11. Stability Analysis of Sabo Dam Structure

* Facility name　Pawa-Burabod Rv. Sabo Dam

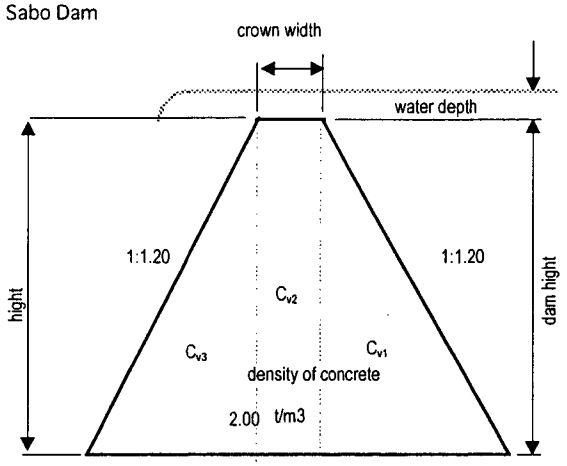
* H=	6.00	(m) Damhight	Density of depsit	2.6	t/m^3
*B2'=	5.00	(m) Crown widh	Internal friction angle	30.0	°
*he=	2.20	(m) Water depth	Concentration of debris	0.6	
*n=	1.20	Downstream slope	Gravity	9.8	
*m=	1.20	Upstream slope	Roughness coeffcient	0.10	
* Ce=	0.30	Coefficient of earth pressure	Factor	1.00	
* ν	0.40	Pecentage of void			
* f	0.60	Friction factor	Discharge	214.0	m^3/s
* τ =	0.00	t/m^2 Shearing force	Design flood discharge	321.0	m^3/s
*	30.00	t/m^2 Bearing capcity	Width of waterway	55.0	m
*Wc=	2.00	t/m^3 Concrete Density	Slope of river bed	1/37.5	
*Ws=	1.10	t/m^3 Depsit Density in water			
*W_0=	1.20	t/m^3 Water Density	Safe factor against Sliding	1.2	

●Analysis (flood case)　Pawa-Burabod Rv. Sabo Dam

(1)Condition

Dam hight	H=	6.00	m
Water depth	h3=	2.20	m
Crown width	B=	5.00	m
Width of bottom	B2=	19.40	m
Downstream slope	n=	1:1.20	
Upperstream slope	m=	1:1.20	

Water density	W0=	1.20	t/m3
Concrete density	Wc=	2.00	t/m3
Coefficient of friction	f =	0.60	
Shearing force	τ =	0.00	t/m2



(2) External force (flood case)

load	Vertical force / Horizontal force (t/m)					Arm length (m)							Resisting/Disturbing moment (tm/m)
C_{v1}	1/2×	1.20×	6.00 ²	×2.00=	43.200				2/3×	1.20×	6.00 =	4.800	207.360
C_{v2}		5.00×	6.00	×2.00=	60.000			1/2×	5.00+	1.20×	6.00 =	9.700	582.000
C_{v3}	1/2×	1.20×	6.00 ²	×2.00=	43.200	1/3×	1.20 ×	6.00+	5.00+	1.20×	6.00 =	14.600	630.720
W_{v1}	1/2×	1.20×	6.00 ²	×1.20=	25.920				1/3×	1.20×	6.00 =	2.400	62.208
W_{v2}	1.20×	6.00×	2.20	×1.20=	19.008				1/2×	1.20×	6.00 =	3.600	68.429
W_{v3}		5.00×	2.20	×1.20=	13.200			1/2×	5.00+	1.20×	6.00 =	9.700	128.040
W_{h1}		1/2×	6.00 ²	×1.20=	21.600					1/3×	6.00 =	2.000	43.200
W_{h2}		6.00×	2.20	×1.20=	15.840					1/2×	6.00 =	3.000	47.520
				Vertical force=	204.528							Resisting moment=	1,678.757
				Horizontal force=	37.440							Disturbing moment=	90.720

(3) Stability of structure

1) Sliding

$$F_s = \frac{f \times \Sigma V + \tau \times \ell}{\Sigma H} = \frac{0.60 \times 204.53 + 0.00 \times 19.40}{37.44} = 3.278 \ >= Fs = 1.20 \ \text{O.K}$$

2) Overturning

$$e = \frac{M_r + M_0}{\Sigma V} - \frac{B}{2} = \left| \frac{1,678.76 + 90.72}{204.53} - \frac{19.40}{2} \right| = 1.05 \ <= B0/6 = 3.23 \ \text{O.K}$$

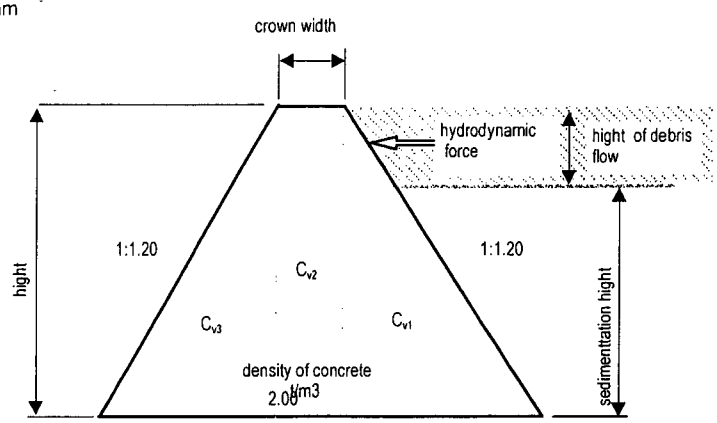
3) Subgrage reaction

$$\sigma = \frac{\Sigma V}{B_0} \cdot \left(1 \pm \frac{6e}{B_0} \right) = \frac{204.53}{19.40} \left(1 \pm \frac{6 \times 3.233}{19.40} \right) \begin{cases} \sigma d = 13.96 \ \text{t/m2(downstreem)} \\ \sigma u = 7.13 \ \text{t/m2(upperstreem)} \end{cases}$$

●Analysis(debris flow case)　　Pawa-Burabod Rv. Sabo Dam

(1)Condition

Dam hight	H=	6.00	m
Crown width	B=	5.00	m
Bottom width	B2=	19.40	m
Downstream slope	n=	1:1.20	
Upperstream slope	m=	1:1.20	
Water density	W0=	1.20	t/m^3
Concrete density	Wc=	2.00	t/m^3
Density of deposit	Ws=	1.10	t/m^3
Hight of deposit	Hs =	3.45	m
Void of deposit	ν =	0.40	
Coefficient of earth pressure	Ce=	0.30	
Coefficient of friction	f =	0.60	
Shearing force	τ =	0.00	t/m^2



(2)Debris flow Discharge and Fluid force

1)Debris flow Discharge:Qsp

$Q_{sp}=\frac{C_*}{C_*-C_d}\times Q_p$ = 428.00 m^3/s

Qp: discarge	214.00	m^3/s
C*:condensy of deposit	0.60	
Cd:debris flow concentration		
0.3<=Cd<=0.9Cd(=0.54)	0.3	
$Cd=\frac{\rho\tan\theta}{(\sigma-\rho)(\tan\phi-\tan\theta)}$ =	0.042	
σ:densty of gravel	2.60	t/m^3
ρ:densty of water	1.20	t/m^3
ϕ:in-angle of deposit	30.0	°
θ:Bed slope	1.53	°

2)Debris flow Hight, Velocity, Hydorodynamic force

hight of debris $Hd=\left(\frac{n\,Q_{sp}}{B\sqrt{\sin\theta}}\right)^{3/5}$ = 2.55 m

n : roughness factor	0.10	
B : Debris width	55.00	m
Qsp:debris flow quantity	428.00	m3/s
Verosity Ud = $1/n\times R^{2/3}\times\sqrt{\sin\theta}$	3.049	m/s
Fluid force $F_d=\alpha\frac{\rho}{d}H_d\times U_d^2$ =	3.922	tf/m
R : radius debris flow		
ρd: densty ofdebris flow	1.62	t/m^3
g : gravity	9.8	m/s^2
α : factor	1.0	
debris flow max case sedimentetion hight Hs=	3.45	m

(3) External force(debris flow case)

load		Vertical force / Horizontal force (t/m)					Arm length (m)					Resisting/Disturbing moment (tm/m)
dam weight	Cv1	1/2×	1.20×	6.00	×2.00=	43.20	2/3×	1.20×	6.00 =	4.80		207.36
	Cv2		5.00×	6.00	×2.00=	60.00	1/2×	5.00+	1.20×	6.00 =	9.70	582.00
	Cv3	1/2×	1.20×	6.00	×2.00=	43.20	1/3× 1.20 × 6.00+	5.00+	1.20×	6.00 =	14.60	630.72
depsit presure	Sv	1/2×	1.20×	3.45	×1.10=	7.85		1/3×	1.20×	3.45 =	1.38	10.82
water presure	Wv	1/2×	1.20×	3.45	×1.20=	8.56		1/3×	1.20×	3.45 =	1.38	11.80
debris flow weight	Dv1	1.20×	2.55×	3.45	×1.62=	17.11		1/2×	1.20×	3.45 =	2.07	35.39
	Dv2	1/2×	1.20×	3.45	×1.62=	6.33	1/3× 1.20 × 2.55+		1.20×	3.45 =	5.16	32.65
depsit presure	Sh1	0.30×	1/2×	3.448	×1.10=	1.96			1/3×	3.45 =	1.15	2.25
	Sh2	0.30×	2.55×	3.448	×1.62=	4.28			1/2×	3.45 =	1.72	7.37
water presure	Wh1		1/2×	3.448	×1.20=	7.13			1/3×	3.45 =	1.15	8.20
	Wh2		2.55×	3.448	×1.20=	10.56			1/2×	3.45 =	1.72	18.20
fluid force	Fd					3.92		1/2×	2.55+	3.45 =	4.72	18.53
					Vertical force=	186.24					Resisting moment=	1,510.75
					Horizontal force=	27.85					Disturbing moment=	54.55

(4) Stability of structure

1) Sliding

$$F_s=\frac{f\times\Sigma V+\tau\times\ell}{\Sigma H}=\frac{0.60\times186.24+0.00\times19.40}{27.85}=4.012\ >=Fs=\ 1.20\ \text{O.K}$$

2) Overturning

$$e=\frac{M_r+M_0}{\Sigma V}-\frac{B}{2}=\left|\frac{1,510.75+54.55}{186.24}-\frac{19.40}{2}\right|=1.30\ <=B0/6=\ 3.23\ \text{O.K}$$

3) Subgrage reaction

$$\sigma=\frac{\Sigma V}{B_0}\cdot\left(1\pm\frac{6e}{B_0}\right)=\frac{186.24}{19.40}\left(1\pm\frac{6\times3.233}{19.40}\right)$$

σd= 13.45 t/m2(downstreem)

σu= 5.76 t/m2(upperstreem)

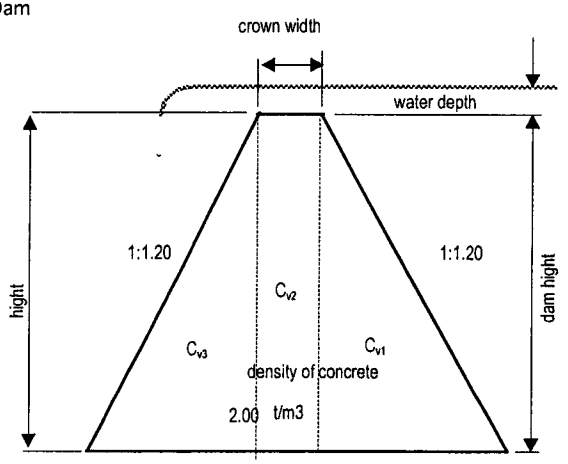
* Facility name　　Budiao Rv. Sabo Dam

* H=	6.00	(m) Damhight	Density of depsit	2.6	t/m^3
*B2'=	5.00	(m) Crown widh	Internal friction angle	30.0	°
*he=	2.20	(m) Water depth	Concentration of debris	0.6	
*n=	1.20	Downstream slope	Gravity	9.8	
*m=	1.20	Upstream slope	Roughness coeffcient	0.10	
* Ce=	0.30	Coefficient of earth pressure	Factor	1.00	
* ν	0.40	Pecentage of void			
* f	0.60	Friction factor	Discharge	189.0	m^3/s
* τ =	0.00	t/m^2 Shearing force	Design flood discharge	284.0	m^3/s
*	30.00	t/m^2 Bearing capcity	Width of waterway	50.0	m
*Wc=	2.00	t/m^3 Concrete Density	Slope of river bed	1/20.0	
*Ws=	1.10	t/m^3 Depsit Density in water			
*W_0=	1.20	t/m^3 Water Density	Safe factor against Sliding	1.2	

●Analysis (flood case)　　Budiao Rv. Sabo Dam

(1)Condition

Dam hight	H=	6.00	m
Water depth	h3=	2.20	m
Crown width	B=	5.00	m
Width of bottom	B2=	19.40	m
Downstream slope	n=	1:1.20	
Upperstream slope	m=	1:1.20	
Water density	W0=	1.20	t/m3
Concrete density	Wc=	2.00	t/m3
Coefficient of friction	f =	0.60	
Shearing force	τ =	0.00	t/m2



(2) External force (flood case)

load	Vertical force / Horizontal force (t/m)					Arm length (m)							Resisting/Disturbing moment (tm/m)
C_{v1}	1/2×	1.20×	6.00 ²	×2.00=	43.200				2/3×	1.20×	6.00 =	4.800	207.360
C_{v2}		5.00×	6.00	×2.00=	60.000			1/2×	5.00+	1.20×	6.00 =	9.700	582.000
C_{v3}	1/2×	1.20×	6.00 ²	×2.00=	43.200	1/3×	1.20 ×	6.00+	5.00+	1.20×	6.00 =	14.600	630.720
W_{v1}	1/2×	1.20×	6.00 ₂	×1.20=	25.920				1/3×	1.20×	6.00 =	2.400	62.208
W_{v2}	1.20×	6.00×	2.20	×1.20=	19.008				1/2×	1.20×	6.00 =	3.600	68.429
W_{v3}		5.00×	2.20	×1.20=	13.200			1/2×	5.00+	1.20×	6.00 =	9.700	128.040
W_{h1}		1/2×	6.00 ₂	×1.20=	21.600					1/3×	6.00 =	2.000	43.200
W_{h2}		6.00×	2.20	×1.20=	15.840					1/2×	6.00 =	3.000	47.520
				Vertical force=	204.528							Resisting moment=	1,678.757
				Horizontal force=	37.440							Disturbing moment=	90.720

(3) Stability of structure

1) Sliding

$$F_s = \frac{f \times \Sigma V + \tau \times \ell}{\Sigma H} = \frac{0.60 \times 204.53 + 0.00 \times 19.40}{37.44} = 3.278 \ >= Fs = 1.20 \ \text{O.K}$$

2) Overturning

$$e = \frac{M_r + M_0}{\Sigma V} - \frac{B}{2} = \left| \frac{1,678.76 + 90.72}{204.53} - \frac{19.40}{2} \right| = 1.05 \ <= B0/6 = 3.23 \ \text{O.K}$$

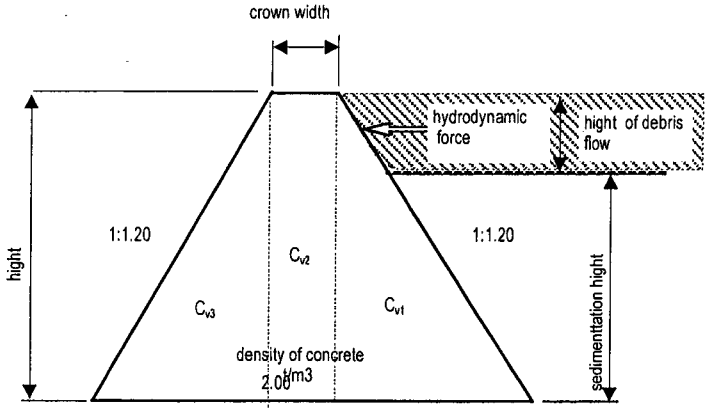
3) Subgrage reaction

$$\sigma = \frac{\Sigma V}{B_0} \cdot \left(1 \pm \frac{6e}{B_0} \right) = \frac{204.53}{19.40} \left(1 \pm \frac{6 \times 3.233}{19.40} \right) \begin{cases} \sigma d = 13.96 \ t/m2 \text{(downstreem)} \\ \sigma u = 7.13 \ t/m2 \text{(upperstreem)} \end{cases}$$

●Analysis(debris flow case)　　Budiao Rv. Sabo Dam

(1)Condition

Dam hight	H=	6.00	m
Crown width	B=	5.00	m
Bottom width	B2=	19.40	m
Downstream slope	n=	1:1.20	
Upperstream slope	m=	1:1.20	
Water density	W0=	1.20	t/m^3
Concrete density	Wc=	2.00	t/m^3
Density of deposit	Ws=	1.10	t/m^3
Hight of deposit	Hs =	3.92	m
Void of deposit	ν =	0.40	
Coefficient of earth pressure	Ce=	0.30	
Coefficient of friction	f =	0.60	
Shearing force	τ =	0.00	t/m^2



(2)Debris flow Discharge and Fluid force

1)Debris flow Discharge:Qsp

$Q_{sp}=\frac{C.}{C.-C_d} \times Q_p =$ 378.00 m^3/s

Qp: discarge	189.00	m^3/s
C*:condensy of deposit	0.60	
Cd:debris flow concentration		
0.3<=Cd<=0.9Cd(=0.54)	0.3	
$Cd=\frac{\rho \tan\theta}{(\sigma-\rho)(\tan\phi-\tan\theta)}=$	0.081	
σ :densty of gravel	2.60	t/m^3
ρ :densty of water	1.20	t/m^3
ϕ :in-angle of deposit	30.0	°
θ :Bed slope	2.86	°

2)Debris flow Hight, Velocity, Hydorodynamic force

hight of debris $Hd=\left(\frac{n\ Q_{sp}}{R\sqrt{\sin\theta}}\right)^{3/5}$ = 2.08 m

n : roughness factor	0.10	
B : Debris width	50.00	m
Qsp:debris flow quantity	378.00	m3/s
Verosity $Ud = 1/n \times R^{2/3} \times\sqrt{\sin\theta}$	3.639	m/s
Fluid force $F_d = \alpha \frac{\rho}{d} H_d \times U_d^2 =$	4.549	tf/m
R : radius debris flow		
ρd: densty ofdebris flow	1.62	t/m^3
g : gravity	9.8	m/s^2
α : factor	1.0	
debris flow max case sedimentetion hight Hs=	3.92	m

(3) External force(debris flow case)

load		Vertical force / Horizontal force (t/m)					Arm length (m)					Resisting/Disturbing moment (tm/m)
dam weight	Cv1	1/2×	1.20×	6.00	×2.00=	43.20		2/3×	1.20×	6.00 =	4.80	207.36
	Cv2		5.00×	6.00	×2.00=	60.00	1/2×	5.00+	1.20×	6.00 =	9.70	582.00
	Cv3	1/2×	1.20×	6.00	×2.00=	43.20	1/3× 1.20 × 6.00+	5.00+	1.20×	6.00 =	14.60	630.72
depsit presure	Sv	1/2×	1.20×	3.92	×1.10=	10.15		1/3×	1.20×	3.92 =	1.57	15.93
water presure	Wv	1/2×	1.20×	3.92	×1.20=	11.08		1/3×	1.20×	3.92 =	1.57	17.38
debris flow weight	Dv1	1.20×	2.08×	3.92	×1.62=	15.84		1/2×	1.20×	3.92 =	2.35	37.28
	Dv2	1/2×	1.20×	3.92	×1.62=	4.20	1/3× 1.20 × 2.08+		1.20×	3.92 =	5.54	23.24
depsit presure	Sh1	0.30×	1/2×	3.922	×1.10=	2.54			1/3×	3.92 =	1.31	3.32
	Sh2	0.30×	2.08×	3.922	×1.62=	3.96			1/2×	3.92 =	1.96	7.77
water presure	Wh1		1/2×	3.922	×1.20=	9.23			1/3×	3.92 =	1.31	12.06
	Wh2		2.08×	3.922	×1.20=	9.78			1/2×	3.92 =	1.96	19.18
fluid force	Fd					4.55		1/2×	2.08+	3.92 =	4.96	22.57
					Vertical force=	187.67					Resisting moment=	1,513.91
					Horizontal force=	30.06					Disturbing moment=	64.89

(4) Stability of structure

1) Sliding

$$F_s=\frac{f\times\sum V+\tau\times\ell}{\sum H}=\frac{0.60\times187.67+0.00\times19.40}{30.06}=3.746 >= Fs= 1.20\ O.K$$

2) Overturning

$$e=\frac{M_r+M_0}{\sum V}-\frac{B}{2}=\left|\frac{1,513.91+64.89}{187.67}-\frac{19.40}{2}\right|=1.29 <= B0/6= 3.23\ O.K$$

3) Subgrage reaction

$$\sigma=\frac{\sum V}{B_0}\cdot\left(1\pm\frac{6e}{B_0}\right)=\frac{187.67}{19.40}\left(1\pm\frac{6\times3.233}{19.40}\right)$$

σd= 13.52 t/m2(downstreem)

σu= 5.82 t/m2(upperstreem)

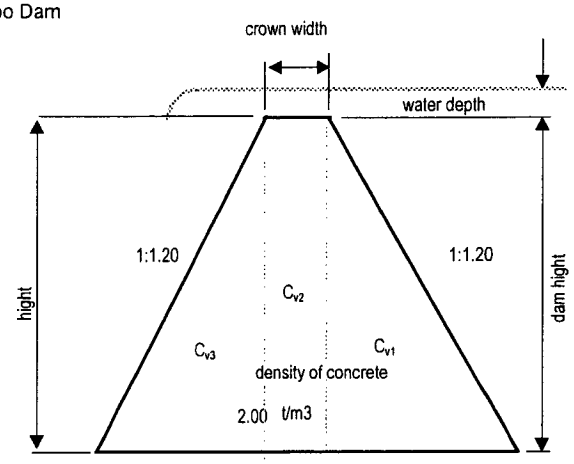
* Facility name　　Anoling　Rv. Sabo Dam

* H=	6.00	(m) Damhight	Density of depsit	2.6	t/m^3
*B2'=	5.00	(m) Crown widh	Internal friction angle	30.0	°
*he=	2.20	(m) Water depth	Concentration of debris	0.6	
*n=	1.20	Downstream slope	Gravity	9.8	
*m=	1.20	Upstream slope	Roughness coeffcient	0.10	
* Ce=	0.30	Coefficient of earth pressure	Factor	1.00	
* ν	0.40	Pecentage of void			
* f	0.60	Friction factor	Discharge	257.0	m^3/s
* τ =	0.00	t/m^2 Shearing force	Design flood discharge	386.0	m^3/s
*	30.00	t/m^2 Bearing capcity	Width of waterway	68.0	m
*Wc=	2.00	t/m^3 Concrete Density	Slope of river bed	1/20.0	
*Ws=	1.10	t/m^3 Depsit Density in water			
*W_0=	1.20	t/m^3 Water Density	Safe factor against Sliding	1.2	

●Analysis (flood case)　　Anoling R Rv. Sabo Dam

(1)Condition

Dam hight	H=	6.00	m
Water depth	h3=	2.20	m
Crown width	B=	5.00	m
Width of bottom	B2=	19.40	m
Downstream slope	n=	1:1.20	
Upperstream slope	m=	1:1.20	
Water density	W0=	1.20	t/m3
Concrete density	Wc=	2.00	t/m3
Coefficient of friction	f =	0.60	
Shearing force	τ =	0.00	t/m2



(2) External force (flood case)

load	Vertical force / Horizontal force (t/m)					Arm length (m)						Resisting/Disturbing moment (tm/m)
C_{v1}	1/2×	1.20×	6.00 ²	×2.00=	43.200			2/3×	1.20×	6.00 =	4.800	207.360
C_{v2}		5.00×	6.00	×2.00=	60.000		1/2×	5.00+	1.20×	6.00 =	9.700	582.000
C_{v3}	1/2×	1.20×	6.00 ²	×2.00=	43.200	1/3× 1.20 ×	6.00+	5.00+	1.20×	6.00 =	14.600	630.720
W_{v1}	1/2×	1.20×	6.00 ²	×1.20=	25.920			1/3×	1.20×	6.00 =	2.400	62.208
W_{v2}	1.20×	6.00×	2.20	×1.20=	19.008			1/2×	1.20×	6.00 =	3.600	68.429
W_{v3}		5.00×	2.20	×1.20=	13.200		1/2×	5.00+	1.20×	6.00 =	9.700	128.040
W_{h1}		1/2×	6.00 ²	×1.20=	21.600				1/3×	6.00 =	2.000	43.200
W_{h2}		6.00×	2.20	×1.20=	15.840				1/2×	6.00 =	3.000	47.520
				Vertical force=	204.528						Resisting moment=	1,678.757
				Horizontal force=	37.440						Disturbing moment=	90.720

(3) Stability of structure

1) Sliding

$$F_s = \frac{f \times \Sigma V + \tau \times \ell}{\Sigma H} = \frac{0.60 \times 204.53 + 0.00 \times 19.40}{37.44} = 3.278 \ >= Fs = 1.20 \ \text{O.K}$$

2) Overturning

$$e = \frac{M_r + M_0}{\Sigma V} - \frac{B}{2} = \left| \frac{1,678.76 + 90.72}{204.53} - \frac{19.40}{2} \right| = 1.05 <= B0/6 = 3.23 \ \text{O.K}$$

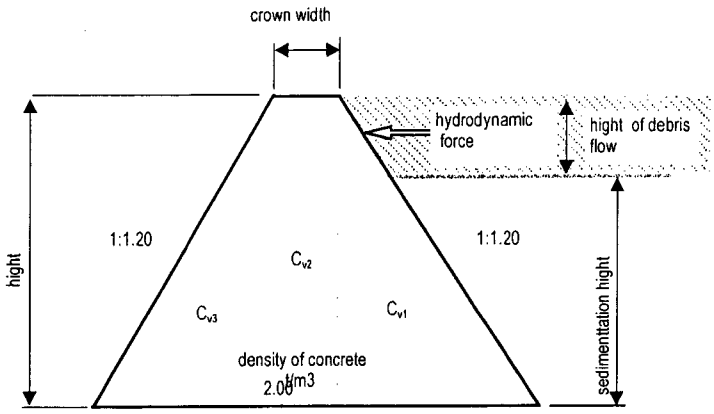
3) Subgrage reaction

$$\sigma = \frac{\Sigma V}{B_0} \cdot \left(1 \pm \frac{6e}{B_0} \right) = \frac{204.53}{19.40} \left(1 \pm \frac{6 \times 3.233}{19.40} \right) \begin{cases} \sigma d = 13.96 \ \text{t/m2(downstreem)} \\ \sigma u = 7.13 \ \text{t/m2(upperstreem)} \end{cases}$$

●Analysis(debris flow case)　　Anoling　Rv. Sabo Dam

(1)Condition

Dam hight	H=	6.00	m
Crown width	B=	5.00	m
Bottom width	B2=	19.40	m
Downstream slope	n=	1:1.20	
Upperstream slope	m=	1:1.20	
Water density	WO=	1.20	t/m^3
Concrete density	Wc=	2.00	t/m^3
Density of deposit	Ws=	1.10	t/m^3
Hight of deposit	Hs =	3.92	m
Void of deposit	ν =	0.40	
Coefficient of earth pressure	Ce=	0.30	
Coefficient of friction	f =	0.60	
Shearing force	τ =	0.00	t/m^2



(2)Debris flow Discharge and Fluid force

1)Debris flow Discharge:Qsp

$Q_{sp}=\frac{C_*}{C_*-C_d}\times Q_p$ = 514.00 m^3/s

Qp: discarge	257.00	m^3/s
C*:condensy of deposit	0.60	
Cd:debris flow concentration		
0.3<=Cd<=0.9Cd(=0.54)	0.3	

$Cd=\frac{\rho\tan\theta}{(\sigma-\rho)(\tan\phi-\tan\theta)}$ = 0.081

σ :densty of gravel	2.60	t/m^3
ρ :densty of water	1.20	t/m^3
ϕ :in-angle of deposit	30.0	°
θ :Bed slope	2.86	°

2)Debris flow Hight, Velocity, Hydorodynamic force

hight of debris $Hd=\left(\frac{n\,Q_{sp}}{B\sqrt{\sin\theta}}\right)^{3/5}$ = 2.08 m

n : roughness factor	0.10	
B : Debris width	68.00	m
Qsp:debris flow quantity	514.00	m3/s
Verosity Ud = 1/n × R$^{2/3}$ ×$\sqrt{\sin\theta}$	3.639	m/s
Fluid force $F_d=\alpha\frac{\rho}{d}H_d\times U_d^2$ =	4.549	tf/m
R : radius debris flow		
ρd: densty ofdebris flow	1.62	t/m^3
g : gravity	9.8	m/s^2
α : factor	1.0	
debris flow max case sedimentetion hight Hs=	3.92	m

(3) External force(debris flow case)

load		Vertical force / Horizontal force (t/m)					Arm length (m)					Resisting/Disturbing moment (tm/m)
dam weight	Cv1	1/2×	1.20×	6.00	×2.00=	43.20		2/3×	1.20×	6.00 =	4.80	207.36
	Cv2		5.00×	6.00	×2.00=	60.00	1/2×	5.00+	1.20×	6.00 =	9.70	582.00
	Cv3	1/2×	1.20×	6.00	×2.00=	43.20	1/3× 1.20 × 6.00+	5.00+	1.20×	6.00 =	14.60	630.72
depsit presure	Sv	1/2×	1.20×	3.92	×1.10=	10.15		1/3×	1.20×	3.92 =	1.57	15.93
water presure	Wv	1/2×	1.20×	3.92	×1.20=	11.08		1/3×	1.20×	3.92 =	1.57	17.38
debris flow weight	Dv1	1.20×	2.08×	3.92	×1.62=	15.84		1/2×	1.20×	3.92 =	2.35	37.28
	Dv2	1/2×	1.20×	3.92	×1.62=	4.20	1/3× 1.20 × 2.08+		1.20×	3.92 =	5.54	23.24
depsit presure	Sh1	0.30×	1/2×	3.922	×1.10=	2.54			1/3×	3.92 =	1.31	3.32
	Sh2	0.30×	2.08×	3.922	×1.62=	3.96			1/2×	3.92 =	1.96	7.77
water presure	Wh1		1/2×	3.922	×1.20=	9.23			1/3×	3.92 =	1.31	12.06
	Wh2		2.08×	3.922	×1.20=	9.78			1/2×	3.92 =	1.96	19.18
fluid force	Fd					4.55		1/2×	2.08+	3.92 =	4.96	22.57
					Vertical force=	187.67					Resisting moment=	1,513.91
					Horizontal force=	30.06					Disturbing moment=	64.89

(4) Stability of structure

1) Sliding

$$F_s=\frac{f\times\sum V+\tau\times\ell}{\sum H}=\frac{0.60\times187.67+0.00\times19.40}{30.06}=3.746\ >=Fs=\ 1.20\ \text{O.K}$$

2) Overturning

$$e=\frac{M_r+M_0}{\sum V}-\frac{B}{2}=\left|\frac{1,513.91+64.89}{187.67}-\frac{19.40}{2}\right|=1.29\ <=B0/6=\ 3.23\ \text{O.K}$$

3) Subgrage reaction

$$\sigma=\frac{\sum V}{B_0}\cdot\left(1\pm\frac{6e}{B_0}\right)=\frac{187.67}{19.40}\left(1\pm\frac{6\times3.233}{19.40}\right)\begin{cases}\sigma d=\ 13.52\ \text{t/m2(downstreem)}\\ \sigma u=\ 5.82\ \text{t/m2(upperstreem)}\end{cases}$$