For components

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



$A=$ 732 mm2

$I_x=$ 145250 mm4

$I_y=$ 9054649 mm4

$r_x=$ 14.1 mm

$r_y=$ 111.2 mm

$W_{pl,y}=$ 8236 mm3

Slenderness $C/t=$ 291/8 C= 305-2*2-2*5
= 291mm
t= 8mm

= 36.38
< 38.00

Section is class 2 so plastic design allowable

Material is mild steel fy=275N/mm2

Moment capacity

From BS EN 1993-1-1- 6.2.5

$M_{c,Rd}= W_{el} f_y / \gamma_{M0}$

$W_{el}=$ 8.24cm3
$f_y=$ 275N/mm2
$\gamma_{M0}=$ 1.1

= 8.24*275/1100
= 2.06 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= 3.00 kN/m2
and point load W= 4.00 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

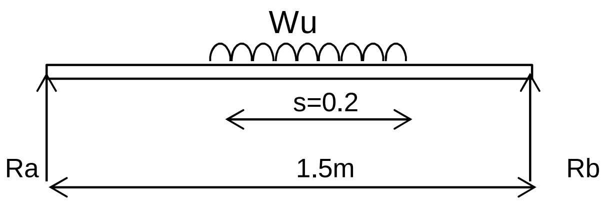
w= 3kN/m2
B= 0.305m
L= 1.5m

= 1.5*3*0.305*1.5^2/8
= **0.39 kNm**

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

Wu= γW γ= 1.5

= 1.5*4
= 6.00 kN



Ra= Wu/2   Wu= 6kN
= 6/2
= 3.00

M_{Ed}= Ra.L/2-Wu.s/4

s= 0.2m
Wu= 6kN

L= 1.5m

= 3*1.5/2-6*0.2/4
= **1.95 kNm**

from previous calculations

$M_{c,Rd}$= **2.06 kNm**
> **1.95**   **ok**

Shear

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

V_{Ed}= γ.w.B.L/2 γ= 1.5

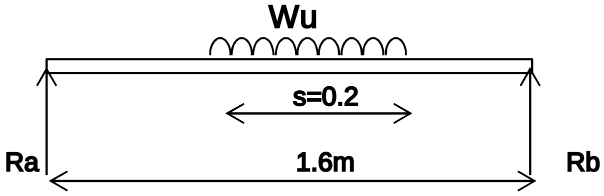
w= 1kN/m2
B= 0.225m
L= 1.6m

= 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

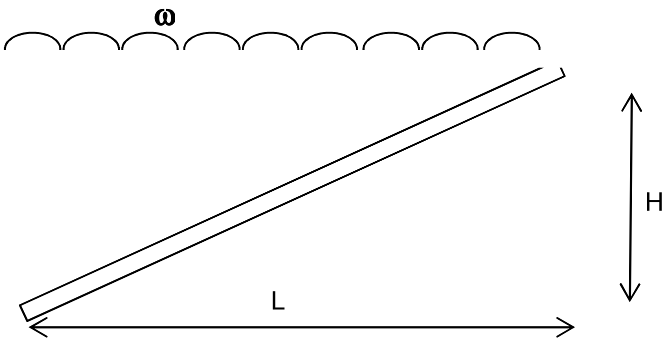
and M= Wu.la
= 2.25*0.0125
= **0.03 kNm**
<< **0.13** **ok**

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.
but the load on the tread is 3kN/m

so the stringer will carry the load as shown below



where
for one stringer w= 3.0kN/m2*1.5m/2
= 3*1.5/2
= **2.25 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= varies as below

Angle ^{o}	Moment kNm	Axial kN	Combined	Length m
30	0.84	3.37	1.00	2.59
35	0.83	3.79	1.00	2.40
40	0.81	4.17	1.00	2.21
45	0.80	4.51	1.00	2.00
50	0.79	4.82	1.00	1.80
55	0.78	5.09	1.00	1.59

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 1991-1-1 Table NA.3

UDL	w=	3.00	kN/m2
Point load	W=	4.00	kN
on 200 by 200mm			

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	2.59
35	2.40
40	2.21
45	2.00
50	1.80
55	1.59