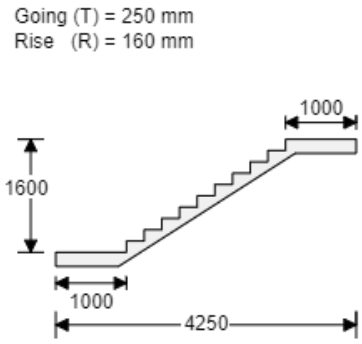
1.0 INPUT

1.1 Dimensions

Height of Staircase	H	= **1600** mm
No of Risers in Flight	N_{step}	= **10** Nos
Rise	R	= **160** mm
Going	T	= **250** mm
Length of Upper Landing	L_u	= **1000** mm
Length of Lower Landing	L_l	= **1000** mm



1.2 Sizes

Waist Slab Thickness	h_{span}	= **200** mm
Upper Landing Thickness	h_u	= **200** mm
Lower Landing Thickness	h_l	= **200** mm

1.3 Support Condition

Upper Landing Support Condition	s_{cu}	= **Simple**
Lower Landing Support Condition	s_{cl}	= **Simple**

1.4 Loads (Unfactored)

Characteristic Imposed Load	Q_k	= **4** kN/m^2
Characteristic Loads Due to Finishes	G_k	= **1** kN/m^2

1.4.1 Design Load Factors

Imposed Load Factor	γ_{fq}	= **1.6**
Dead Load Factor	γ_{fg}	= **1.4**

1.5 Reinforcement Details

Waist Slab		**D 10 @ 110** mm C/C
Upper Landing		**D 10 @ 120** mm C/C
Lower Landing		**D 10 @ 150** mm C/C
Clear Cover for Reinforcement	C_C	= **25** mm

1.6 Materials

Concrete Grade	f_{cu}	= **35** N/mm^2
Main Reinforcement Grade	f_y	= **460** N/mm^2
Density of Concrete	γ_{conc}	= **24** kN/m^3

1.7 Deflection

Support Condition	SC	= **Simple**

Allowable L/d Ratio	$(L/d)_A$	= **20**	

1.8 Material Safety Factors

Concrete in Compression	γ_{mc}	= **1.5**	
Concrete in Shear	γ_{mcs}	= **1.25**	
Reinforcement	γ_{ms}	= **1.15**	

2.0 OUTPUT

Ref: BS 8110 - Part 1

2.1 Design Load

Length of Staircase	L	= $(N_{step} - 1) * T + L_u + L_l$ = **4250** mm	
Angle of Staircase	Θ	= atan(R / T) = **32.6** deg	
Self-Weight of Staircase	q_{kswt}	= $[(h_{span} / T) + (Rise / 2)] * \gamma_{conc}$ = **7.6** kN/m^2	
Design Load	F	= $\gamma_{fg} * (q_{kswt} + G_k) + \gamma_{fq} * Q_k$ = **18.5** kN/m^2	*Cl.3.2.1.2.2*

2.2 Waist Slab

Moment Coefficient	β	= **0.086**	*Table 3.12*
Design Moment /m	M_{span}	= $\beta * F * L^2$ = **28.7** kNm	
Depth of Reinforcement	d	= **170** mm	
K Factor	K	= $M_{span} / (b * d^2 * f_{cu})$ = **0.028**	*Cl.3.4.4.4*
K' Factor	K'	= 0.2336 / γ_{mc} = **0.156**	
Lever Arm	z	= $d * \min((0.5 + (0.25 - K / 0.9)^{0.5}) , 0.95)$	
		= **161.5** mm	
Area of Reinforcement Required /m	$A_{s,span}$	= $M_{span} / (f_y / \gamma_{ms} * z)$ = **444** mm^2	
Area of Reinforcement Provided /m	$A_{ss,p}$	= **714.3** mm^2	

2.2.1 Deflection Check

Design Service Stress	f_s	= $(2 * f_y * A_{s,span}) / (3 * A_{ss,p})$ = **190.6** N/mm^2	
Modification Factor	MF	= $\min (0.55 + ([477 - f_s] / \{120 * [0.9 + (M_{span} / d^2)]\}) , 2)$ = **1.81**	*Cl.3.4.6.5*
Allowable Span/Effective Depth Ratio	$(L/d)_{Allow}$	= MF * $(L/d)_A$ = **36.2**	*Table 3.9*
Actual Span/Effective Depth Ratio	$(L/d)_{Actual}$	= $(L/d)_A$ = **25**	

2.3 Upper Landing

Depth of Reinforcement	d	= **170** mm	
Area of Reinforcement Provided /m	$A_{su,p}$	= **654.8** mm^2	

2.3.1 Shear Check

Shear Coefficient	α_u	= **0.5**	*Table 3.12*
Design Shear Force	V_u	= $\alpha_u * F * L$ = **39.2** kN	
Design Shear Stress	v	= $V_u / (b * d)$ = **0.231** N/mm^2	*Cl.3.4.5.2*
Percentage of Reinforcement	P_t	= **0.39** %	
Concrete Shear Stress	v_c	= **0.637** N/mm^2	*Table 3.8*
Maximum Shear Stress	v_{max}	= $\min(0.8 * f_{cu}^{1/2} , 5)$ = **4.733** N/mm^2	*Cl.3.4.5.2*

2.4 Lower Landing

Depth of Reinforcement	d	= **170** mm
Area of Reinforcement Provided /m	$A_{sl,p}$	= **523.8** mm^2

2.4.1 Shear Check

Shear Coefficient	α_l	= **0.5**
Design Shear Force	V_l	= α_l * F * L = **39.2** kN
Design Shear Stress	v	= V_l / (b * d) = **0.231** N/mm^2
Percentage of Reinforcement	P_t	= **0.31** %
Concrete Shear Stress	v_c	= **0.591** N/mm^2

3.0 SUMMARY

3.1 Waist Slab

Description	Required		Actual		Status
Waist Slab Reinforcement (mm^2/m)	$A_{s,span}$	>= **444**	$A_{ss,p}$	= **714.3**	**PASS**
Minimum Area of Reinforcement (mm^2/m)	A_{min}	>= **260**	$A_{ss,p}$	= **714.3**	**PASS**
Deflection	$(L/d)_{Allow}$	<= **36.2**	$(L/d)_{Actual}$	= **25**	**PASS**

3.2 Upper Landing

Description	Required		Actual		Status
Upper Landing Reinforcement (mm^2/m)	-		$A_{su,p}$	= **654.8**	**PASS**
Minimum Area of Reinforcement (mm^2/m)	A_{min}	>= **260**	$A_{su,p}$	= **654.8**	**PASS**
Shear Resistance (N/mm^2)	v	>= **0.231**	v_c	= **0.637**	**PASS**

3.3 Lower Landing

Description	Required		Actual		Status
Lower Landing Reinforcement (mm^2/m)	-		$A_{su,l}$	= **523.8**	**PASS**
Minimum Area of Reinforcement (mm^2/m)	A_{min}	>= **260**	$A_{su,l}$	= **523.8**	**PASS**
Shear Resistance (N/mm^2)	v	>= **0.231**	v_c	= **0.591**	**PASS**