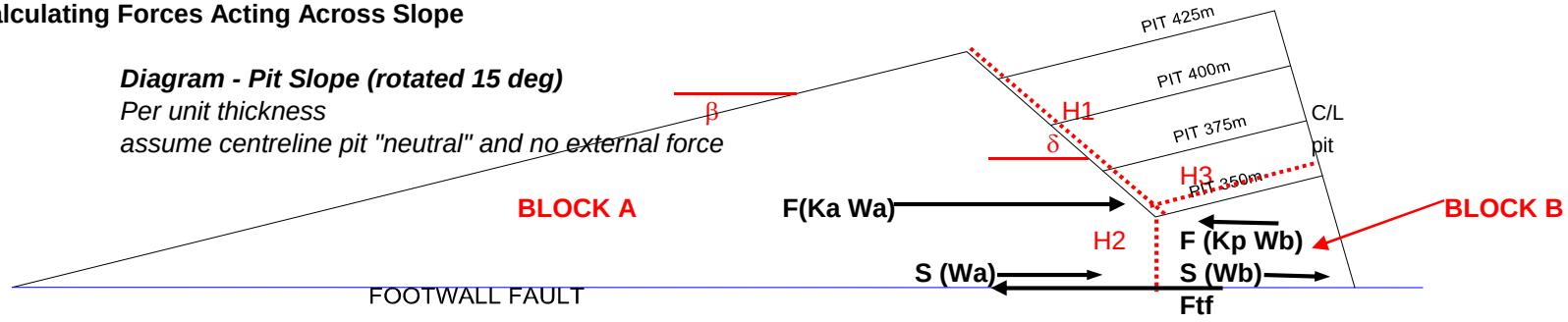
Calculating Forces Acting Across Slope

Diagram - Pit Slope (rotated 15 deg)
Per unit thickness
assume centreline pit "neutral" and no external force



Knowns:

β	15	deg	0.26	
δ	44	deg	0.77	
γ	18	kN/m3		base of pit
Ka	0.17		***ϕ, HMSZ***	***45 deg***
Kp	5.8			
Lft	544	m		
c'	0	kPa		
ϕ'	9	deg	0.16	

Table of Variables *average height across fault*

Pit Level	Aa	Ab	H1	H2	H3	z
350	25152	3025	105	30	70	51.8
375	24281	5837	76	51	85	55.4
400	22982	9459	47	71	101	59.6
425	21254	13892	18	91.5	116	64.6
360	24855	3952.5	94	39	76	53.0

Pit Base(mF	**350**	**360**	**375**	**400**	**425**
Wa (kN)	452736	447390	437058	413676	382572
Wb (kN)	54450	71145	105066	170262	250056
Sa (kN)	117177	115793	113119	107067	99017
Sb (kN)	14093	18414	27193	44067	64719
Fwa (kN)	25796	21898	16773	12605	13527
Fwb (kN)	98382	139988	211564	370151	578188
Ftf (kN)	74949	76626	80112	86291	93486
ΣF →	157066	156105	157085	163740	177263
ΣF ←	173331	216614	291676	456442	671674
FOS	**1.1**	**1.4**	**1.9**	**2.8**	**3.8**
Fault offset	30	39	51	71	91.5
Force imbala	16266	60509	134591	292702	494411

Formulae:

Sa = Wa sin β
Sb = Wb sin β

S = Shear Force acting on Fault as a result of the Weight of block
W = A x γ

Fw = earth pressure acting on block separation (approx.)
Fwa = Ka x γ x {0.5 (H1 x sin δ)^2 + 0.5 (H2)^2 + (H1)^2}
Fwb = Kp x γ x {0.5 (H3 x sin δ)^2 + (H3)^2 + 0.5 (H2)^2}

Ftf = shear strength mobilised along the Fault to resist movement
tf = c' + (γ x z x cos(β)^2) x tan(ϕ')
Ftf = tf x Lft

ΣF → = Sa + Sb + Fwa
ΣF ← = Fwb + Ftf

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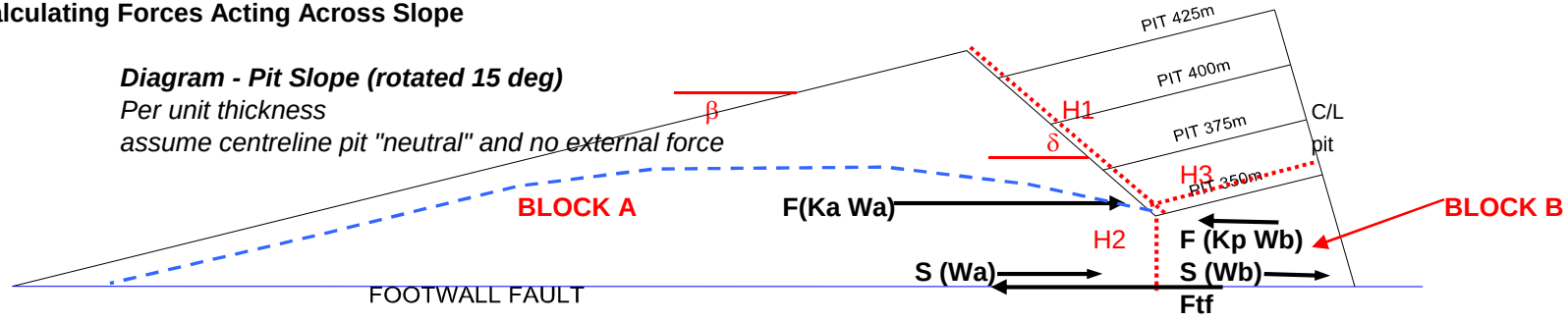
STABILITY OF WEST WALL - TOTAL
HMSZ 45°, DRY

PSM71-107R | **Figure B1**

Calculating Forces Acting Across Slope

Diagram - Pit Slope (rotated 15 deg)
Per unit thickness
assume centreline pit "neutral" and no external force



WATER
5m below surface - (pre-pit)
drained to bottom of pit

Knowns:

β	15	deg	0.26
δ	44	deg	0.77
γ	18	kN/m3	
Ka	0.17		***ϕ, HMSZ 45 deg***
Kp	5.8		
Lft	544	m	
c'	0	kPa	
ϕ'	9	deg	0.16
γω	9.8	kN/m3	

Table of Variables

average height across fault *average water depth*

Pit Level	Aa	Ab	H1	H2	H3	z	Aw	Hw	Uw
350	25152	3025	105	30	70	51.8	15745	36.8	361
375	24281	5837	76	51	85	55.4	18157	42.4	416
400	22982	9459	47	71	101	59.6	20481	47.9	469
425	21254	13892	18	91.5	116	64.6	23000	53.8	527
360	24855	3952.5	94	39	76	53.0	16324	38.1	374

Pit Base(mF	350	360	375	400	425
Wa (kN)	452736	447390	437058	413676	382572
Wb (kN)	54450	71145	105066	170262	250056
Sa (kN)	117177	115793	113119	107067	99017
Sb (kN)	14093	18414	27193	44067	64719
Fwa (kN)	11752	9976	7641	5742	6162
Fwb (kN)	44818	63772	96379	168624	263397
Fτf (kN)	43880	44414	44283	45876	48101
Fw (kN)	6190	6653	8231	10473	13208
ΣF →	149211	150836	156184	167350	183107
ΣF ←	88698	108187	140662	214501	311497
FOS	**0.59**	**0.72**	**0.90**	**1.28**	**1.70**
Fault offset	**30**	39	51	71	91.5
Force imbala	-60512	-42649	-15522	47150	128391

Formulae:

S = Shear Force acting on Fault as a result of the Weight of block
W = A x γ

Sa = Wa sin β
Sb = Wb sin β

Fw = earth pressure acting on block separation (approx.)
Fwa = Ka x (γ - γw) x {0.5 (H1 x sin δ)^2 + 0.5 (H2)^2 + (H1)^2}
Fwb = Kp x (γ - γw) x {0.5 (H3 x sin δ)^2 + (H3)^2 + 0.5 (H2)^2}

F τf = shear strength mobilised along the Fault to resist movement
τf = c' + ((γ x z x cos(β)^2) - Uw) x tan(ϕ')
Fτf = τf x Lft

Fw = 0.5 x γω Hw x Hw

ΣF → = Sa + Sb + Fwa + Fw
ΣF ← = Fwb + Ftf

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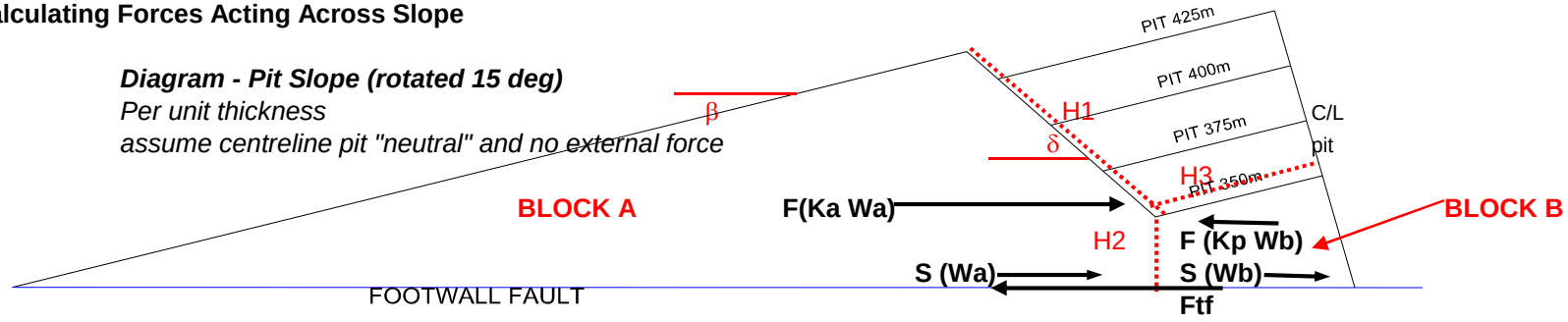
STABILITY OF WEST WALL - EFFECTIVE
HMSZ 45°, WATER

PSM71-107R | **Figure B2**

Calculating Forces Acting Across Slope

Diagram - Pit Slope (rotated 15 deg)
Per unit thickness
assume centreline pit "neutral" and no external force



Knowns:

β	15	deg	0.26	
δ	44	deg	0.77	
γ	18	kN/m3		base of pit
Ka	0.3		***ϕ, HMSZ***	***30 deg***
Kp	3			
Lft	544	m		
c'	0	kPa		
ϕ'	9	deg	0.16	

Table of Variables *average height across fault*

Pit Level	Aa	Ab	H1	H2	H3	z
350	25152	3025	105	30	70	51.8
375	24281	5837	76	51	85	55.4
400	22982	9459	47	71	101	59.6
425	21254	13892	18	91.5	116	64.6
360	24855	3952.5	94	39	76	53.0

Pit Base(mF	350	360	375	400	425
Wa (kN)	452736	447390	437058	413676	382572
Wb (kN)	54450	71145	105066	170262	250056
Sa (kN)	117177	115793	113119	107067	99017
Sb (kN)	14093	18414	27193	44067	64719
Fwa (kN)	45523	38644	29599	22245	23871
Fwb (kN)	50887	72407	109430	191457	299063
Ftf (kN)	74949	76626	80112	86291	93486
ΣF →	176792	172850	169911	173379	187608
ΣF ←	125837	149034	189542	277749	392549
FOS	**0.71**	**0.86**	**1.12**	**1.60**	**2.09**
Fault offset	30	39	51	71	91.5
Force imbala	-50956	-23817	19631	104369	204941

Formulae:

Sa = Wa sin β
Sb = Wb sin β

S = Shear Force acting on Fault as a result of the Weight of block
W = A x γ

Fw = earth pressure acting on block separation (approx.)
Fwa = Ka x γ x {0.5 (H1 x sin δ)^2 + 0.5 (H2)^2 + (H1)^2}
Fwb = Kp x γ x {0.5 (H3 x sin δ)^2 + (H3)^2 + 0.5 (H2)^2}

Ftf = shear strength mobilised along the Fault to resist movement
tf = c' + (γ x z x cos(β)^2) x tan(ϕ')
Ftf = tf x Lft

ΣF → = Sa + Sb + Fwa
ΣF ← = Fwb + Ftf

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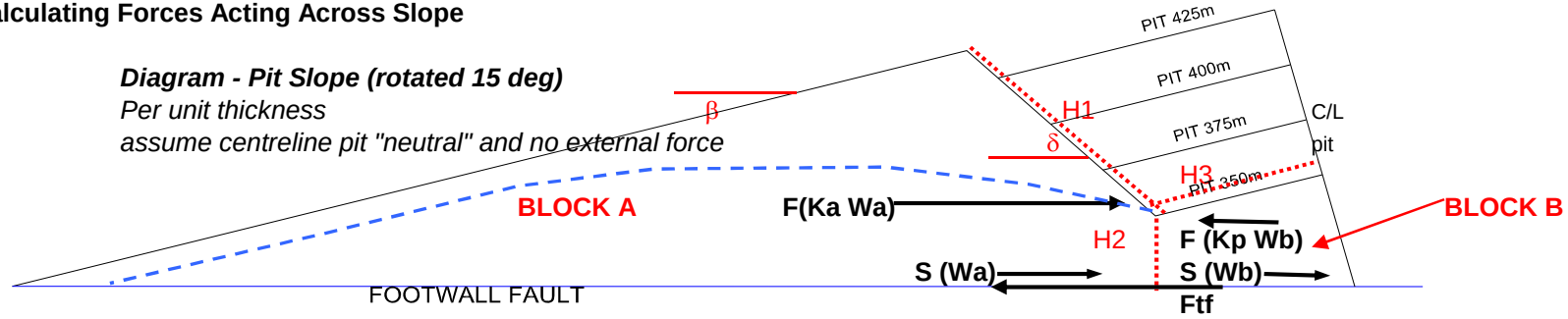
STABILITY OF WEST WALL - TOTAL
HMSZ 30°, DRY

PSM71-107R | **Figure B3**

Calculating Forces Acting Across Slope

Diagram - Pit Slope (rotated 15 deg)
Per unit thickness
assume centreline pit "neutral" and no external force



WATER
5m below surface - (pre-pit)
drained to bottom of pit

Knowns:

β	15	deg	0.26
δ	44	deg	0.77
γ	18	kN/m3	
Ka	0.3		***ϕ, HMSZ 30 deg***
Kp	3		
Lft	544	m	
c'	0	kPa	
ϕ'	9	deg	0.16
γω	9.8	kN/m3	

Table of Variables

average height across fault | *average values*

Pit Level	Aa	Ab	H1	H2	H3	z	Aw	Hw	Uw-base
350	25152	3025	105	30	70	51.8	15745	36.8	361
375	24281	5837	76	51	85	55.4	18157	42.4	416
400	22982	9459	47	71	101	59.6	20481	47.9	469
425	21254	13892	18	91.5	116	64.6	23000	53.8	527
360	24855	3952.5	94	39	76	53.0	16324	38.1	374

Pit Base(mF	350	360	375	400	425
Wa (kN)	452736	447390	437058	413676	382572
Wb (kN)	54450	71145	105066	170262	250056
Sa (kN)	117177	115793	113119	107067	99017
Sb (kN)	14093	18414	27193	44067	64719
Fwa (kN)	20738	17604	13484	10134	10875
Fwb (kN)	23182	32986	49851	87219	136240
Fτf (kN)	43880	44414	44283	45876	48101
Fw (kN)	6190	6653	8231	10473	13208
ΣF →	158197	158464	162028	171742	187819
ΣF ←	67062	77400	94135	133096	184340
FOS	**0.42**	**0.49**	**0.58**	**0.77**	**0.98**
Fault offset	30	39	51	71	91.5
Force imbala	-91136	-81064	-67893	-38646	-3479

Formulae:

S = Shear Force acting on Fault as a result of the Weight of block
W = A x γ

Sa = Wa sin β
Sb = Wb sin β

Fw = earth pressure acting on block separation (approx.)
Fwa = Ka x (γ - γw) x {0.5 (H1 x sin δ)^2 + 0.5 (H2)^2 + (H1)^2}
Fwb = Kp x (γ - γw) x {0.5 (H3 x sin δ)^2 + (H3)^2 + 0.5 (H2)^2}

F τf = shear strength mobilised along the Fault to resist movement
τf = c' + ((γ x z x cos(β)^2) - Uw) x tan(ϕ')
Fτf = τf x Lft

Fw = 0.5 x γω (Hw x cos(β))^2

ΣF → = Sa + Sb + Fwa + Fw
ΣF ← = Fwb + Ftf

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STABILITY OF WEST WALL - EFFECTIVE
HMSZ 30°, WATER

PSM71-107R | **Figure B4**