

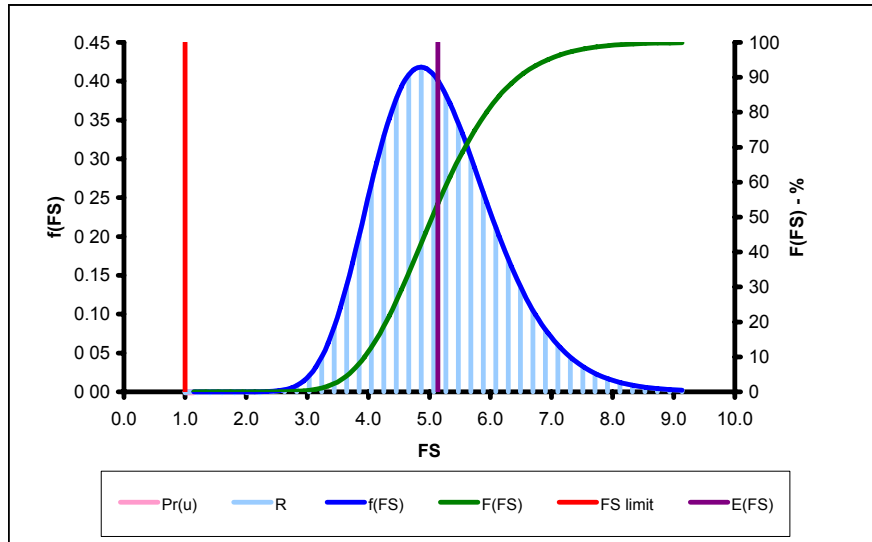
Bolivar Dam Seepage Reliability Analysis - Seepage Barrier and Downstream Blanket Augmentation

Station | **Pool Elevation (ft)** | **Probability of Unsatisfactory Performance Due To Through Seepage**

43+00 | 952

Taylor's Series Results

Case	Random Variables						FS _(progressive erosion) (Through Seepage)	Variance (FS)	% of Variance (FS)
	K _{X_{ig}} , foundation gravel K _x (ft/s)	K _{X_{iss}} , foundation silty sand K _x (ft/s)	K _{Y_{iss}/K_{X_{iss}}} , foundation silty sand K _y /K _x	γ _{sat} , unit weight (pcf)	φ, friction angle (degrees)	TW, tail water elevation (ft)			
Mean (Expected)	3.3E-02	2.8E-03	8.5E-02	120.0	33.0	906.0	5.14		
Mean + 1σ K _{X_{ig}}	4.1E-02	2.8E-03	8.5E-02	120.0	33.0	906.0	5.11		
Mean - 1σ K _{X_{ig}}	2.5E-02	2.8E-03	8.5E-02	120.0	33.0	906.0	5.18	0.00122	0.12
Mean + 1σ K _{X_{iss}}	3.3E-02	3.4E-03	8.5E-02	120.0	33.0	906.0	5.11		
Mean - 1σ K _{X_{iss}}	3.3E-02	2.2E-03	8.5E-02	120.0	33.0	906.0	5.18	0.00122	0.12
Mean + 1σ K _{Y_{iss}/K_{X_{iss}}}	3.3E-02	2.8E-03	1.1E-01	120.0	33.0	906.0	4.60		
Mean - 1σ K _{Y_{iss}/K_{X_{iss}}}	3.3E-02	2.8E-03	6.4E-02	120.0	33.0	906.0	6.27	0.69723	69.82
Mean + 1σ γ _{sat}	3.3E-02	2.8E-03	8.5E-02	124.0	33.0	906.0	5.50		
Mean - 1σ γ _{sat}	3.3E-02	2.8E-03	8.5E-02	116.0	33.0	906.0	4.79	0.12603	12.62
Mean + 1σ φ	3.3E-02	2.8E-03	8.5E-02	120.0	35.0	906.0	5.55		
Mean - 1σ φ	3.3E-02	2.8E-03	8.5E-02	120.0	31.0	906.0	4.76	0.15603	15.62
Mean + 1σ TW	3.3E-02	2.8E-03	8.5E-02	120.0	33.0	908.0	4.96		
Mean - 1σ TW	3.3E-02	2.8E-03	8.5E-02	120.0	33.0	904.0	5.22	0.01690	1.69
Total								0.99863	100.00



E(FS) =	5.14
σ(FS) =	1.00
V(FS) =	19.4%
E(ln FS) =	1.62
σ(ln FS) =	0.19
FS limit =	1.00
ln FS limit =	0.00

β _{in} =	8.4
Pr(u) =	0.00000%
R =	100.00000%

E(X) = expected (mean) value for X; σ(X) = standard deviation for X; V(X) = coefficient of variation for X; FS = factor of safety; FS limit = FS limit state

Pr(u) = probability of unsatisfactory performance = probability that FS against progressive erosion is less than 1.0; R = reliability = 1-Pr(u); β_{in} = reliability index

f(FS) is a probability density function (PDF); F(FS) is a cumulative distribution function (CDF); FS assumed lognormally distributed

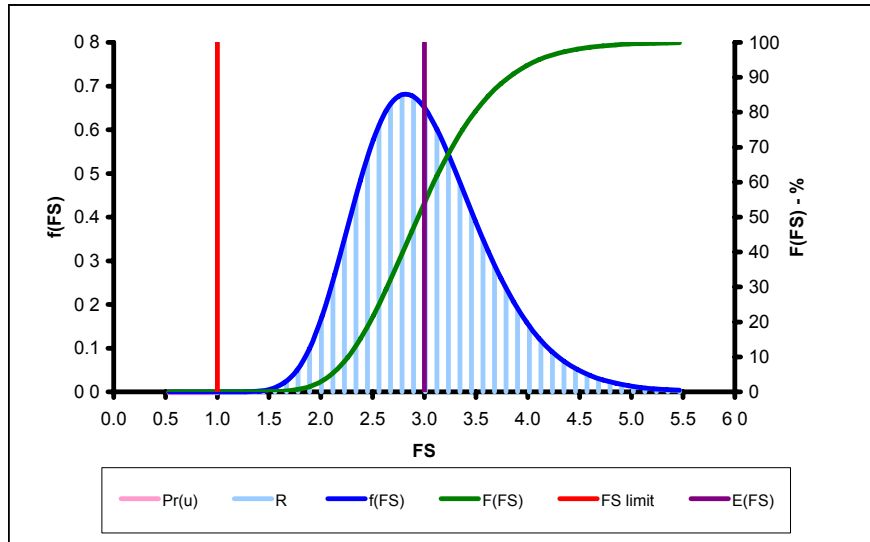
Bolivar Dam Seepage Reliability Analysis - Seepage Barrier and Downstream Blanket Augmentation

Station Pool Elevation (ft) **Probability of Unsatisfactory Performance Due To Through Seepage**

43+00 962

Taylor's Series Results

Case	Random Variables						FS _(progressive erosion) (Through Seepage)	Variance (FS)	% of Variance (FS)
	K _{x_{ig}} , foundation gravel Kx (ft/s)	K _{x_{iss}} , foundation silty sand Kx (ft/s)	K _{y_{iss}} /K _{x_{iss}} , foundation silty sand K _y /K _x	γ _{sat} , unit weight (pcf)	φ, friction angle (degrees)	TW, tail water elevation (ft)			
Mean (Expected)	3.3E-02	2.8E-03	8.5E-02	120.0	33.0	908.5	3.00		
Mean + 1σ K _{x_{ig}}	4.1E-02	2.8E-03	8.5E-02	120.0	33.0	908.5	2.99		
Mean - 1σ K _{x_{ig}}	2.5E-02	2.8E-03	8.5E-02	120.0	33.0	908.5	3.04	0.00062	0.16
Mean + 1σ K _{x_{iss}}	3.3E-02	3.4E-03	8.5E-02	120.0	33.0	908.5	3.03		
Mean - 1σ K _{x_{iss}}	3.3E-02	2.2E-03	8.5E-02	120.0	33.0	908.5	2.99	0.00040	0.11
Mean + 1σ K _{y_{iss}} /K _{x_{iss}}	3.3E-02	2.8E-03	1.1E-01	120.0	33.0	908.5	2.83		
Mean - 1σ K _{y_{iss}} /K _{x_{iss}}	3.3E-02	2.8E-03	6.4E-02	120.0	33.0	908.5	3.36	0.07023	18.49
Mean + 1σ γ _{sat}	3.3E-02	2.8E-03	8.5E-02	124.0	33.0	908.5	3.21		
Mean - 1σ γ _{sat}	3.3E-02	2.8E-03	8.5E-02	116.0	33.0	908.5	2.79	0.04410	11.61
Mean + 1σ φ	3.3E-02	2.8E-03	8.5E-02	120.0	35.0	908.5	3.23		
Mean - 1σ φ	3.3E-02	2.8E-03	8.5E-02	120.0	31.0	908.5	2.77	0.05290	13.93
Mean + 1σ TW	3.3E-02	2.8E-03	8.5E-02	120.0	33.0	911.3	3.75		
Mean - 1σ TW	3.3E-02	2.8E-03	8.5E-02	120.0	33.0	905.7	2.83	0.21160	55.71
Total								0.37985	100.00



E(FS) =	3.00
σ(FS) =	0.62
V(FS) =	20.5%
E(ln FS) =	1.08
σ(ln FS) =	0.20
FS limit =	1.00
ln FS limit =	0.00

β _{in} =	5.3
Pr(u) =	0.00001%
R =	99.99999%

E(X) = expected (mean) value for X; σ(X) = standard deviation for X; V(X) = coefficient of variation for X; FS = factor of safety; FS limit = FS limit state

Pr(u) = probability of unsatisfactory performance = probability that FS against progressive erosion is less than 1.0; R = reliability = 1-Pr(u); β_{in} = reliability index

f(FS) is a probability density function (PDF); F(FS) is a cumulative distribution function (CDF); FS assumed lognormally distributed

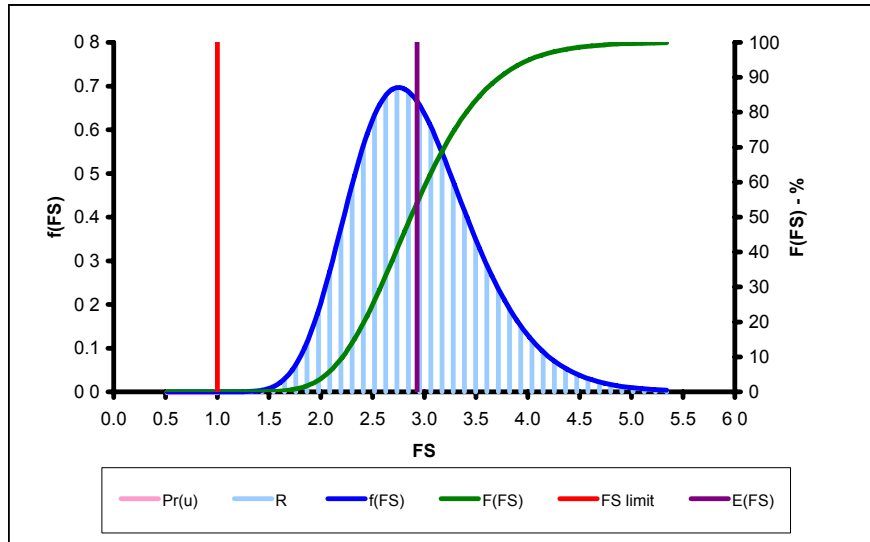
Bolivar Dam Seepage Reliability Analysis - Seepage Barrier and Downstream Blanket Augmentation

Station **Pool Elevation (ft)** **Probability of Unsatisfactory Performance Due To Through Seepage**

43+00 964

Taylor's Series Results

Case	Random Variables						FS _(progressive erosion) (Through Seepage)	Variance (FS)	% of Variance (FS)
	K _{x_{ig}} , foundation gravel K _x (ft/s)	K _{x_{iss}} , foundation silty sand K _x (ft/s)	K _{y_{iss}} /K _{x_{iss}} , foundation silty sand K _y /K _x	γ _{sat} , unit weight (pcf)	φ, friction angle (degrees)	TW, tail water elevation (ft)			
Mean (Expected)	3.3E-02	2.8E-03	8.5E-02	120.0	33.0	908.5	2.93		
Mean + 1σ K _{x_{ig}}	4.1E-02	2.8E-03	8.5E-02	120.0	33.0	908.5	2.92		
Mean - 1σ K _{x_{ig}}	2.5E-02	2.8E-03	8.5E-02	120.0	33.0	908.5	2.97	0.00063	0.17
Mean + 1σ K _{x_{iss}}	3.3E-02	3.4E-03	8.5E-02	120.0	33.0	908.5	2.96		
Mean - 1σ K _{x_{iss}}	3.3E-02	2.2E-03	8.5E-02	120.0	33.0	908.5	2.92	0.00040	0.11
Mean + 1σ K _{y_{iss}} /K _{x_{iss}}	3.3E-02	2.8E-03	1.1E-01	120.0	33.0	908.5	2.76		
Mean - 1σ K _{y_{iss}} /K _{x_{iss}}	3.3E-02	2.8E-03	6.4E-02	120.0	33.0	908.5	3.28	0.06760	18.58
Mean + 1σ γ _{sat}	3.3E-02	2.8E-03	8.5E-02	124.0	33.0	908.5	3.14		
Mean - 1σ γ _{sat}	3.3E-02	2.8E-03	8.5E-02	116.0	33.0	908.5	2.73	0.04203	11.55
Mean + 1σ φ	3.3E-02	2.8E-03	8.5E-02	120.0	35.0	908.5	3.16		
Mean - 1σ φ	3.3E-02	2.8E-03	8.5E-02	120.0	31.0	908.5	2.71	0.05063	13.92
Mean + 1σ TW	3.3E-02	2.8E-03	8.5E-02	120.0	33.0	911.3	3.66		
Mean - 1σ TW	3.3E-02	2.8E-03	8.5E-02	120.0	33.0	905.7	2.76	0.20250	55.67
Total								0.36378	100.00



E(FS) =	2.93
σ(FS) =	0.60
V(FS) =	20.6%
E(ln FS) =	1.05
σ(ln FS) =	0.20
FS limit =	1.00
ln FS limit =	0.00

β _{in} =	5.2
Pr(u) =	0.00001%
R =	99.99999%

E(X) = expected (mean) value for X; σ(X) = standard deviation for X; V(X) = coefficient of variation for X; FS = factor of safety; FS limit = FS limit state

Pr(u) = probability of unsatisfactory performance = probability that FS against progressive erosion is less than 1.0; R = reliability = 1-Pr(u); β_n = reliability index

f(FS) is a probability density function (PDF); F(FS) is a cumulative distribution function (CDF); FS assumed lognormally distributed

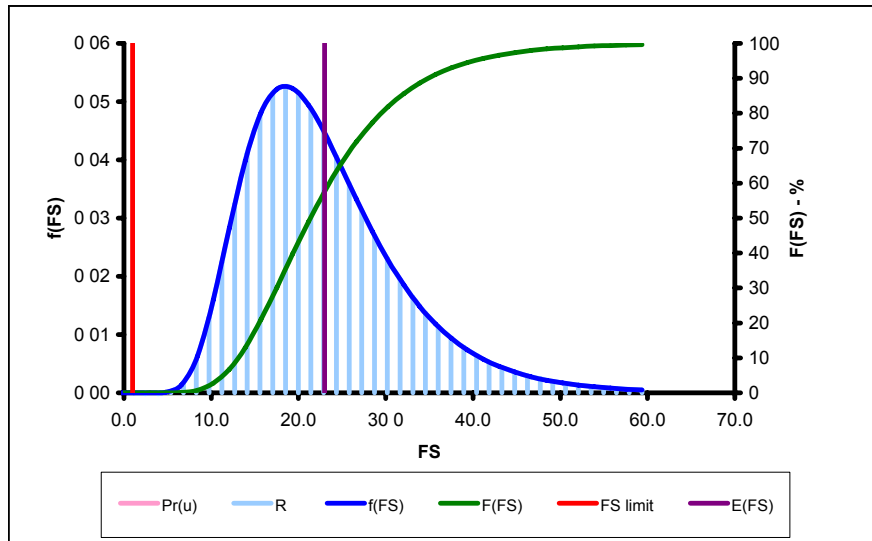
Bolivar Dam Seepage Reliability Analysis - Seepage Barrier and Downstream Blanket Augmentation

Station | **Pool Elevation (ft)** | **Probability of Unsatisfactory Performance Due To Through Seepage**

43+00 | 982

Taylor's Series Results

Case	Random Variables						FS _(progressive erosion) (Through Seepage)	Variance (FS)	% of Variance (FS)
	K _{X_{ig}} , foundation gravel K _x (ft/s)	K _{X_{iss}} , foundation silty sand K _x (ft/s)	K _{Y_{iss}/K_{X_{iss}}} , foundation silty sand K _y /K _x	γ _{sat} , unit weight (pcf)	φ, friction angle (degrees)	TW, tail water elevation (ft)			
Mean (Expected)	3.3E-02	2.8E-03	8.5E-02	120.0	33.0	930.0	22.98		
Mean + 1σ K _{X_{ig}}	4.1E-02	2.8E-03	8.5E-02	120.0	33.0	930.0	26.58		
Mean - 1σ K _{X_{ig}}	2.5E-02	2.8E-03	8.5E-02	120.0	33.0	930.0	18.22	17.47240	21.12
Mean + 1σ K _{X_{iss}}	3.3E-02	3.4E-03	8.5E-02	120.0	33.0	930.0	19.33		
Mean - 1σ K _{X_{iss}}	3.3E-02	2.2E-03	8.5E-02	120.0	33.0	930.0	26.58	13.14063	15.89
Mean + 1σ K _{Y_{iss}/K_{X_{iss}}}	3.3E-02	2.8E-03	1.1E-01	120.0	33.0	930.0	18.22		
Mean - 1σ K _{Y_{iss}/K_{X_{iss}}}	3.3E-02	2.8E-03	6.4E-02	120.0	33.0	930.0	27.94	23.61960	28.55
Mean + 1σ γ _{sat}	3.3E-02	2.8E-03	8.5E-02	124.0	33.0	930.0	24.57		
Mean - 1σ γ _{sat}	3.3E-02	2.8E-03	8.5E-02	116.0	33.0	930.0	21.38	2.54403	3.08
Mean + 1σ φ	3.3E-02	2.8E-03	8.5E-02	120.0	35.0	930.0	24.78		
Mean - 1σ φ	3.3E-02	2.8E-03	8.5E-02	120.0	31.0	930.0	21.26	3.09760	3.74
Mean + 1σ TW	3.3E-02	2.8E-03	8.5E-02	120.0	33.0	933.3	25.51		
Mean - 1σ TW	3.3E-02	2.8E-03	8.5E-02	120.0	33.0	926.7	15.95	22.84840	27.62
Total								82.72265	100.00



E(FS) =	22.98
σ(FS) =	9.10
V(FS) =	39.6%
E(ln FS) =	3.06
σ(ln FS) =	0.38
FS limit =	1.00
ln FS limit =	0.00

β _{in} =	8.0
Pr(u) =	0.00000%
R =	100.00000%

E(X) = expected (mean) value for X; σ(X) = standard deviation for X; V(X) = coefficient of variation for X; FS = factor of safety; FS limit = FS limit state

Pr(u) = probability of unsatisfactory performance = probability that FS against progressive erosion is less than 1.0; R = reliability = 1-Pr(u); β_{in} = reliability index

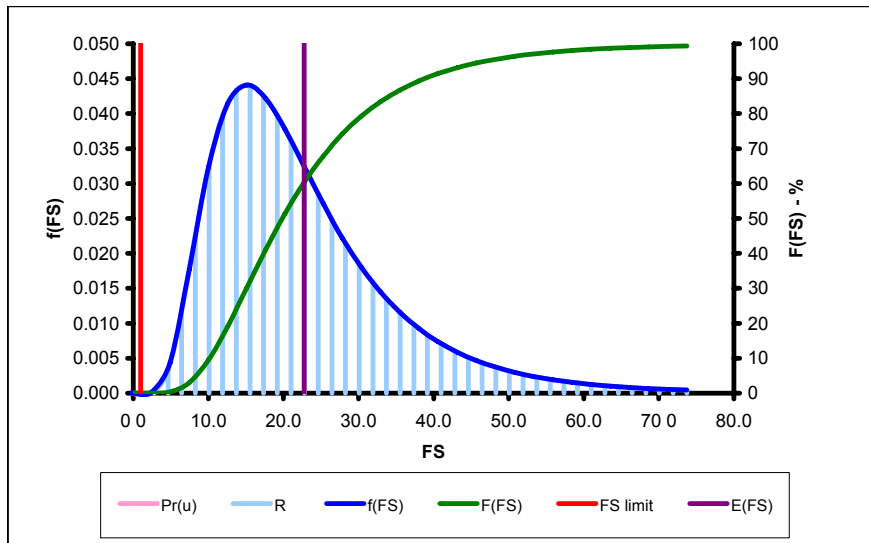
f(FS) is a probability density function (PDF); F(FS) is a cumulative distribution function (CDF); FS assumed lognormally distributed

Bolivar Dam Seepage Reliability Analysis - Seepage Barrier and Downstream Blanket Augmentation

Station **43+00** Pool Elevation (ft) **964** Probability of Unsatisfactory Performance Due To Under Seepage

Taylor's Series Results

Case	Random Variables					FS _(progressive erosion) (Under Seepage)	Variance (FS)	% of Variance (FS)	
	Kx _w , relief well Kx (ft/s)	Ky _B , D/S blanket (ft/s)	Ky _D , D/S blanket (ft/s)	γ _{sat} , unit weight (pcf)	Bt _{D/S} , D/S blanket thickness (ft)				TW, tail water elevation (ft)
Mean (Expected)	3.3E-03	1.7E-04		120.0	6.0	908.5	22.75		
Mean + 1σ Kx _w	6.3E-03	1.7E-04		120.0	6.0	908.5	23.59		
Mean - 1σ Kx _w	3.3E-04	1.7E-04		120.0	6.0	908.5	16.33	13.17690	
Mean + 1σ Ky _B	3.3E-03	3.3E-04		120.0	6.0	908.5	25.48		
Mean - 1σ Ky _B	3.3E-03	7.0E-06		120.0	6.0	908.5	18.73	11.39063	
Mean + 1σ γ _{sat}	3.3E-03	1.7E-04		124.0	6.0	908.5	24.33		
Mean - 1σ γ _{sat}	3.3E-03	1.7E-04		116.0	6.0	908.5	21.17	2.49640	
Mean + 1σ Bt _{D/S}	3.3E-03	1.7E-04		120.0	7.5	908.5	22.75		
Mean - 1σ Bt _{D/S}	3.3E-03	1.7E-04		120.0	4.5	908.5	2.68	100.70123	
Mean + 1σ TW	3.3E-03	1.7E-04		120.0	6.0	911.3	27.69		
Mean - 1σ TW	3.3E-03	1.7E-04		120.0	6.0	905.7	15.92	34.63323	
								21.33	
							Total	162.39838	100.00



E(FS) =	22.75
σ(FS) =	12.74
V(FS) =	56.0%
E(ln FS) =	2.99
σ(ln FS) =	0.52
FS limit =	1.00
ln FS limit =	0.00
β _{in} =	5.7
Pr(u) =	0.00000%
R =	100.00000%

E(X) = expected (mean) value for X; σ(X) = standard deviation for X; V(X) = coefficient of variation for X; FS = factor of safety; FS limit = FS limit state
 Pr(u) = probability of unsatisfactory performance = probability that FS against progressive erosion is less than 1.0; R = reliability = 1-Pr(u); β_n = reliability index
 f(FS) is a probability density function (PDF); F(FS) is a cumulative distribution function (CDF); FS assumed lognormally distributed

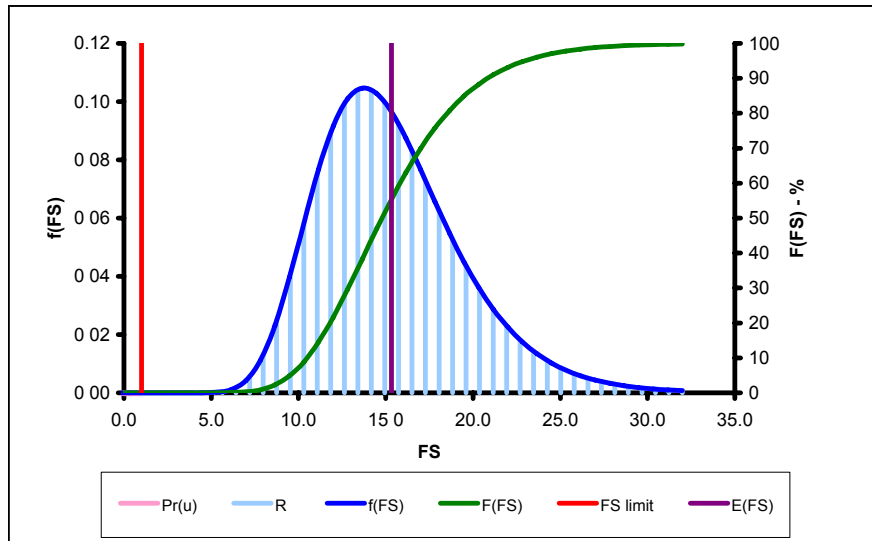
Bolivar Dam Seepage Reliability Analysis - Seepage Barrier and Downstream Blanket Augmentation

Station **Pool Elevation (ft)** **Probability of Unsatisfactory Performance Due To Through Seepage**

49+00 936

Taylor's Series Results

Case	Random Variables						FS _(progressive erosion) (Through Seepage)	Variance (FS)	% of Variance (FS)
	K _{X_{ig}} , foundation gravel Kx (ft/s)	K _{X_{iss}} , foundation silty sand Kx (ft/s)	K _{Y_{iss}/K_{X_{iss}}} , foundation silty sand Ky/Kx	γ _{sat} , unit weight (pcf)	φ, friction angle (degrees)	TW, tail water elevation (ft)			
Mean (Expected)	3.3E-02	2.8E-03	8.5E-02	120.0	33.0	894.0	15.32		
Mean + 1σ _{K_{X_{ig}}}	4.1E-02	2.8E-03	8.5E-02	120.0	33.0	894.0	13.79		
Mean - 1σ _{K_{X_{ig}}}	2.5E-02	2.8E-03	8.5E-02	120.0	33.0	894.0	15.32	0.58523	3.37
Mean + 1σ _{K_{X_{iss}}}	3.3E-02	3.4E-03	8.5E-02	120.0	33.0	894.0	19.70		
Mean - 1σ _{K_{X_{iss}}}	3.3E-02	2.2E-03	8.5E-02	120.0	33.0	894.0	13.79	8.73203	50.21
Mean + 1σ _{K_{Y_{iss}/K_{X_{iss}}}}	3.3E-02	2.8E-03	1.1E-01	120.0	33.0	894.0	16.81		
Mean - 1σ _{K_{Y_{iss}/K_{X_{iss}}}}	3.3E-02	2.8E-03	6.4E-02	120.0	33.0	894.0	12.09	5.56960	32.03
Mean + 1σ _{γ_{sat}}	3.3E-02	2.8E-03	8.5E-02	124.0	33.0	894.0	16.38		
Mean - 1σ _{γ_{sat}}	3.3E-02	2.8E-03	8.5E-02	116.0	33.0	894.0	14.26	1.12360	6.46
Mean + 1σ _φ	3.3E-02	2.8E-03	8.5E-02	120.0	35.0	894.0	16.52		
Mean - 1σ _φ	3.3E-02	2.8E-03	8.5E-02	120.0	31.0	894.0	14.17	1.38063	7.94
Mean + 1σ _{TW}	3.3E-02	2.8E-03	8.5E-02	120.0	33.0	894.7	15.32		
Mean - 1σ _{TW}	3.3E-02	2.8E-03	8.5E-02	120.0	33.0	893.3	15.32	0.00000	0.00
Total								17.39108	100.00



E(FS) =	15.32
σ(FS) =	4.17
V(FS) =	27.2%
E(ln FS) =	2.69
σ(ln FS) =	0.27
FS limit =	1.00
ln FS limit =	0.00

β _{in} =	10.1
Pr(u) =	0.00000%
R =	100.00000%

E(X) = expected (mean) value for X; σ(X) = standard deviation for X; V(X) = coefficient of variation for X; FS = factor of safety; FS limit = FS limit state

Pr(u) = probability of unsatisfactory performance = probability that FS against progressive erosion is less than 1.0; R = reliability = 1-Pr(u); β_{in} = reliability index

f(FS) is a probability density function (PDF); F(FS) is a cumulative distribution function (CDF); FS assumed lognormally distributed

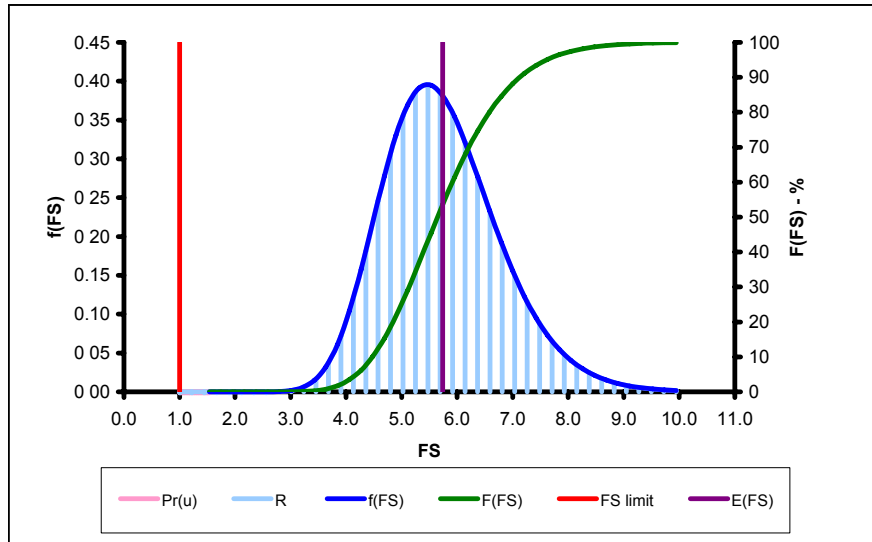
Bolivar Dam Seepage Reliability Analysis - Seepage Barrier and Downstream Blanket Augmentation

Station Pool Elevation (ft) **Probability of Unsatisfactory Performance Due To Through Seepage**

49+00 949

Taylor's Series Results

Case	Random Variables						FS _(progressive erosion) (Through Seepage)	Variance (FS)	% of Variance (FS)
	K _{X_{ig}} , foundation gravel K _x (ft/s)	K _{X_{iss}} , foundation silty sand K _x (ft/s)	K _{Y_{iss}/K_{X_{iss}}} , foundation silty sand K _y /K _x	γ _{sat} , unit weight (pcf)	φ, friction angle (degrees)	TW, tail water elevation (ft)			
Mean (Expected)	3.3E-02	2.8E-03	8.5E-02	120.0	33.0	896.0	5.74		
Mean + 1σ K _{X_{ig}}	4.1E-02	2.8E-03	8.5E-02	120.0	33.0	896.0	5.74		
Mean - 1σ K _{X_{ig}}	2.5E-02	2.8E-03	8.5E-02	120.0	33.0	896.0	5.51	0.01323	1.20
Mean + 1σ K _{X_{iss}}	3.3E-02	3.4E-03	8.5E-02	120.0	33.0	896.0	5.74		
Mean - 1σ K _{X_{iss}}	3.3E-02	2.2E-03	8.5E-02	120.0	33.0	896.0	5.30	0.04840	4.38
Mean + 1σ K _{Y_{iss}/K_{X_{iss}}}	3.3E-02	2.8E-03	1.1E-01	120.0	33.0	896.0	4.60		
Mean - 1σ K _{Y_{iss}/K_{X_{iss}}}	3.3E-02	2.8E-03	6.4E-02	120.0	33.0	896.0	6.27	0.69723	63.15
Mean + 1σ γ _{sat}	3.3E-02	2.8E-03	8.5E-02	124.0	33.0	896.0	6.14		
Mean - 1σ γ _{sat}	3.3E-02	2.8E-03	8.5E-02	116.0	33.0	896.0	5.35	0.15603	14.13
Mean + 1σ φ	3.3E-02	2.8E-03	8.5E-02	120.0	35.0	896.0	6.19		
Mean - 1σ φ	3.3E-02	2.8E-03	8.5E-02	120.0	31.0	896.0	5.32	0.18923	17.14
Mean + 1σ TW	3.3E-02	2.8E-03	8.5E-02	120.0	33.0	897.3	5.74		
Mean - 1σ TW	3.3E-02	2.8E-03	8.5E-02	120.0	33.0	894.7	5.74	0.00000	0.00
Total								1.10410	100.00



E(FS) =	5.74
σ(FS) =	1.05
V(FS) =	18.3%
E(ln FS) =	1.73
σ(ln FS) =	0.18
FS limit =	1.00
ln FS limit =	0.00

β _{in} =	9.5
Pr(u) =	0.00000%
R =	100.00000%

E(X) = expected (mean) value for X; σ(X) = standard deviation for X; V(X) = coefficient of variation for X; FS = factor of safety; FS limit = FS limit state

Pr(u) = probability of unsatisfactory performance = probability that FS against progressive erosion is less than 1.0; R = reliability = 1-Pr(u); β_{in} = reliability index

f(FS) is a probability density function (PDF); F(FS) is a cumulative distribution function (CDF); FS assumed lognormally distributed

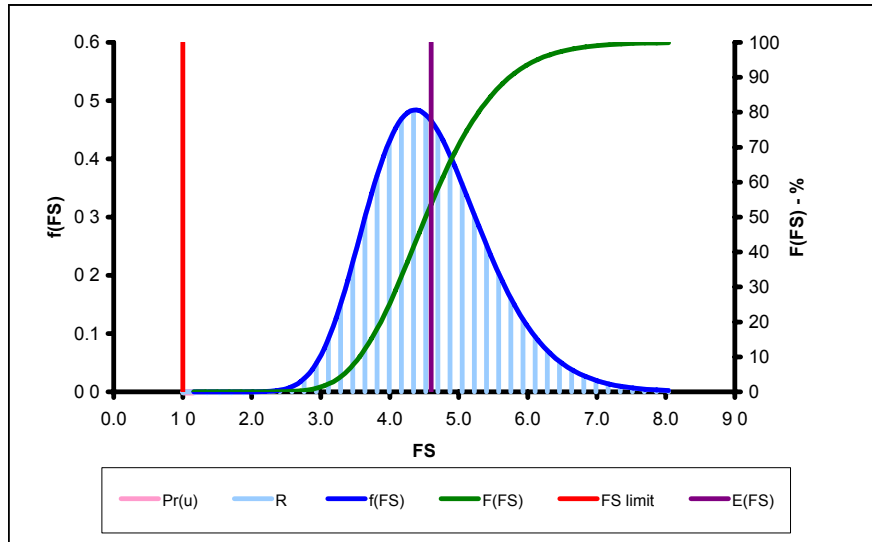
Bolivar Dam Seepage Reliability Analysis - Seepage Barrier and Downstream Blanket Augmentation

Station Pool Elevation (ft) **Probability of Unsatisfactory Performance Due To Through Seepage**

49+00 952

Taylor's Series Results

Case	Random Variables						FS _(progressive erosion) (Through Seepage)	Variance (FS)	% of Variance (FS)
	K _{X_{ig}} , foundation gravel K _x (ft/s)	K _{X_{iss}} , foundation silty sand K _x (ft/s)	K _{Y_{iss}/K_{X_{iss}}} , foundation silty sand K _y /K _x	γ _{sat} , unit weight (pcf)	φ, friction angle (degrees)	TW, tail water elevation (ft)			
Mean (Expected)	3.3E-02	2.8E-03	8.5E-02	120.0	33.0	906.0	4.60		
Mean + 1σ K _{X_{ig}}	4.1E-02	2.8E-03	8.5E-02	120.0	33.0	906.0	4.60		
Mean - 1σ K _{X_{ig}}	2.5E-02	2.8E-03	8.5E-02	120.0	33.0	906.0	4.60	0.00000	0.00
Mean + 1σ K _{X_{iss}}	3.3E-02	3.4E-03	8.5E-02	120.0	33.0	906.0	4.92		
Mean - 1σ K _{X_{iss}}	3.3E-02	2.2E-03	8.5E-02	120.0	33.0	906.0	4.45	0.05522	7.46
Mean + 1σ K _{Y_{iss}/K_{X_{iss}}}	3.3E-02	2.8E-03	1.1E-01	120.0	33.0	906.0	4.06		
Mean - 1σ K _{Y_{iss}/K_{X_{iss}}}	3.3E-02	2.8E-03	6.4E-02	120.0	33.0	906.0	5.30	0.38440	51.91
Mean + 1σ γ _{sat}	3.3E-02	2.8E-03	8.5E-02	124.0	33.0	906.0	4.91		
Mean - 1σ γ _{sat}	3.3E-02	2.8E-03	8.5E-02	116.0	33.0	906.0	4.28	0.09923	13.40
Mean + 1σ φ	3.3E-02	2.8E-03	8.5E-02	120.0	35.0	906.0	4.96		
Mean - 1σ φ	3.3E-02	2.8E-03	8.5E-02	120.0	31.0	906.0	4.25	0.12603	17.02
Mean + 1σ TW	3.3E-02	2.8E-03	8.5E-02	120.0	33.0	908.0	5.30		
Mean - 1σ TW	3.3E-02	2.8E-03	8.5E-02	120.0	33.0	904.0	4.75	0.07563	10.21
Total								0.74050	100.00



E(FS) =	4.60
σ(FS) =	0.86
V(FS) =	18.7%
E(ln FS) =	1.51
σ(ln FS) =	0.19
FS limit =	1.00
ln FS limit =	0.00

β _{in} =	8.1
Pr(u) =	0.00000%
R =	100.00000%

E(X) = expected (mean) value for X; σ(X) = standard deviation for X; V(X) = coefficient of variation for X; FS = factor of safety; FS limit = FS limit state

Pr(u) = probability of unsatisfactory performance = probability that FS against progressive erosion is less than 1.0; R = reliability = 1-Pr(u); β_{in} = reliability index

f(FS) is a probability density function (PDF); F(FS) is a cumulative distribution function (CDF); FS assumed lognormally distributed

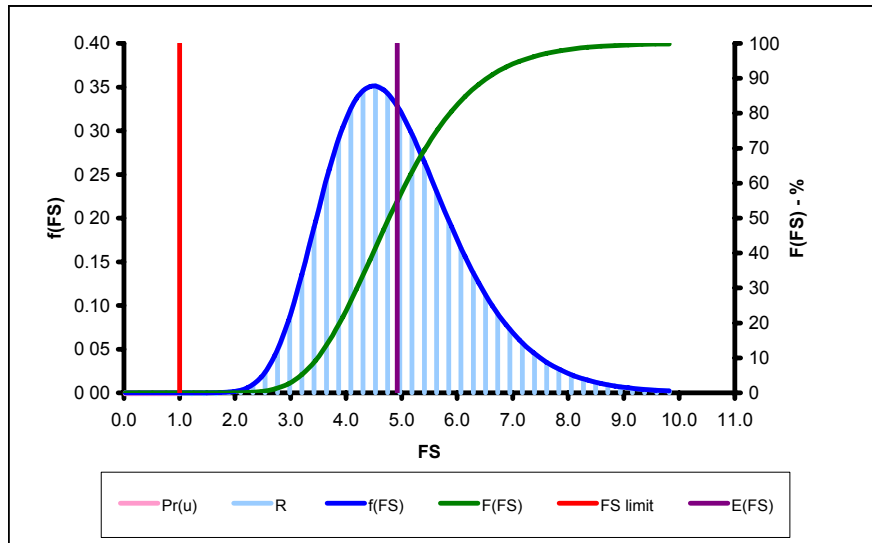
Bolivar Dam Seepage Reliability Analysis - Seepage Barrier and Downstream Blanket Augmentation

Station Pool Elevation (ft) **Probability of Unsatisfactory Performance Due To Through Seepage**

49+00 962

Taylor's Series Results

Case	Random Variables						FS _(progressive erosion) (Through Seepage)	Variance (FS)	% of Variance (FS)
	K _{X_{ig}} , foundation gravel K _x (ft/s)	K _{X_{iss}} , foundation silty sand K _x (ft/s)	K _{Y_{iss}/K_{X_{iss}}} , foundation silty sand K _y /K _x	γ _{sat} , unit weight (pcf)	φ, friction angle (degrees)	TW, tail water elevation (ft)			
Mean (Expected)	3.3E-02	2.8E-03	8.5E-02	120.0	33.0	908.5	4.92		
Mean + 1σ K _{X_{ig}}	4.1E-02	2.8E-03	8.5E-02	120.0	33.0	908.5	4.34		
Mean - 1σ K _{X_{ig}}	2.5E-02	2.8E-03	8.5E-02	120.0	33.0	908.5	5.26	0.21160	14.12
Mean + 1σ K _{X_{iss}}	3.3E-02	3.4E-03	8.5E-02	120.0	33.0	908.5	5.26		
Mean - 1σ K _{X_{iss}}	3.3E-02	2.2E-03	8.5E-02	120.0	33.0	908.5	4.61	0.10563	7.05
Mean + 1σ K _{Y_{iss}/K_{X_{iss}}}	3.3E-02	2.8E-03	1.1E-01	120.0	33.0	908.5	4.61		
Mean - 1σ K _{Y_{iss}/K_{X_{iss}}}	3.3E-02	2.8E-03	6.4E-02	120.0	33.0	908.5	6.14	0.58523	39.05
Mean + 1σ γ _{sat}	3.3E-02	2.8E-03	8.5E-02	124.0	33.0	908.5	5.27		
Mean - 1σ γ _{sat}	3.3E-02	2.8E-03	8.5E-02	116.0	33.0	908.5	4.58	0.11903	7.94
Mean + 1σ φ	3.3E-02	2.8E-03	8.5E-02	120.0	35.0	908.5	5.31		
Mean - 1σ φ	3.3E-02	2.8E-03	8.5E-02	120.0	31.0	908.5	4.56	0.14063	9.38
Mean + 1σ TW	3.3E-02	2.8E-03	8.5E-02	120.0	33.0	911.3	5.26		
Mean - 1σ TW	3.3E-02	2.8E-03	8.5E-02	120.0	33.0	905.7	4.10	0.33640	22.45
Total								1.49850	100.00



E(FS) =	4.92
σ(FS) =	1.22
V(FS) =	24.9%
E(ln FS) =	1.56
σ(ln FS) =	0.25
FS limit =	1.00
ln FS limit =	0.00

β _{in} =	6.4
Pr(u) =	0.00000%
R =	100.00000%

E(X) = expected (mean) value for X; σ(X) = standard deviation for X; V(X) = coefficient of variation for X; FS = factor of safety; FS limit = FS limit state

Pr(u) = probability of unsatisfactory performance = probability that FS against progressive erosion is less than 1.0; R = reliability = 1-Pr(u); β_{in} = reliability index

f(FS) is a probability density function (PDF); F(FS) is a cumulative distribution function (CDF); FS assumed lognormally distributed

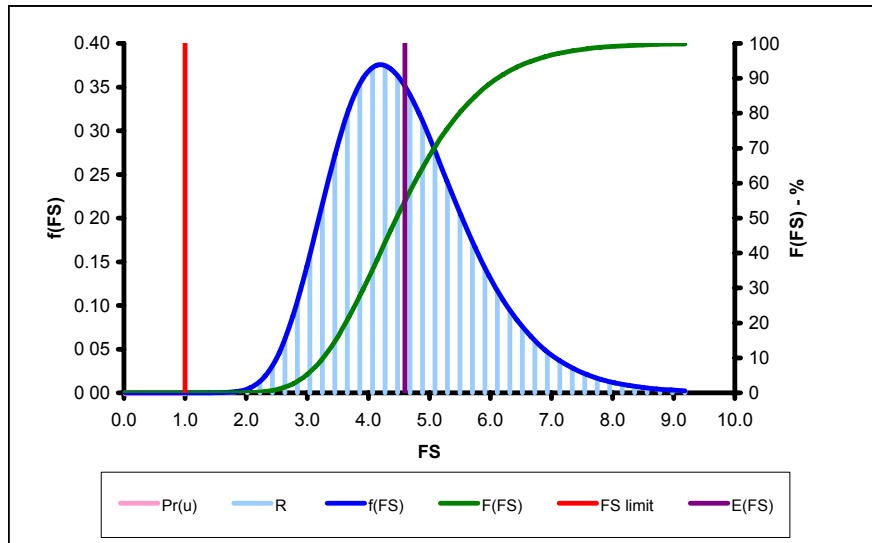
Bolivar Dam Seepage Reliability Analysis - Seepage Barrier and Downstream Blanket Augmentation

Station **Pool Elevation (ft)** **Probability of Unsatisfactory Performance Due To Through Seepage**

49+00 964

Taylor's Series Results

Case	Random Variables						FS _(progressive erosion) (Through Seepage)	Variance (FS)	% of Variance (FS)
	K _{X_{ig}} , foundation gravel K _x (ft/s)	K _{X_{iss}} , foundation silty sand K _x (ft/s)	K _{Y_{iss}/K_{X_{iss}}} , foundation silty sand K _y /K _x	γ _{sat} , unit weight (pcf)	φ, friction angle (degrees)	TW, tail water elevation (ft)			
Mean (Expected)	3.3E-02	2.8E-03	8.5E-02	120.0	33.0	908.5	4.60		
Mean + 1σ K _{X_{ig}}	4.1E-02	2.8E-03	8.5E-02	120.0	33.0	908.5	4.06		
Mean - 1σ K _{X_{ig}}	2.5E-02	2.8E-03	8.5E-02	120.0	33.0	908.5	4.92	0.18490	14.10
Mean + 1σ K _{X_{iss}}	3.3E-02	3.4E-03	8.5E-02	120.0	33.0	908.5	4.92		
Mean - 1σ K _{X_{iss}}	3.3E-02	2.2E-03	8.5E-02	120.0	33.0	908.5	4.31	0.09303	7.09
Mean + 1σ K _{Y_{iss}/K_{X_{iss}}}	3.3E-02	2.8E-03	1.1E-01	120.0	33.0	908.5	4.31		
Mean - 1σ K _{Y_{iss}/K_{X_{iss}}}	3.3E-02	2.8E-03	6.4E-02	120.0	33.0	908.5	5.74	0.51123	38.98
Mean + 1σ γ _{sat}	3.3E-02	2.8E-03	8.5E-02	124.0	33.0	908.5	4.91		
Mean - 1σ γ _{sat}	3.3E-02	2.8E-03	8.5E-02	116.0	33.0	908.5	4.28	0.09923	7.57
Mean + 1σ φ	3.3E-02	2.8E-03	8.5E-02	120.0	35.0	908.5	4.96		
Mean - 1σ φ	3.3E-02	2.8E-03	8.5E-02	120.0	31.0	908.5	4.25	0.12603	9.61
Mean + 1σ TW	3.3E-02	2.8E-03	8.5E-02	120.0	33.0	911.3	4.92		
Mean - 1σ TW	3.3E-02	2.8E-03	8.5E-02	120.0	33.0	905.7	3.83	0.29703	22.65
Total								1.31143	100.00



E(FS) =	4.60
σ(FS) =	1.15
V(FS) =	24.9%
E(ln FS) =	1.50
σ(ln FS) =	0.25
FS limit =	1.00
ln FS limit =	0.00

β _{in} =	6.1
Pr(u) =	0.00000%
R =	100.00000%

E(X) = expected (mean) value for X; σ(X) = standard deviation for X; V(X) = coefficient of variation for X; FS = factor of safety; FS limit = FS limit state

Pr(u) = probability of unsatisfactory performance = probability that FS against progressive erosion is less than 1.0; R = reliability = 1-Pr(u); β_{in} = reliability index

f(FS) is a probability density function (PDF); F(FS) is a cumulative distribution function (CDF); FS assumed lognormally distributed

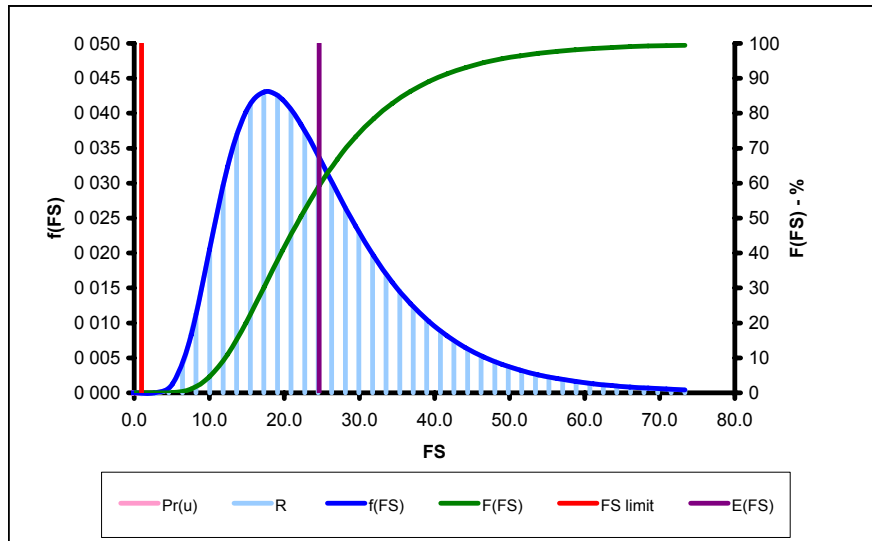
Bolivar Dam Seepage Reliability Analysis - Seepage Barrier and Downstream Blanket Augmentation

Station Pool Elevation (ft) **Probability of Unsatisfactory Performance Due To Through Seepage**

49+00 982

Taylor's Series Results

Case	Random Variables						FS _(progressive erosion) (Through Seepage)	Variance (FS)	% of Variance (FS)
	K _{X_{ig}} , foundation gravel Kx (ft/s)	K _{X_{iss}} , foundation silty sand Kx (ft/s)	K _{Y_{iss}/K_{X_{iss}}} , foundation silty sand Ky/Kx	γ _{sat} , unit weight (pcf)	φ, friction angle (degrees)	TW, tail water elevation (ft)			
Mean (Expected)	3.3E-02	2.8E-03	8.5E-02	120.0	33.0	930.0	24.62		
Mean + 1σ _{K_{X_{ig}}}	4.1E-02	2.8E-03	8.5E-02	120.0	33.0	930.0	28.72		
Mean - 1σ _{K_{X_{ig}}}	2.5E-02	2.8E-03	8.5E-02	120.0	33.0	930.0	19.70	20.34010	13.71
Mean + 1σ _{K_{X_{iss}}}	3.3E-02	3.4E-03	8.5E-02	120.0	33.0	930.0	20.89		
Mean - 1σ _{K_{X_{iss}}}	3.3E-02	2.2E-03	8.5E-02	120.0	33.0	930.0	28.72	15.32723	10.33
Mean + 1σ _{K_{Y_{iss}/K_{X_{iss}}}}	3.3E-02	2.8E-03	1.1E-01	120.0	33.0	930.0	19.15		
Mean - 1σ _{K_{Y_{iss}/K_{X_{iss}}}}	3.3E-02	2.8E-03	6.4E-02	120.0	33.0	930.0	29.97	29.26810	19.73
Mean + 1σ _{γ_{sat}}	3.3E-02	2.8E-03	8.5E-02	124.0	33.0	930.0	26.33		
Mean - 1σ _{γ_{sat}}	3.3E-02	2.8E-03	8.5E-02	116.0	33.0	930.0	22.91	2.92410	1.97
Mean + 1σ _φ	3.3E-02	2.8E-03	8.5E-02	120.0	35.0	930.0	26.54		
Mean - 1σ _φ	3.3E-02	2.8E-03	8.5E-02	120.0	31.0	930.0	22.78	3.53440	2.38
Mean + 1σ _{TW}	3.3E-02	2.8E-03	8.5E-02	120.0	33.0	933.3	7.08		
Mean - 1σ _{TW}	3.3E-02	2.8E-03	8.5E-02	120.0	33.0	926.7	24.62	76.91290	51.86
Total								148.30683	100.00



E(FS) =	24.62
σ(FS) =	12.18
V(FS) =	49.5%
E(ln FS) =	3.09
σ(ln FS) =	0.47
FS limit =	1.00
ln FS limit =	0.00

β _{in} =	6.6
Pr(u) =	0.00000%
R =	100.00000%

E(X) = expected (mean) value for X; σ(X) = standard deviation for X; V(X) = coefficient of variation for X; FS = factor of safety; FS limit = FS limit state

Pr(u) = probability of unsatisfactory performance = probability that FS against progressive erosion is less than 1.0; R = reliability = 1-Pr(u); β_{in} = reliability index

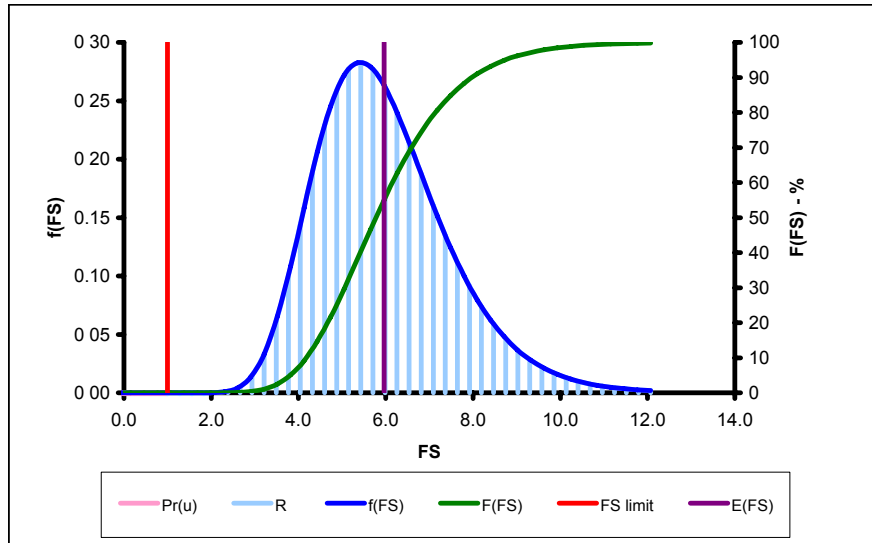
f(FS) is a probability density function (PDF); F(FS) is a cumulative distribution function (CDF); FS assumed lognormally distributed

Bolivar Dam Seepage Reliability Analysis - Seepage Barrier and Downstream Blanket Augmentation

Station 49+00 Pool Elevation (ft) 936 Probability of Unsatisfactory Performance Due To Under Seepage

Taylor's Series Results

Case	Random Variables						FS ^(progressive erosion) (Under Seepage)	Variance (FS)	% of Variance (FS)
	K _x , relief well K _x (ft/s)	K _y , D/S blanket K _y (ft/s)	γ _{sat} , unit weight (pcf)	B _t , D/S blanket thickness (ft)	K _x , rock toe K _x (ft/s)	TW, tail water elevation (ft)			
Mean (Expected)	3.3E-03	1.7E-04	120.0	6.0	1.6E-01	894.0	5.96		
Mean + 1σ K _{xw}	6.3E-03	1.7E-04	120.0	6.0	1.6E-01	894.0	5.96		
Mean - 1σ K _{xw}	3.3E-04	1.7E-04	120.0	6.0	1.6E-01	894.0	5.96	0.00000	0.00
Mean + 1σ K _{yB}	3.3E-03	3.3E-04	120.0	6.0	1.6E-01	894.0	5.96		
Mean - 1σ K _{yB}	3.3E-03	7.0E-06	120.0	6.0	1.6E-01	894.0	5.96	0.00000	0.00
Mean + 1σ γ _{sat}	3.3E-03	1.7E-04	124.0	6.0	1.6E-01	894.0	6.38		
Mean - 1σ γ _{sat}	3.3E-03	1.7E-04	116.0	6.0	1.6E-01	894.0	5.55	0.17223	7.38
Mean + 1σ B _{tD/S}	3.3E-03	1.7E-04	120.0	7.5	1.6E-01	894.0	5.96		
Mean - 1σ B _{tD/S}	3.3E-03	1.7E-04	120.0	4.5	1.6E-01	894.0	3.04	2.13160	91.38
Mean + 1σ K _{xrt}	3.3E-03	1.7E-04	120.0	6.0	3.0E-01	894.0	5.96		
Mean - 1σ K _{xrt}	3.3E-03	1.7E-04	120.0	6.0	1.6E-02	894.0	5.96	0.00000	0.00
Mean + 1σ TW	3.3E-03	1.7E-04	120.0	6.0	1.6E-01	894.7	5.96		
Mean - 1σ TW	3.3E-03	1.7E-04	120.0	6.0	1.6E-01	893.3	5.62	0.02890	1.24
Total								2.33273	100.00



E(FS) =	5.96
σ(FS) =	1.53
V(FS) =	25.6%
E(ln FS) =	1.75
σ(ln FS) =	0.25
FS limit =	1.00
ln FS limit =	0.00

β _{ln} =	7.0
Pr(u) =	0.00000%
R =	100.00000%

E(X) = expected (mean) value for X; σ(X) = standard deviation for X; V(X) = coefficient of variation for X; FS = factor of safety; FS limit = FS limit state

Pr(u) = probability of unsatisfactory performance = probability that FS against progressive erosion is less than 1.0; R = reliability = 1-Pr(u); β_{ln} = reliability index

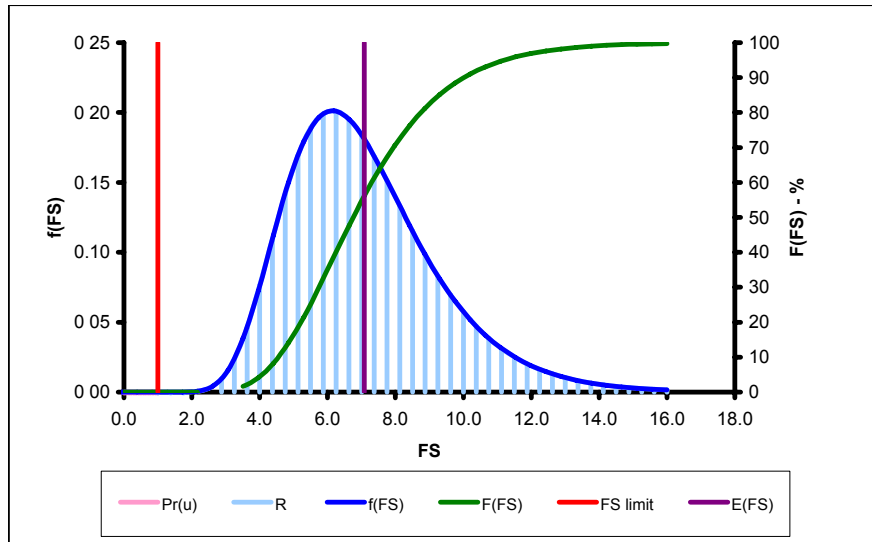
f(FS) is a probability density function (PDF); F(FS) is a cumulative distribution function (CDF); FS assumed lognormally distributed

Bolivar Dam Seepage Reliability Analysis - Seepage Barrier and Downstream Blanket Augmentation

Station 49+00 Pool Elevation (ft) 949 Probability of Unsatisfactory Performance Due To Under Seepage

Taylor's Series Results

Case	Random Variables						FS (progressive erosion) (Under Seepage)	Variance (FS)	% of Variance (FS)
	Kx _{rw} , relief well Kx (ft/s)	Ky _B , D/S blanket Ky (ft/s)	Y _{sat} , unit weight (pcf)	Bt _{D/S} , D/S blanket thickness (ft)	Kx _{rt} , rock toe Kx (ft/s)	TW, tail water elevation (ft)			
Mean (Expected)	3.3E-03	1.7E-04	120.0	6.0	1.6E-01	896.0	7.08		
Mean + 1σ Kx _{rw}	6.3E-03	1.7E-04	120.0	6.0	1.6E-01	896.0	7.08		
Mean - 1σ Kx _{rw}	3.3E-04	1.7E-04	120.0	6.0	1.6E-01	896.0	7.08	0.00000	0.00
Mean + 1σ Ky _B	3.3E-03	3.3E-04	120.0	6.0	1.6E-01	896.0	7.08		
Mean - 1σ Ky _B	3.3E-03	7.0E-06	120.0	6.0	1.6E-01	896.0	6.32	0.14440	2.90
Mean + 1σ Y _{sat}	3.3E-03	1.7E-04	124.0	6.0	1.6E-01	896.0	7.57		
Mean - 1σ Y _{sat}	3.3E-03	1.7E-04	116.0	6.0	1.6E-01	896.0	6.59	0.24010	4.83
Mean + 1σ Bt _{D/S}	3.3E-03	1.7E-04	120.0	7.5	1.6E-01	896.0	7.08		
Mean - 1σ Bt _{D/S}	3.3E-03	1.7E-04	120.0	4.5	1.6E-01	896.0	3.04	4.08040	82.00
Mean + 1σ Kx _{rt}	3.3E-03	1.7E-04	120.0	6.0	3.0E-01	896.0	7.08		
Mean - 1σ Kx _{rt}	3.3E-03	1.7E-04	120.0	6.0	1.6E-02	896.0	7.08	0.00000	0.00
Mean + 1σ TW	3.3E-03	1.7E-04	120.0	6.0	1.6E-01	897.3	7.08		
Mean - 1σ TW	3.3E-03	1.7E-04	120.0	6.0	1.6E-01	894.7	5.65	0.51123	10.27
Total								4.97613	100.00



E(FS) =	7.08
σ(FS) =	2.23
V(FS) =	31.5%
E(ln FS) =	1.91
σ(ln FS) =	0.31
FS limit =	1.00
ln FS limit =	0.00

β _{ln} =	6.2
Pr(u) =	0.00000%
R =	100.00000%

E(X) = expected (mean) value for X; σ(X) = standard deviation for X; V(X) = coefficient of variation for X; FS = factor of safety; FS limit = FS limit state

Pr(u) = probability of unsatisfactory performance = probability that FS against progressive erosion is less than 1.0; R = reliability = 1-Pr(u); β_{ln} = reliability index

f(FS) is a probability density function (PDF); F(FS) is a cumulative distribution function (CDF); FS assumed lognormally distributed

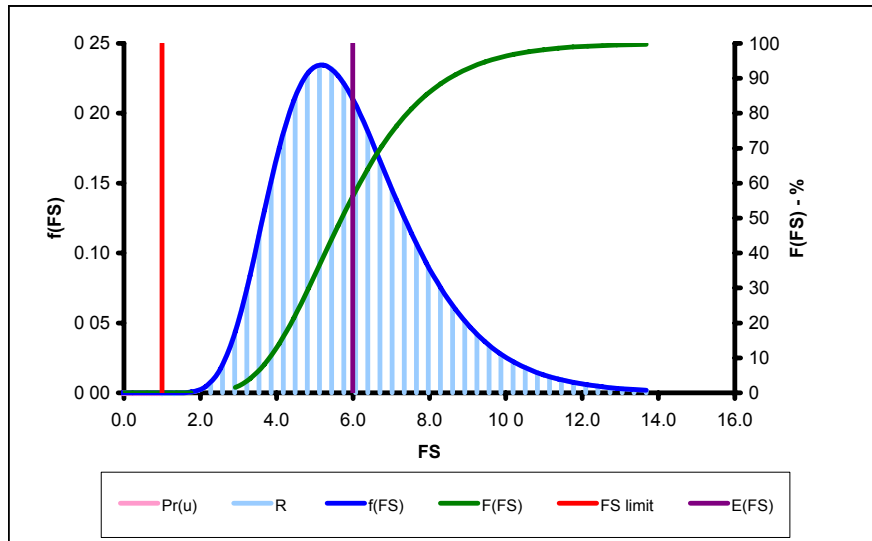
Bolivar Dam Seepage Reliability Analysis - Rehab Condition - Seepage Barrier and Downstream Blanket Augmentation

Station Pool Elevation (ft) **Probability of Unsatisfactory Performance Due To Through Seepage**

51+00 964

Taylor's Series Results

Case	Random Variables						FS _(progressive erosion) (Through Seepage)	Variance (FS)	% of Variance (FS)
	K _{X_{ig}} , foundation gravel K _x (ft/s)	K _{X_{iss}} , foundation silty sand K _x (ft/s)	K _{Y_{iss}/K_{X_{iss}}} , foundation silty sand K _y /K _x	γ _{sat} , unit weight (pcf)	φ, friction angle (degrees)	TW, tail water elevation (ft)			
Mean (Expected)	3.3E-02	2.8E-03	8.5E-02	120.0	33.0	908.5	5.99		
Mean + 1σ K _{X_{ig}}	4.1E-02	2.8E-03	8.5E-02	120.0	33.0	908.5	6.27		
Mean - 1σ K _{X_{ig}}	2.5E-02	2.8E-03	8.5E-02	120.0	33.0	908.5	5.99	0.01960	0.53
Mean + 1σ K _{X_{iss}}	3.3E-02	3.4E-03	8.5E-02	120.0	33.0	908.5	5.99		
Mean - 1σ K _{X_{iss}}	3.3E-02	2.2E-03	8.5E-02	120.0	33.0	908.5	6.27	0.01960	0.53
Mean + 1σ K _{Y_{iss}/K_{X_{iss}}}	3.3E-02	2.8E-03	1.1E-01	120.0	33.0	908.5	4.75		
Mean - 1σ K _{Y_{iss}/K_{X_{iss}}}	3.3E-02	2.8E-03	6.4E-02	120.0	33.0	908.5	8.11	2.82240	76.35
Mean + 1σ γ _{sat}	3.3E-02	2.8E-03	8.5E-02	124.0	33.0	908.5	6.41		
Mean - 1σ γ _{sat}	3.3E-02	2.8E-03	8.5E-02	116.0	33.0	908.5	5.58	0.17223	4.66
Mean + 1σ φ	3.3E-02	2.8E-03	8.5E-02	120.0	35.0	908.5	6.46		
Mean - 1σ φ	3.3E-02	2.8E-03	8.5E-02	120.0	31.0	908.5	5.55	0.20703	5.60
Mean + 1σ TW	3.3E-02	2.8E-03	8.5E-02	120.0	33.0	911.3	4.92		
Mean - 1σ TW	3.3E-02	2.8E-03	8.5E-02	120.0	33.0	905.7	6.27	0.45563	12.33
Total								3.69648	100.00



E(FS) =	5.99
σ(FS) =	1.92
V(FS) =	32.1%
E(ln FS) =	1.74
σ(ln FS) =	0.31
FS limit =	1.00
ln FS limit =	0.00

β _{in} =	5.6
Pr(u) =	0.00000%
R =	100.00000%

E(X) = expected (mean) value for X; σ(X) = standard deviation for X; V(X) = coefficient of variation for X; FS = factor of safety; FS limit = FS limit state

Pr(u) = probability of unsatisfactory performance = probability that FS against progressive erosion is less than 1.0; R = reliability = 1-Pr(u); β_{in} = reliability index

f(FS) is a probability density function (PDF); F(FS) is a cumulative distribution function (CDF); FS assumed lognormally distributed

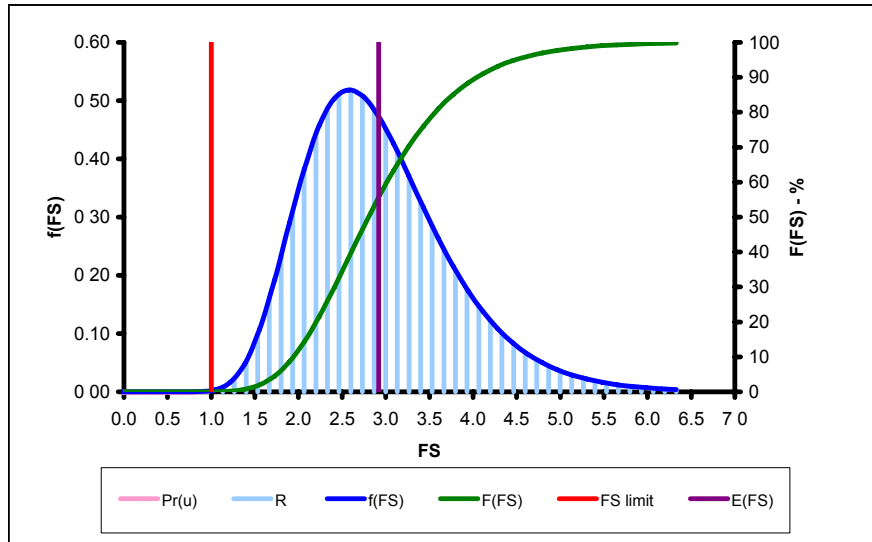
Bolivar Dam Seepage Reliability Analysis - Rehab Condition - Seepage Barrier and Downstream Blanket Augmentation

Station Pool Elevation (ft) **Probability of Unsatisfactory Performance Due To Through Seepage**

51+00 982

Taylor's Series Results

Case	Random Variables						FS _(progressive erosion) (Through Seepage)	Variance (FS)	% of Variance (FS)
	Kx _{fg} , foundation gravel Kx (ft/s)	Kx _{fs} , foundation silty sand Kx (ft/s)	Ky _{fs} /Kx _{fs} , foundation silty sand Ky/Kx	γ _{sat} , unit weight (pcf)	φ, friction angle (degrees)	TW, tail water elevation (ft)			
Mean (Expected)	3.3E-02	2.8E-03	8.5E-02	120.0	33.0	930.0	2.92		
Mean + 1σ Kx _{fg}	4.1E-02	2.8E-03	8.5E-02	120.0	33.0	930.0	2.99		
Mean - 1σ Kx _{fg}	2.5E-02	2.8E-03	8.5E-02	120.0	33.0	930.0	2.87	0.00360	0.50
Mean + 1σ Kx _{fs}	3.3E-02	3.4E-03	8.5E-02	120.0	33.0	930.0	2.69		
Mean - 1σ Kx _{fs}	3.3E-02	2.2E-03	8.5E-02	120.0	33.0	930.0	3.24	0.07563	10.40
Mean + 1σ Ky _{fs} /Kx _{fs}	3.3E-02	2.8E-03	1.1E-01	120.0	33.0	930.0	2.41		
Mean - 1σ Ky _{fs} /Kx _{fs}	3.3E-02	2.8E-03	6.4E-02	120.0	33.0	930.0	3.79	0.47610	65.49
Mean + 1σ γ _{sat}	3.3E-02	2.8E-03	8.5E-02	124.0	33.0	930.0	3.13		
Mean - 1σ γ _{sat}	3.3E-02	2.8E-03	8.5E-02	116.0	33.0	930.0	2.72	0.04202	5.78
Mean + 1σ φ	3.3E-02	2.8E-03	8.5E-02	120.0	35.0	930.0	2.92		
Mean - 1σ φ	3.3E-02	2.8E-03	8.5E-02	120.0	31.0	930.0	2.92	0.00000	0.00
Mean + 1σ TW	3.3E-02	2.8E-03	8.5E-02	120.0	33.0	933.3	3.32		
Mean - 1σ TW	3.3E-02	2.8E-03	8.5E-02	120.0	33.0	926.7	2.60	0.12960	17.83
Total								0.72695	100.00



E(FS) =	2.92
σ(FS) =	0.85
V(FS) =	29.2%
E(ln FS) =	1.03
σ(ln FS) =	0.29
FS limit =	1.00
ln FS limit =	0.00

β _{in} =	3.6
Pr(u) =	0.01571%
R =	99.98429%

E(X) = expected (mean) value for X; σ(X) = standard deviation for X; V(X) = coefficient of variation for X; FS = factor of safety; FS limit = FS limit state

Pr(u) = probability of unsatisfactory performance = probability that FS against progressive erosion is less than 1.0; R = reliability = 1-Pr(u); β_{in} = reliability index

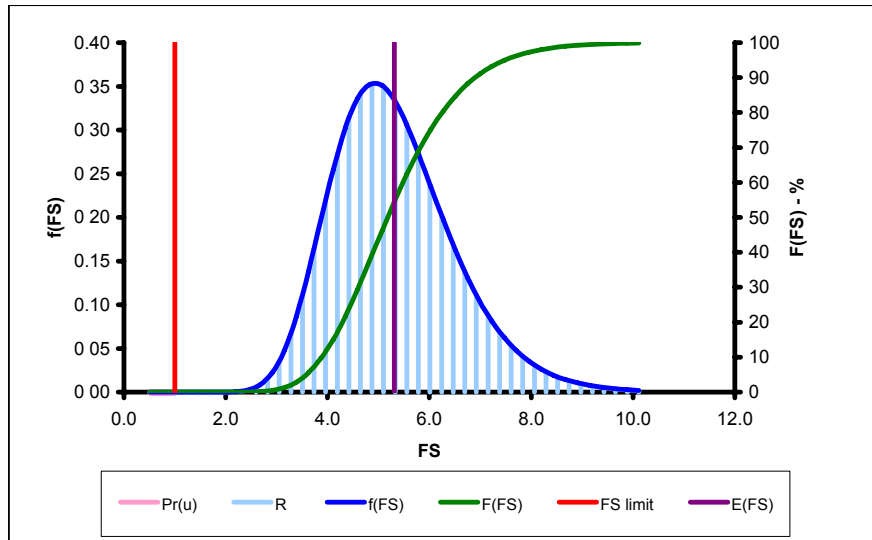
f(FS) is a probability density function (PDF); F(FS) is a cumulative distribution function (CDF); FS assumed lognormally distributed

Bolivar Dam Seepage Reliability Analysis - Rehab Condition - Seepage Barrier and Downstream Blanket Augmentation

Station	Pool Elevation (ft)	Probability of Unsatisfactory Performance Due To Under Seepage
51+00	936	

Taylor's Series Results

Case	Random Variables						FS ^(progressive erosion) (Under Seepage)	Variance (FS)	% of Variance (FS)
	K _x , relief well K _x (ft/s)	K _y , D/S blanket K _y (ft/s)	γ _{sat} , unit weight (pcf)	B _t , D/S blanket thickness (ft)	K _x , rock toe K _x (ft/s)	TW, tail water elevation (ft)			
Mean (Expected)	3.3E-03	1.7E-04	120.0	6.0	1.6E-01	894.0	5.31		
Mean + 1σ K _{xw}	6.3E-03	1.7E-04	120.0	6.0	1.6E-01	894.0	5.31		
Mean - 1σ K _{xw}	3.3E-04	1.7E-04	120.0	6.0	1.6E-01	894.0	5.31	0.00000	0.00
Mean + 1σ K _{yB}	3.3E-03	3.3E-04	120.0	6.0	1.6E-01	894.0	5.31		
Mean - 1σ K _{yB}	3.3E-03	7.0E-06	120.0	6.0	1.6E-01	894.0	5.31	0.00000	0.00
Mean + 1σ γ _{sat}	3.3E-03	1.7E-04	124.0	6.0	1.6E-01	894.0	5.68		
Mean - 1σ γ _{sat}	3.3E-03	1.7E-04	116.0	6.0	1.6E-01	894.0	4.94	0.13690	9.49
Mean + 1σ B _{tD/S}	3.3E-03	1.7E-04	120.0	7.5	1.6E-01	894.0	5.31		
Mean - 1σ B _{tD/S}	3.3E-03	1.7E-04	120.0	4.5	1.6E-01	894.0	3.04	1.28823	89.33
Mean + 1σ K _{xrt}	3.3E-03	1.7E-04	120.0	6.0	3.0E-01	894.0	5.31		
Mean - 1σ K _{xrt}	3.3E-03	1.7E-04	120.0	6.0	1.6E-02	894.0	5.31	0.00000	0.00
Mean + 1σ TW	3.3E-03	1.7E-04	120.0	6.0	1.6E-01	894.7	5.31		
Mean - 1σ TW	3.3E-03	1.7E-04	120.0	6.0	1.6E-01	893.3	5.05	0.01690	1.17
							Total	1.44203	100.00



E(FS) =	5.31
σ(FS) =	1.20
V(FS) =	22.6%
E(ln FS) =	1.64
σ(ln FS) =	0.22
FS limit =	1.00
ln FS limit =	0.00

β _{ln} =	7.4
Pr(u) =	0.00000%
R =	100.00000%

E(X) = expected (mean) value for X; σ(X) = standard deviation for X; V(X) = coefficient of variation for X; FS = factor of safety; FS limit = FS limit state

Pr(u) = probability of unsatisfactory performance = probability that FS against progressive erosion is less than 1.0; R = reliability = 1-Pr(u); β_{ln} = reliability index

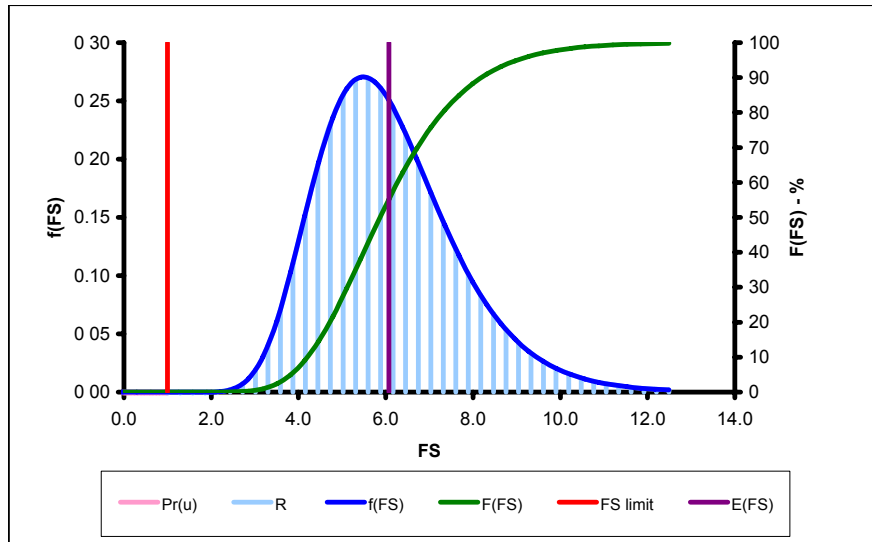
f(FS) is a probability density function (PDF); F(FS) is a cumulative distribution function (CDF); FS assumed lognormally distributed

Bolivar Dam Seepage Reliability Analysis - Rehab Condition - Seepage Barrier and Downstream Blanket Augmentation

Station	Pool Elevation (ft)	Probability of Unsatisfactory Performance Due To Under Seepage
51+00	949	

Taylor's Series Results

Case	Random Variables						FS (progressive erosion) (Under Seepage)	Variance (FS)	% of Variance (FS)
	Kx _{rw} , relief well Kx (ft/s)	Ky _B , D/S blanket Ky (ft/s)	Y _{sat} , unit weight (pcf)	Bt _{D/S} , D/S blanket thickness (ft)	Kx _{rt} , rock toe Kx (ft/s)	TW, tail water elevation (ft)			
Mean (Expected)	3.3E-03	1.7E-04	120.0	6.0	1.6E-01	896.0	6.07		
Mean + 1σ Kx _{rw}	6.3E-03	1.7E-04	120.0	6.0	1.6E-01	896.0	6.07		
Mean - 1σ Kx _{rw}	3.3E-04	1.7E-04	120.0	6.0	1.6E-01	896.0	6.07	0.00000	0.00
Mean + 1σ Ky _B	3.3E-03	3.3E-04	120.0	6.0	1.6E-01	896.0	6.07		
Mean - 1σ Ky _B	3.3E-03	7.0E-06	120.0	6.0	1.6E-01	896.0	6.07	0.00000	0.00
Mean + 1σ Y _{sat}	3.3E-03	1.7E-04	124.0	6.0	1.6E-01	896.0	6.49		
Mean - 1σ Y _{sat}	3.3E-03	1.7E-04	116.0	6.0	1.6E-01	896.0	5.64	0.18063	7.01
Mean + 1σ Bt _{D/S}	3.3E-03	1.7E-04	120.0	7.5	1.6E-01	896.0	6.07		
Mean - 1σ Bt _{D/S}	3.3E-03	1.7E-04	120.0	4.5	1.6E-01	896.0	3.04	2.29523	89.13
Mean + 1σ Kx _{rt}	3.3E-03	1.7E-04	120.0	6.0	3.0E-01	896.0	6.07		
Mean - 1σ Kx _{rt}	3.3E-03	1.7E-04	120.0	6.0	1.6E-02	896.0	6.07	0.00000	0.00
Mean + 1σ TW	3.3E-03	1.7E-04	120.0	6.0	1.6E-01	897.3	6.07		
Mean - 1σ TW	3.3E-03	1.7E-04	120.0	6.0	1.6E-01	894.7	5.44	0.09923	3.85
Total								2.57508	100.00



E(FS) =	6.07
σ(FS) =	1.60
V(FS) =	26.4%
E(ln FS) =	1.77
σ(ln FS) =	0.26
FS limit =	1.00
ln FS limit =	0.00

β _{ln} =	6.8
Pr(u) =	0.00000%
R =	100.00000%

E(X) = expected (mean) value for X; σ(X) = standard deviation for X; V(X) = coefficient of variation for X; FS = factor of safety; FS limit = FS limit state

Pr(u) = probability of unsatisfactory performance = probability that FS against progressive erosion is less than 1.0; R = reliability = 1-Pr(u); β_{ln} = reliability index

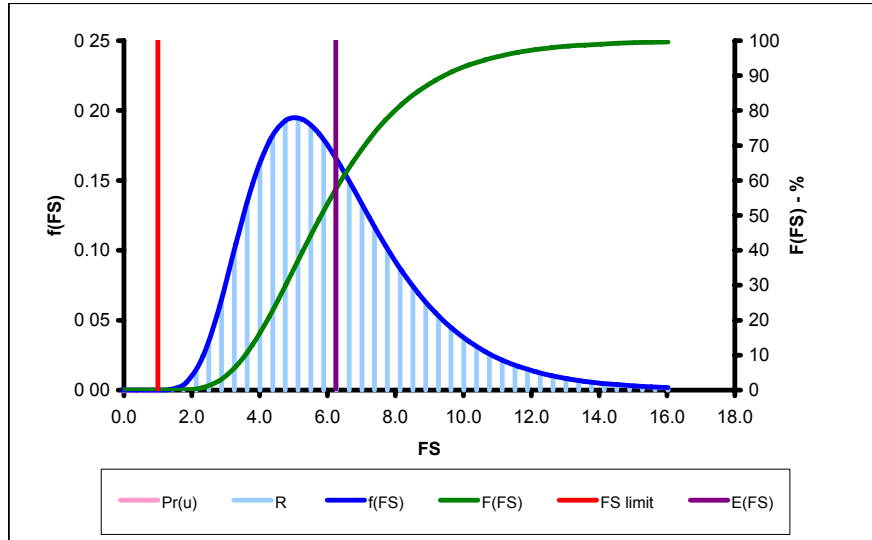
f(FS) is a probability density function (PDF); F(FS) is a cumulative distribution function (CDF); FS assumed lognormally distributed

Bolivar Dam Seepage Reliability Analysis - Rehab Condition - Downstream Blanket Augmentation

Station	Pool Elevation (ft)	Probability of Unsatisfactory Performance Due To Under Seepage
57+00	929	

Taylor's Series Results

Case	Random Variables						FS ^(progressive erosion) (Under Seepage)	Variance (FS)	% of Variance (FS)
	K _{x_{rw}} , relief well K _x (ft/s)	K _{y_B} , D/S blanket K _y (ft/s)	γ _{sat} , unit weight (pcf)	B _{t_{D/S}} , D/S blanket thickness (ft)	K _{x_{rt}} , rock toe K _x (ft/s)	TW, tail water elevation (ft)			
Mean (Expected)	3.3E-03	1.7E-04	120.0	11.0	1.6E-01	894.0	6.24		
Mean + 1σ K _{x_{rw}}	6.3E-03	1.7E-04	120.0	11.0	1.6E-01	894.0	6.24		
Mean - 1σ K _{x_{rw}}	3.3E-04	1.7E-04	120.0	11.0	1.6E-01	894.0	6.24	0.00000	0.00
Mean + 1σ K _{y_B}	3.3E-03	3.3E-04	120.0	11.0	1.6E-01	894.0	6.51		
Mean - 1σ K _{y_B}	3.3E-03	7.0E-06	120.0	11.0	1.6E-01	894.0	3.12	2.87303	47.99
Mean + 1σ γ _{sat}	3.3E-03	1.7E-04	124.0	11.0	1.6E-01	894.0	6.68		
Mean - 1σ γ _{sat}	3.3E-03	1.7E-04	116.0	11.0	1.6E-01	894.0	5.81	0.18923	3.16
Mean + 1σ B _{t_{D/S}}	3.3E-03	1.7E-04	120.0	14.0	1.6E-01	894.0	6.24		
Mean - 1σ B _{t_{D/S}}	3.3E-03	1.7E-04	120.0	8.0	1.6E-01	894.0	2.82	2.92410	48.85
Mean + 1σ K _{x_{rt}}	3.3E-03	1.7E-04	120.0	11.0	3.0E-01	894.0	6.24		
Mean - 1σ K _{x_{rt}}	3.3E-03	1.7E-04	120.0	11.0	1.6E-02	894.0	6.24	0.00000	0.00
Mean + 1σ TW	3.3E-03	1.7E-04	120.0	11.0	1.6E-01	888.7	6.24		
Mean - 1σ TW	3.3E-03	1.7E-04	120.0	11.0	1.6E-01	887.3	6.24	0.00000	0.00
Total								5.98635	100.00



E(FS) =	6.24
σ(FS) =	2.45
V(FS) =	39.2%
E(ln FS) =	1.76
σ(ln FS) =	0.38
FS limit =	1.00
ln FS limit =	0.00

β _{ln} =	4.7
Pr(u) =	0.00016%
R =	99.99984%

E(X) = expected (mean) value for X; σ(X) = standard deviation for X; V(X) = coefficient of variation for X; FS = factor of safety; FS limit = FS limit state

Pr(u) = probability of unsatisfactory performance = probability that FS against progressive erosion is less than 1.0; R = reliability = 1-Pr(u); β_{ln} = reliability index

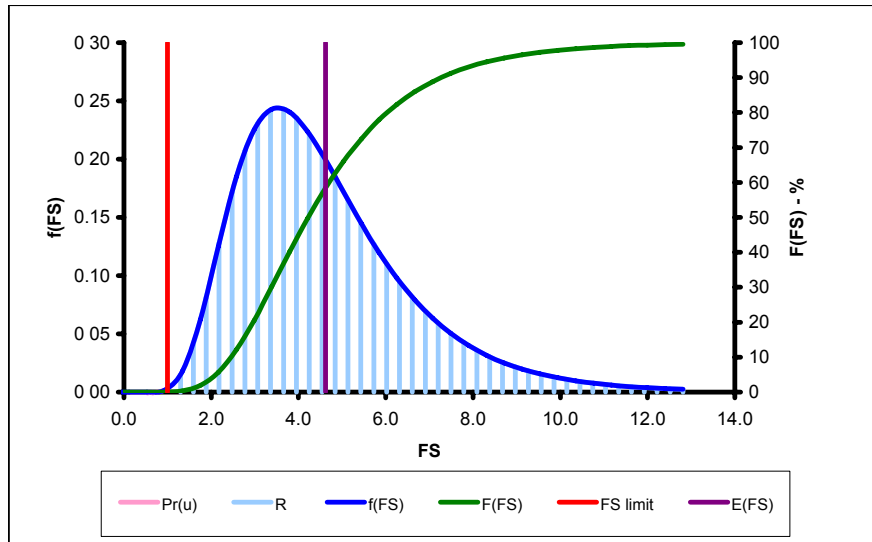
f(FS) is a probability density function (PDF); F(FS) is a cumulative distribution function (CDF); FS assumed lognormally distributed

Bolivar Dam Seepage Reliability Analysis - Rehab Condition - Downstream Blanket Augmentation

Station **57+00** Pool Elevation (ft) **936** Probability of Unsatisfactory Performance Due To Under Seepage

Taylor's Series Results

Case	Random Variables						FS ^(progressive erosion) (Under Seepage)	Variance (FS)	% of Variance (FS)
	K _x , relief well K _x (ft/s)	K _y , D/S blanket K _y (ft/s)	γ _{sat} , unit weight (pcf)	B _t , D/S blanket thickness (ft)	K _x , rock toe K _x (ft/s)	TW, tail water elevation (ft)			
Mean (Expected)	3.3E-03	1.7E-04	120.0	11.0	1.6E-01	894.0	4.62		
Mean + 1σ K _{xw}	6.3E-03	1.7E-04	120.0	11.0	1.6E-01	894.0	4.62		
Mean - 1σ K _{xw}	3.3E-04	1.7E-04	120.0	11.0	1.6E-01	894.0	4.62	0.00000	0.00
Mean + 1σ K _{yB}	3.3E-03	3.3E-04	120.0	11.0	1.6E-01	894.0	6.24		
Mean - 1σ K _{yB}	3.3E-03	7.0E-06	120.0	11.0	1.6E-01	894.0	2.65	3.22203	76.84
Mean + 1σ γ _{sat}	3.3E-03	1.7E-04	124.0	11.0	1.6E-01	894.0	4.94		
Mean - 1σ γ _{sat}	3.3E-03	1.7E-04	116.0	11.0	1.6E-01	894.0	4.29	0.10563	2.52
Mean + 1σ B _{tD/S}	3.3E-03	1.7E-04	120.0	14.0	1.6E-01	894.0	4.62		
Mean - 1σ B _{tD/S}	3.3E-03	1.7E-04	120.0	8.0	1.6E-01	894.0	2.81	0.81903	19.53
Mean + 1σ K _{xrt}	3.3E-03	1.7E-04	120.0	11.0	3.0E-01	894.0	4.62		
Mean - 1σ K _{xrt}	3.3E-03	1.7E-04	120.0	11.0	1.6E-02	894.0	4.62	0.00000	0.00
Mean + 1σ TW	3.3E-03	1.7E-04	120.0	11.0	1.6E-01	894.7	5.05		
Mean - 1σ TW	3.3E-03	1.7E-04	120.0	11.0	1.6E-01	893.3	4.62	0.04622	1.10
Total								4.19290	100.00



E(FS) =	4.62
σ(FS) =	2.05
V(FS) =	44.3%
E(ln FS) =	1.44
σ(ln FS) =	0.42
FS limit =	1.00
ln FS limit =	0.00

β _{ln} =	3.4
Pr(u) =	0.03345%
R =	99.96655%

E(X) = expected (mean) value for X; σ(X) = standard deviation for X; V(X) = coefficient of variation for X; FS = factor of safety; FS limit = FS limit state

Pr(u) = probability of unsatisfactory performance = probability that FS against progressive erosion is less than 1.0; R = reliability = 1-Pr(u); β_{ln} = reliability index

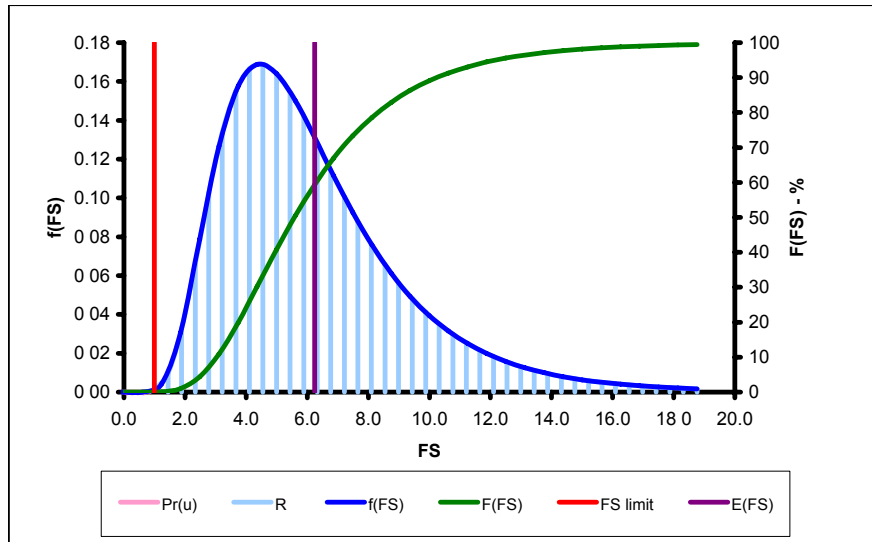
f(FS) is a probability density function (PDF); F(FS) is a cumulative distribution function (CDF); FS assumed lognormally distributed

Bolivar Dam Seepage Reliability Analysis - Rehab Condition - Downstream Blanket Augmentation

Station 57+00 Pool Elevation (ft) 949 Probability of Unsatisfactory Performance Due To Under Seepage

Taylor's Series Results

Case	Random Variables						FS ^(progressive erosion) (Under Seepage)	Variance (FS)	% of Variance (FS)
	K _{xrw} , relief well K _x (ft/s)	K _{yB} , D/S blanket K _y (ft/s)	γ _{sat} , unit weight (pcf)	B _{tD/S} , D/S blanket thickness (ft)	K _{xrt} , rock toe K _x (ft/s)	TW, tail water elevation (ft)			
Mean (Expected)	3.3E-03	1.7E-04	120.0	11.0	1.6E-01	896.0	6.24		
Mean + 1σ K _{xrw}	6.3E-03	1.7E-04	120.0	11.0	1.6E-01	896.0	6.24		
Mean - 1σ K _{xrw}	3.3E-04	1.7E-04	120.0	11.0	1.6E-01	896.0	6.24	0.00000	0.00
Mean + 1σ K _{yB}	3.3E-03	3.3E-04	120.0	11.0	1.6E-01	896.0	7.66		
Mean - 1σ K _{yB}	3.3E-03	7.0E-06	120.0	11.0	1.6E-01	896.0	3.03	5.35923	54.71
Mean + 1σ γ _{sat}	3.3E-03	1.7E-04	124.0	11.0	1.6E-01	896.0	6.68		
Mean - 1σ γ _{sat}	3.3E-03	1.7E-04	116.0	11.0	1.6E-01	896.0	5.81	0.18923	1.93
Mean + 1σ B _{tD/S}	3.3E-03	1.7E-04	120.0	14.0	1.6E-01	896.0	6.24		
Mean - 1σ B _{tD/S}	3.3E-03	1.7E-04	120.0	8.0	1.6E-01	896.0	2.80	2.95840	30.20
Mean + 1σ K _{xrt}	3.3E-03	1.7E-04	120.0	11.0	3.0E-01	896.0	6.24		
Mean - 1σ K _{xrt}	3.3E-03	1.7E-04	120.0	11.0	1.6E-02	896.0	6.24	0.00000	0.00
Mean + 1σ TW	3.3E-03	1.7E-04	120.0	11.0	1.6E-01	897.3	7.58		
Mean - 1σ TW	3.3E-03	1.7E-04	120.0	11.0	1.6E-01	894.7	5.31	1.28823	13.15
Total							9.79508	9.79508	100.00



E(FS) =	6.24
σ(FS) =	3.13
V(FS) =	50.2%
E(ln FS) =	1.72
σ(ln FS) =	0.47
FS limit =	1.00
ln FS limit =	0.00

β _{ln} =	3.6
Pr(u) =	0.01426%
R =	99.98574%

E(X) = expected (mean) value for X; σ(X) = standard deviation for X; V(X) = coefficient of variation for X; FS = factor of safety; FS limit = FS limit state

Pr(u) = probability of unsatisfactory performance = probability that FS against progressive erosion is less than 1.0; R = reliability = 1-Pr(u); β_{ln} = reliability index

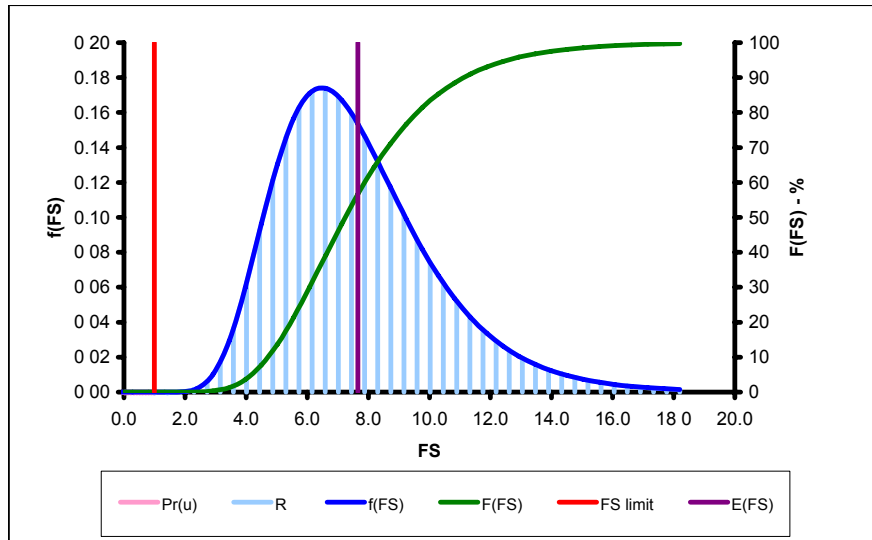
f(FS) is a probability density function (PDF); F(FS) is a cumulative distribution function (CDF); FS assumed lognormally distributed

Bolivar Dam Seepage Reliability Analysis - Rehab Condition - Downstream Blanket Augmentation

Station **57+00** Pool Elevation (ft) **952** Probability of Unsatisfactory Performance Due To Under Seepage

Taylor's Series Results

Case	Random Variables						FS (progressive erosion) (Under Seepage)	Variance (FS)	% of Variance (FS)	
	Kx _{rw} , relief well Kx (ft/s)	Ky _B , D/S blanket (ft/s)	Y _{sat} , unit weight (pcf)	Bt _{D/S} , D/S blanket thickness (ft)	Kx _{rt} , rock toe Kx (ft/s)	TW, tail water elevation (ft)				
Mean (Expected)	3.3E-03	1.7E-04	120.0	11.0	1.6E-01	896.0	7.66			
Mean + 1σ Kx _{rw}	6.3E-03	1.7E-04	120.0	11.0	1.6E-01	896.0	7.66			
Mean - 1σ Kx _{rw}	3.3E-04	1.7E-04	120.0	11.0	1.6E-01	896.0	7.66	0.00000	0.00	
Mean + 1σ Ky _B	3.3E-03	3.3E-04	120.0	11.0	1.6E-01	896.0	7.66			
Mean - 1σ Ky _B	3.3E-03	7.0E-06	120.0	11.0	1.6E-01	896.0	6.24	0.50410	7.26	
Mean + 1σ Y _{sat}	3.3E-03	1.7E-04	124.0	11.0	1.6E-01	896.0	8.19			
Mean - 1σ Y _{sat}	3.3E-03	1.7E-04	116.0	11.0	1.6E-01	896.0	7.13	0.28090	4.04	
Mean + 1σ Bt _{D/S}	3.3E-03	1.7E-04	120.0	14.0	1.6E-01	896.0	7.66			
Mean - 1σ Bt _{D/S}	3.3E-03	1.7E-04	120.0	8.0	1.6E-01	896.0	2.79	5.92923	85.38	
Mean + 1σ Kx _{rt}	3.3E-03	1.7E-04	120.0	11.0	3.0E-01	896.0	7.66			
Mean - 1σ Kx _{rt}	3.3E-03	1.7E-04	120.0	11.0	1.6E-02	896.0	7.66	0.00000	0.00	
Mean + 1σ TW	3.3E-03	1.7E-04	120.0	11.0	1.6E-01	908.0	8.62			
Mean - 1σ TW	3.3E-03	1.7E-04	120.0	11.0	1.6E-01	904.0	7.66	0.23040	3.32	
Total							6.94463	100.00		



E(FS) =	7.66
σ(FS) =	2.64
V(FS) =	34.4%
E(ln FS) =	1.98
σ(ln FS) =	0.33
FS limit =	1.00
ln FS limit =	0.00

β _{ln} =	5.9
Pr(u) =	0.00000%
R =	100.00000%

E(X) = expected (mean) value for X; σ(X) = standard deviation for X; V(X) = coefficient of variation for X; FS = factor of safety; FS limit = FS limit state

Pr(u) = probability of unsatisfactory performance = probability that FS against progressive erosion is less than 1.0; R = reliability = 1-Pr(u); β_{ln} = reliability index

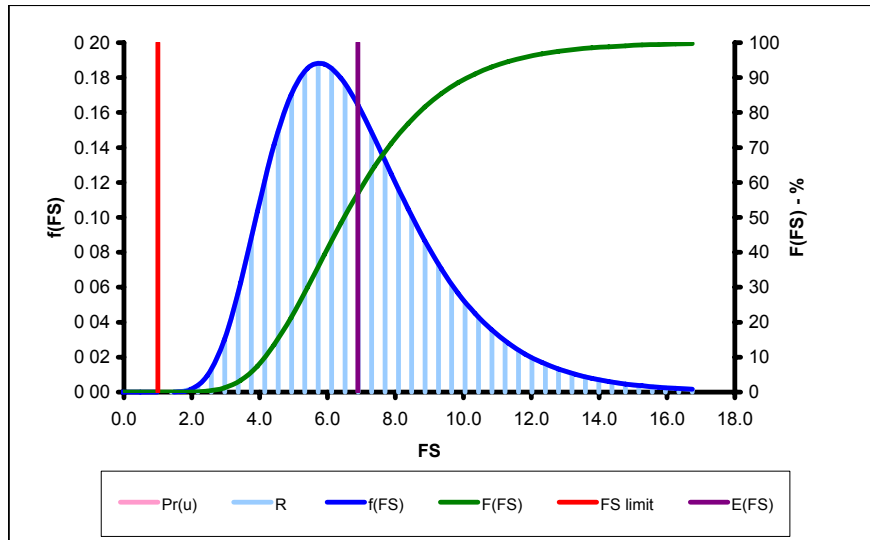
f(FS) is a probability density function (PDF); F(FS) is a cumulative distribution function (CDF); FS assumed lognormally distributed

Bolivar Dam Seepage Reliability Analysis - Rehab Condition - Downstream Blanket Augmentation

Station **57+00** Pool Elevation (ft) **962** Probability of Unsatisfactory Performance Due To Under Seepage

Taylor's Series Results

Case	Random Variables						FS ^(progressive erosion) (Under Seepage)	Variance (FS)	% of Variance (FS)
	K _{xrw} , relief well K _x (ft/s)	K _{yB} , D/S blanket K _y (ft/s)	γ _{sat} , unit weight (pcf)	B _{tD/S} , D/S blanket thickness (ft)	K _{xrt} , rock toe K _x (ft/s)	TW, tail water elevation (ft)			
Mean (Expected)	3.3E-03	1.7E-04	120.0	11.0	1.6E-01	908.5	6.89		
Mean + 1σ K _{xrw}	6.3E-03	1.7E-04	120.0	11.0	1.6E-01	908.5	6.89		
Mean - 1σ K _{xrw}	3.3E-04	1.7E-04	120.0	11.0	1.6E-01	908.5	6.57	0.02560	0.42
Mean + 1σ K _{yB}	3.3E-03	1.0E+00	120.0	11.0	1.6E-01	908.5	6.89		
Mean - 1σ K _{yB}	3.3E-03	7.0E-06	120.0	11.0	1.6E-01	908.5	5.05	0.84640	13.94
Mean + 1σ γ _{sat}	3.3E-03	1.7E-04	124.0	11.0	1.6E-01	908.5	7.37		
Mean - 1σ γ _{sat}	3.3E-03	1.7E-04	116.0	11.0	1.6E-01	908.5	6.41	0.23040	3.80
Mean + 1σ B _{tD/S}	3.3E-03	1.7E-04	120.0	14.0	1.6E-01	908.5	6.89		
Mean - 1σ B _{tD/S}	3.3E-03	1.7E-04	120.0	8.0	1.6E-01	908.5	2.79	4.20250	69.23
Mean + 1σ K _{xrt}	3.3E-03	1.7E-04	120.0	11.0	3.0E-01	908.5	6.89		
Mean - 1σ K _{xrt}	3.3E-03	1.7E-04	120.0	11.0	1.6E-02	908.5	6.89	0.00000	0.00
Mean + 1σ TW	3.3E-03	1.7E-04	120.0	11.0	1.6E-01	911.3	7.57		
Mean - 1σ TW	3.3E-03	1.7E-04	120.0	11.0	1.6E-01	905.7	5.82	0.76563	12.61
Total								6.07053	100.00



E(FS) =	6.89
σ(FS) =	2.46
V(FS) =	35.8%
E(ln FS) =	1.87
σ(ln FS) =	0.35
FS limit =	1.00
ln FS limit =	0.00

β _{in} =	5.4
Pr(u) =	0.00000%
R =	100.00000%

E(X) = expected (mean) value for X; σ(X) = standard deviation for X; V(X) = coefficient of variation for X; FS = factor of safety; FS limit = FS limit state

Pr(u) = probability of unsatisfactory performance = probability that FS against progressive erosion is less than 1.0; R = reliability = 1-Pr(u); β_{in} = reliability index

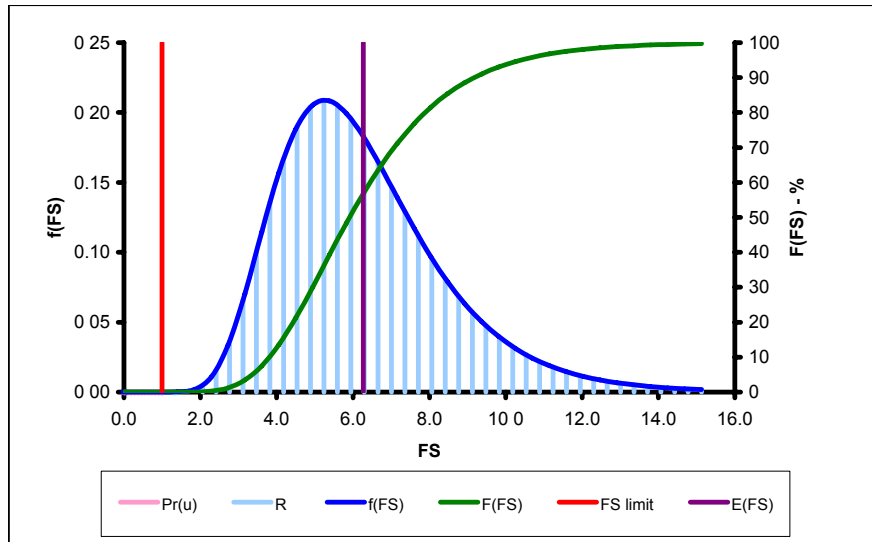
f(FS) is a probability density function (PDF); F(FS) is a cumulative distribution function (CDF); FS assumed lognormally distributed

Bolivar Dam Seepage Reliability Analysis - Rehab Condition - Downstream Blanket Augmentation

Station 57+00 Pool Elevation (ft) 964 Probability of Unsatisfactory Performance Due To Under Seepage

Taylor's Series Results

Case	Random Variables						FS ^(progressive erosion) (Under Seepage)	Variance (FS)	% of Variance (FS)	
	K _{xrw} , relief well K _x (ft/s)	K _{yB} , D/S blanket K _y (ft/s)	γ _{sat} , unit weight (pcf)	B _{tD/S} , D/S blanket thickness (ft)	K _{xrt} , rock toe K _x (ft/s)	TW, tail water elevation (ft)				
Mean (Expected)	3.3E-03	1.7E-04	120.0	11.0	1.6E-01	908.5	6.27			
Mean + 1σ K _{xrw}	6.3E-03	1.7E-04	120.0	11.0	1.6E-01	908.5	6.27			
Mean - 1σ K _{xrw}	3.3E-04	1.7E-04	120.0	11.0	1.6E-01	908.5	5.90	0.03422	0.70	
Mean + 1σ K _{yB}	3.3E-03	1.0E+00	120.0	11.0	1.6E-01	908.5	6.27			
Mean - 1σ K _{yB}	3.3E-03	7.0E-06	120.0	11.0	1.6E-01	908.5	4.25	1.02010	20.80	
Mean + 1σ γ _{sat}	3.3E-03	1.7E-04	124.0	11.0	1.6E-01	908.5	6.70			
Mean - 1σ γ _{sat}	3.3E-03	1.7E-04	116.0	11.0	1.6E-01	908.5	5.83	0.18923	3.86	
Mean + 1σ B _{tD/S}	3.3E-03	1.7E-04	120.0	14.0	1.6E-01	908.5	6.27			
Mean - 1σ B _{tD/S}	3.3E-03	1.7E-04	120.0	8.0	1.6E-01	908.5	2.79	3.02760	61.75	
Mean + 1σ K _{xrt}	3.3E-03	1.7E-04	120.0	11.0	3.0E-01	908.5	6.27			
Mean - 1σ K _{xrt}	3.3E-03	1.7E-04	120.0	11.0	1.6E-02	908.5	6.27	0.00000	0.00	
Mean + 1σ TW	3.3E-03	1.7E-04	120.0	11.0	1.6E-01	911.3	6.89			
Mean - 1σ TW	3.3E-03	1.7E-04	120.0	11.0	1.6E-01	905.7	5.30	0.63203	12.89	
Total							4.90318	100.00		



E(FS) =	6.27
σ(FS) =	2.21
V(FS) =	35.3%
E(ln FS) =	1.78
σ(ln FS) =	0.34
FS limit =	1.00
ln FS limit =	0.00

β _{ln} =	5.2
Pr(u) =	0.00001%
R =	99.99999%

E(X) = expected (mean) value for X; σ(X) = standard deviation for X; V(X) = coefficient of variation for X; FS = factor of safety; FS limit = FS limit state

Pr(u) = probability of unsatisfactory performance = probability that FS against progressive erosion is less than 1.0; R = reliability = 1-Pr(u); β_{ln} = reliability index

f(FS) is a probability density function (PDF); F(FS) is a cumulative distribution function (CDF); FS assumed lognormally distributed