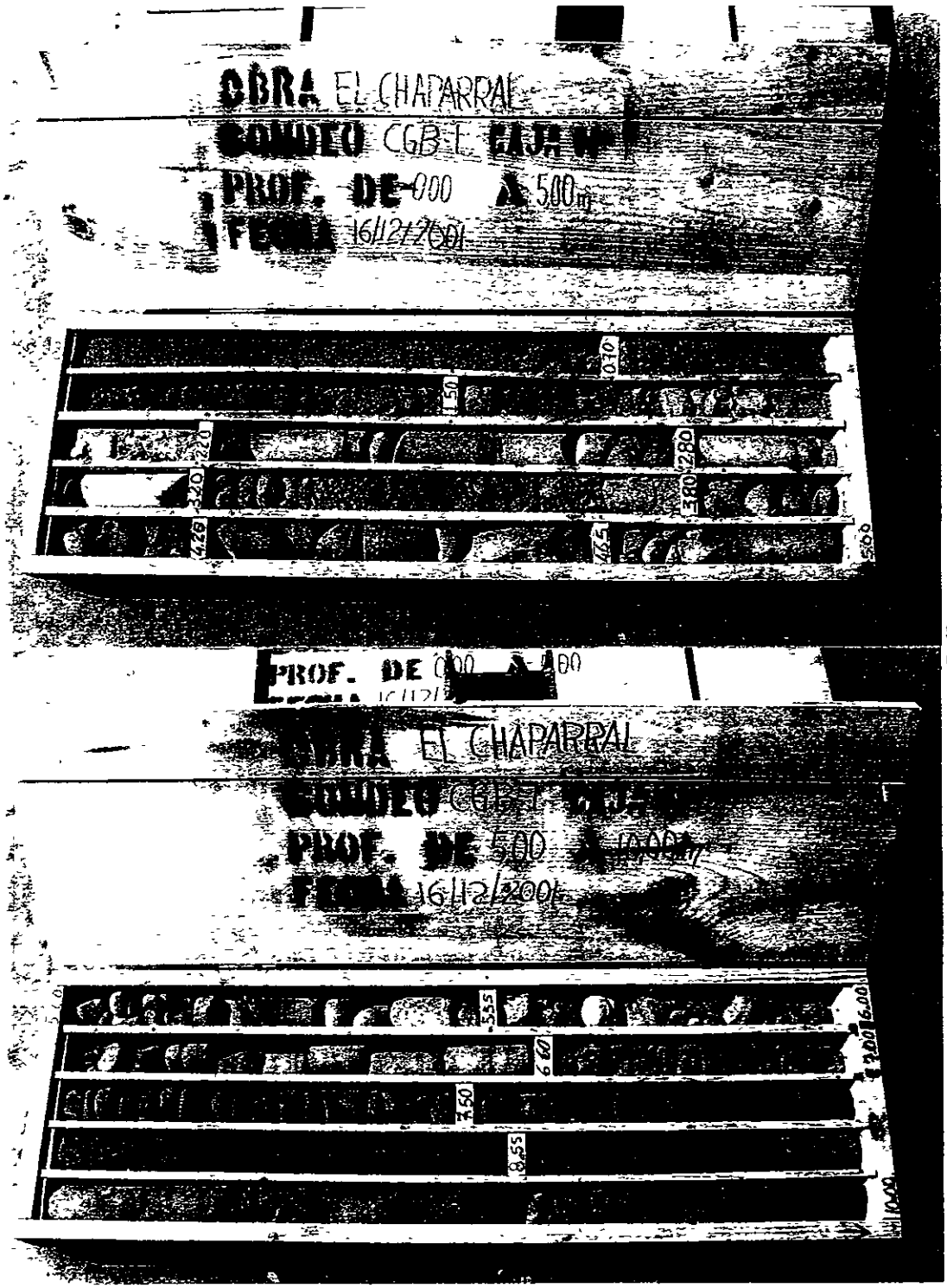
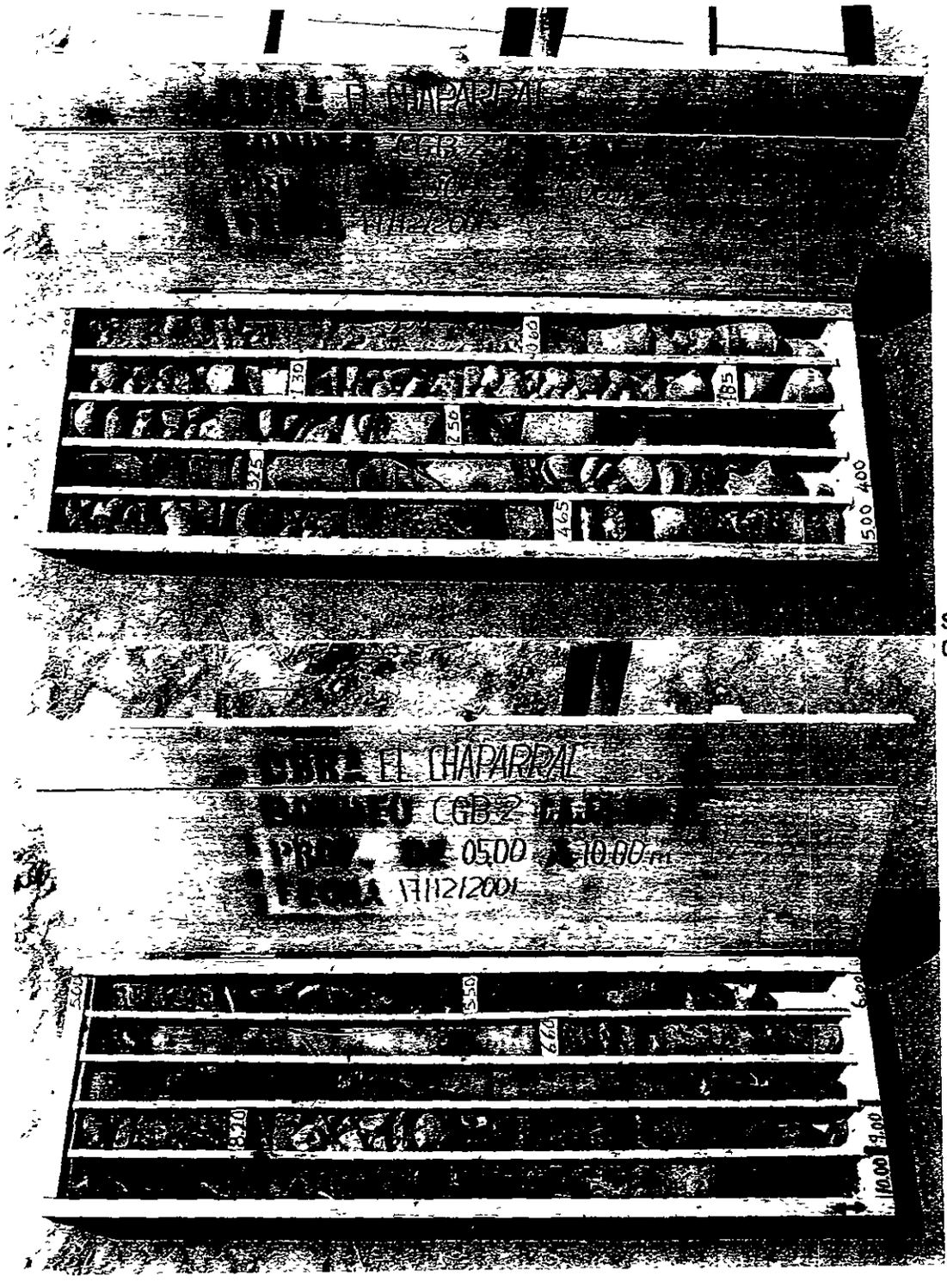
BORROW AREA



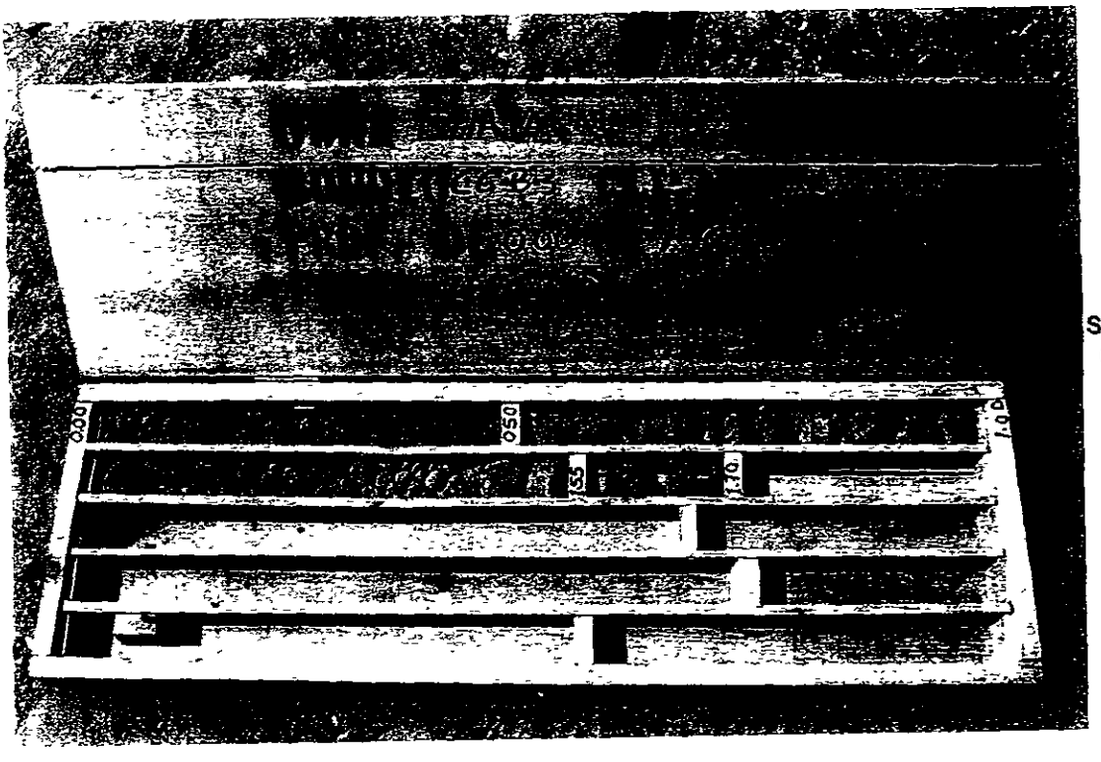
SONDEO CGB - 1
0.00mts a 10.00mts

259



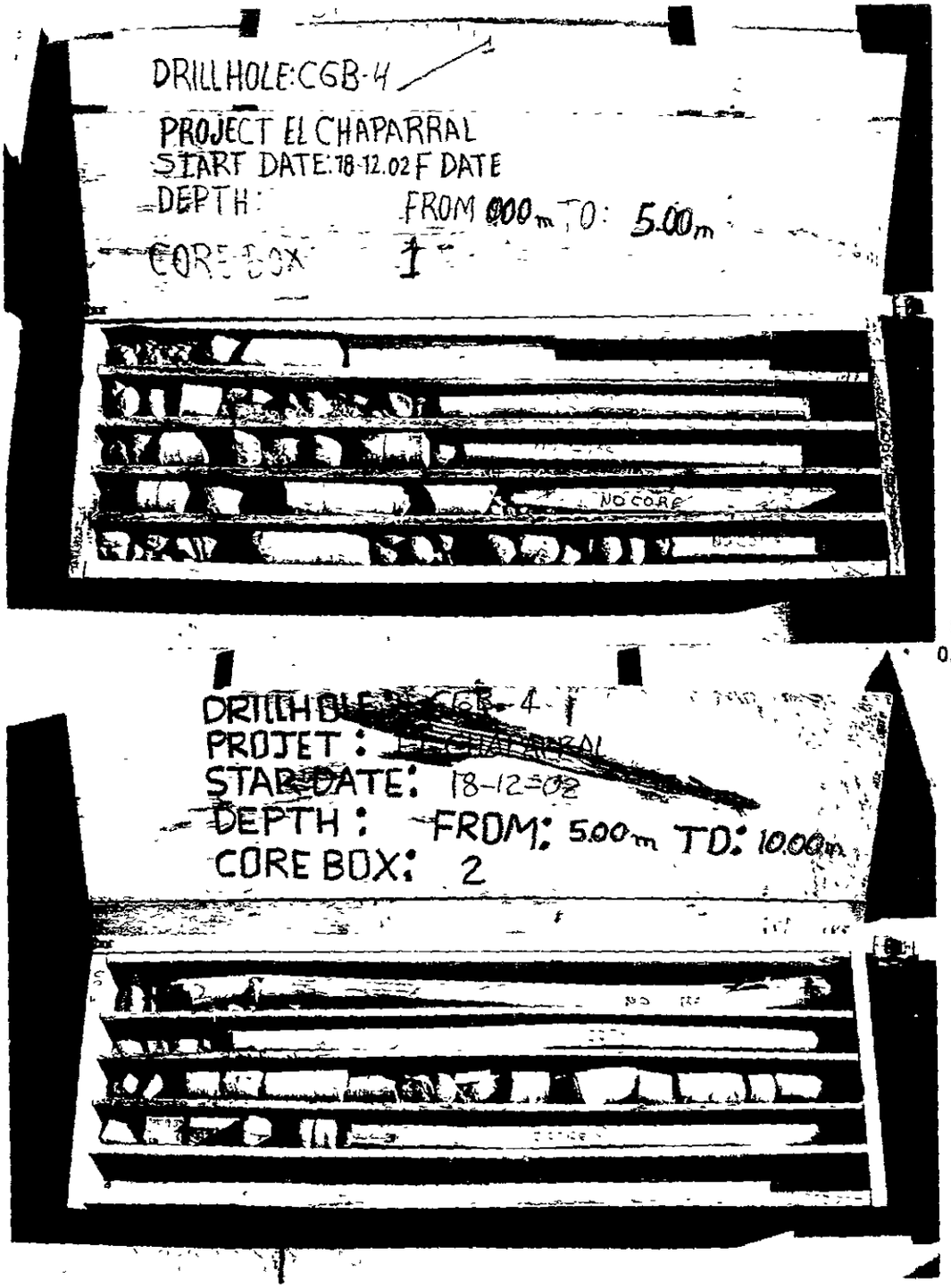
SONDEO CGB - 2
0.00mts a 10.00mts

256

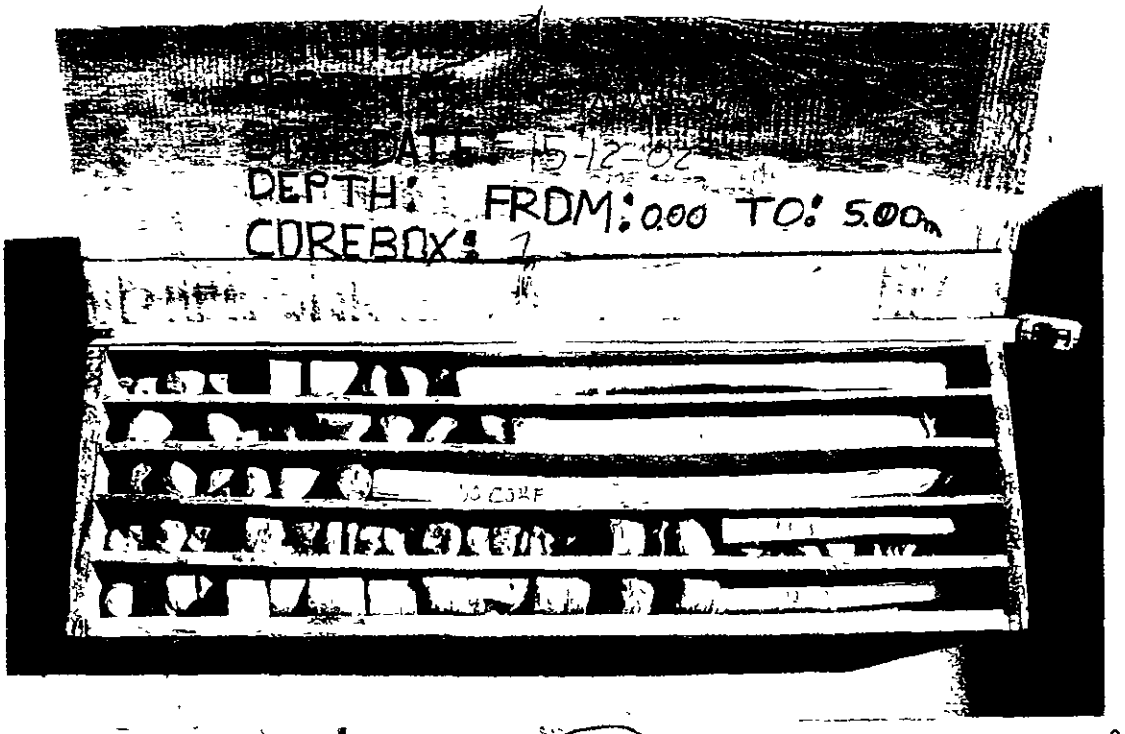


SONDEO CGB - 3
0.00mts a 1.70mts

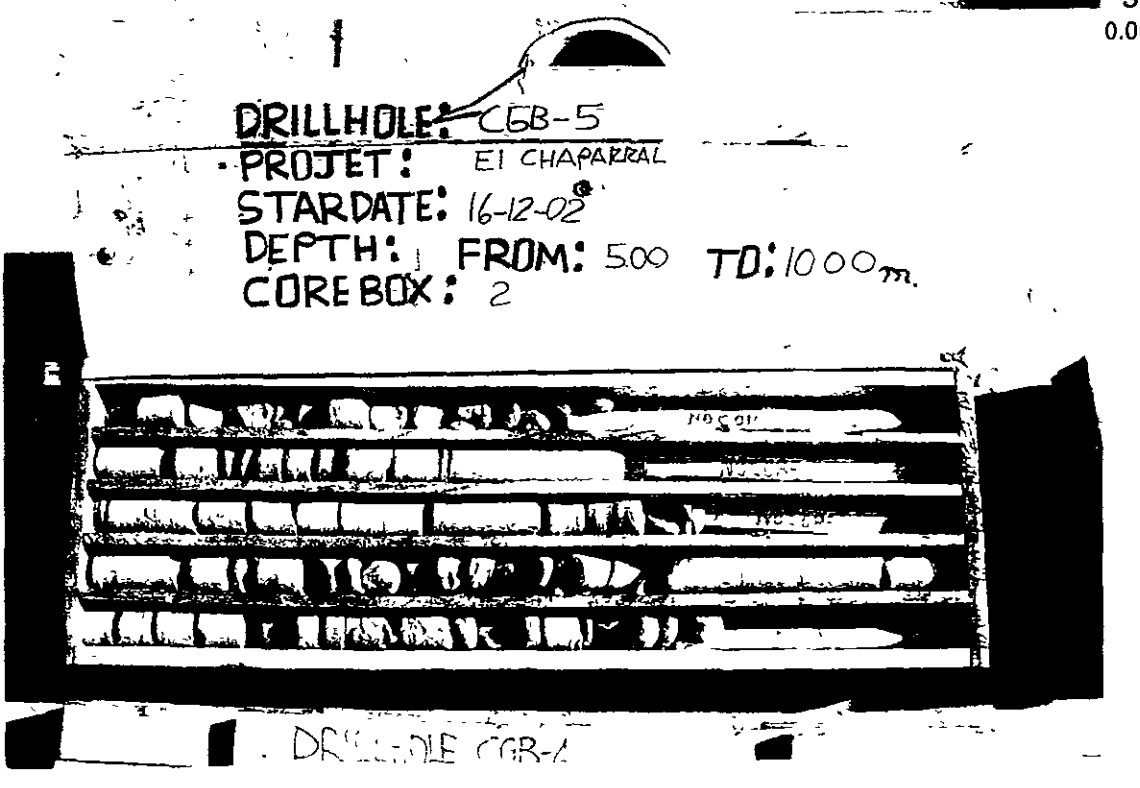
261



SONDEOS CGB-4
0.00mts a 10.00mts



SONDEOS CGB-5
0.00mts a 10.00mts



Appendix 7.5

Result of Permeability Test

PERMEABILITY TEST

swissboring
Swissboring Overseas Corporation Ltd.

CLIENT ELECTRIC POWER DEVELOPMENT Co.	DATE 2-diciembre-2001	LUGEON TEST Nº. 1
PROJECT.TOROLA HYDROELECTRIC COMPLEX	SITE DAM SITE (left margin)	TESTED BY Geols. L.Peréz- R. Alvarado
HOLE No · CDB-1	ELEVATION 208.84 m.s.l	CHECKED BY Geol.W. Hernández

Packer type	Neumatic	Length (m) =	0 80	Water pump	Bean Royal 535	Flood (l/min) =	
				Test depth (m) from	3.00	to	8 00
Test length (cm)		L * Cos X ° =	500 00	Depth of hole (m)	8 00	Dip X (°)=	0
Swivel H1 (m)		H1 =	2 80	Diameter of hole D (cm)	7 57	*W L Before of test (m)=*	*2 8*
Water level Ha (m)	2 8	Ha * Cos X ° =	2 80	Hydrostatic load (kg/cm2)	Lh= (H1+Ha)/10 =		0 560

Steel pipe.	Length (m) =	lt	= 5 00	Plastic Pipe.	Length (m)	1 m = 5 00	Reducciones.	Valv uniones	0 2
	Diameter ϕ_1	(m)	= 0 0603		Diameter ϕ_2	(m) = 0 0254	α	Packer	0 12
	Coef rugosidad	n1	= 0 01		Coef rugosidad	n2 = 0 008		Codo	0 008

PRESSURE READING	LOSS PRESSURE	EFECTIVE PRESSURE	INJECTED TIME	WATER VOLUME	FLOOD			SPECIFIC ABSOPTION	LUGEON UNIT	PERMEABILITY COEFICIENT
Po	Plo=P1+P2+P3	Pe = Po+Lh - Plo	t	Qt	Qo=Qt/t	Q1=Q/60000	Q2=Q*100/6	Ae = Q / L	$UL = \frac{10^* Ae}{Pe}$	$K = \frac{Q2}{2\pi Pe L} * \ln \frac{2L}{D}$
(kg/cm²)	(kg/cm²)	(kg/cm²)	(min)	(l)	(l/min)	(m³/s)	(cm³/s)	(l/min/m)	U L	(cm/s)
1 00	0 00000	1 56	10	0 00	0.00	0 00E+00	0.00	0.00	0.0	0 00E+00
0.00	0 00000	0.56	10	0 00	0 00	0 00E+00	0 00	0 00	0.0	0 00E+00
0 00	0 00000	0.56	10	0 00	0 00	0 00E+00	0.00	0 00	0 0	0 00E+00
0 00	0 00000	0 56	10	0.00	0 00	0 00E+00	0 00	0.00	0 0	0 00E+00
0 00	0 00000	0 56	10	0 00	0.00	0 00E+00	0.00	0 00	0 0	0.00E+00

TOTAL LOSS LOAD

$$Pc = Pc_1 + Pc_2 + Pc_3$$

$$P_1 = \frac{10.34 * (n_1)^2 * (Q_1^2) * lt}{(\phi_1^{5.33})}$$

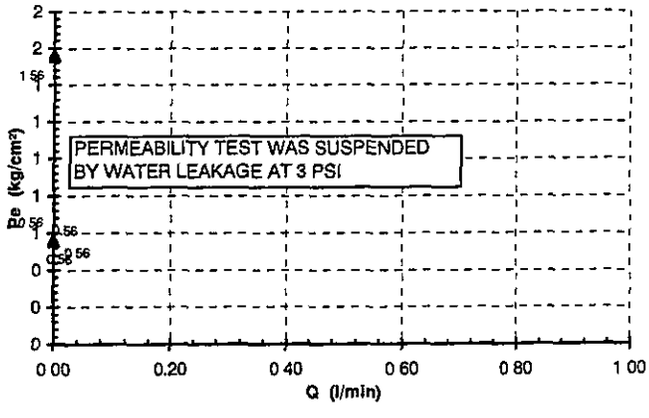
P1= loss load on steel pipe

$$P_2 = \frac{10.34 * (n_2)^2 * (Q_2^2) * lm}{(\phi_2^{5.33})}$$

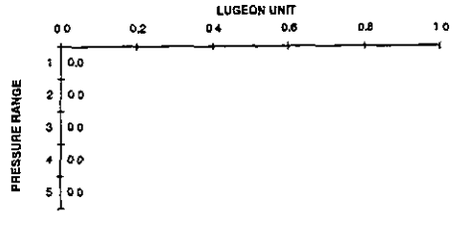
P2= loss load on plastic pipe

$$P_3 = \sum \alpha * (Q_1)$$

P3= loss load on reducciones, *valvulas y uniones*



VALUES OF LUGEON UNIT



PERMEABILITY (LU) = 0 0

Po = Pressure Reading; Lh = Hydrostatic Load; Plo = Loss Pressure.

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PERMEABILITY TEST

swissboring
Swissboring Overseas Corporation Ltd.

CLIENT ELECTRIC POWER DEVELOPMENT Co.	DATE 2-diciembre-2001	LUGEON TEST Nº 2
PROJECT TOROLA HYDROELECTRIC COMPLEX	SITE DAM SITE (left margin)	TESTED BY Geols. L.Peréz- R. Alvarado
HOLE No CDB-1	ELEVATION 208.84 m.s.l	CHECKED BY: Geol.W. Hernández

Packer type	Neumatic	Length (m) =	0 80	Water pump	Bean Royal 535	Flood (l/min) =	
				Test depth (m) from.	5 00	to	10 00
Test length (cm)		L * Cos X ° =	500 00	Depth of hole (m)	10 00	Dip X (°)=	0
Swivel H1 (m)		H1 =	0 60	Diameter of hole D (cm)	7 57	W L Before of test (m)=	2 55
Water level Ha (m)	2 55	Ha * Cos X ° =	2 55	Hydrostatic load (kg/cm2)	Lh= (H1+Ha)/10 =		0 315

Steel pipe.	Length (m) =	lt	= 5 00	Plastic Pipe.	Length (m)	1 m	= 5 00	Reducciones.	Valv uniones 0 2
	Diameter ϕ_1	(m)	= 0 0603		Diameter ϕ_2	(m)	= 0 0254	α	Packer 0 12
	Coef rugosidad	n1	= 0 01		Coef rugosidad	n2	= 0 008		Codo 0 008

PRESSURE READING Po (kg/cm²)	LOSS PRESSURE Plo=P1+P2+P3 (kg/cm²)	EFECTIVE PRESSURE Pe= Po-Lh - Plo (kg/cm²)	INJECTED TIME t (min)	WATER VOLUME Qt (l)	FLOOD Qo=Qt/t (l/min)	FLOOD Q1=Q/60000 (m³/s)	FLOOD Q2=Q*100/6 (cm³/s)	SPECIFIC ABSOPTION Ae = Q / L (l/min/m)	LUGEON UNIT UL = 10* Ae / Pe	PERMEABILITY COEFICIENT K = Q 2 / 2 π Pe L * ln 2L / D (cm/s)
1.00	0.00000	1.32	10	0 00	0 00	0 00E+00	0.00	0 00	0 0	0 00E+00
3 00	0 00019	3 31	10	8.00	0 80	1 33E-05	13 33	0 16	0.5	6 25E-06
5 00	0 00306	5 31	10	32 00	3 20	5 33E-05	53 33	0 64	1 2	1 56E-05
3 00	0 00015	3 31	10	7 00	0 70	1 17E-05	11 67	0 14	0 4	5 47E-06
1 00	0 00000	1 32	10	0 00	0 00	0 00E+00	0 00	0 00	0 0	0 00E+00

TOTAL LOSS LOAD

$$Pc = Pc_1 + Pc_2 + Pc_3$$

$$P_1 = \frac{10.34 * (n_1)^2 * (Q_1^2) * lt}{(\phi_1^{5.33})}$$

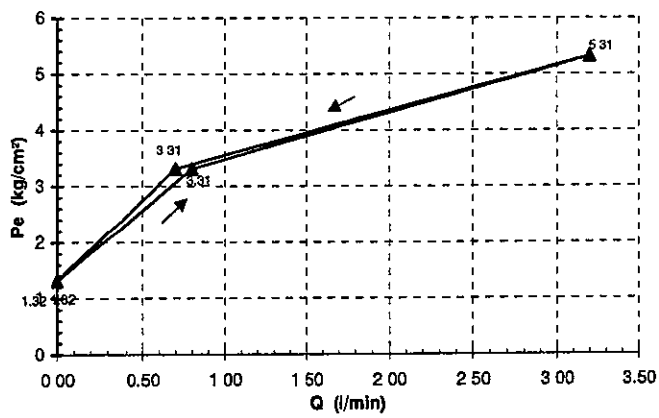
P1= loss load on steel pipe

$$P_2 = \frac{10.34 * (n_2)^2 * (Q_2^2) * lm}{(\phi_2^{5.33})}$$

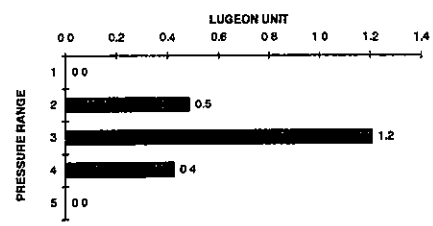
P2= loss load on plastic pipe

$$P_3 = \sum \alpha * (Q_1)$$

P3= loss load on reducciones, valvulas y uniones



VALUES OF LUGEON UNIT



PERMEABILITY (LU) = 1.2

Po = Pressure Reading, Lh = Hydrostatic Load, Plo = Loss Pressure.

PERMEABILITY TEST

swissboring
Swissboring Overseas Corporation Ltd.

CLIENT ELECTRIC POWER DEVELOPMENT Co.	DATE 2-diciembre-2001	LUGEON TEST Nº: 3
PROJECT TOROLA HYDROELECTRIC COMPLEX	SITE: DAM SITE (left margin)	TESTED BY Geols. L.Peréz- R. Alvarado
HOLE No CDB-1	ELEVATION: 208.84 m.s.l	CHECKED BY Geol.W. Hernández

Packer type:	Neumatic	Length (m) =	0 80	Water pump	Bean Royal 535	Flood (l/min) =	
				Test depth (m) from	10 00	to	15 00
Test length (cm)		L * Cos X ° =	500 00	Depth of hole (m):	15 00	Dip X (°)=	0
Swivel H1 (m)		H1 =	1 70	Diameter of hole D (cm)	7 57	W L Before of test (m)=	4 5
Water level Ha (m)	4 5	Ha * Cos X ° =	4 50	Hydrostatic load (kg/cm2)	Lh= (H1+Ha)/10 =		0 620

Steel pipe.	Length (m) =	1t =	5 00	Plastic Pipe.	Length (m)	1 m =	5 00	Reducciones.	Valv uniones	0.2
	Diameter ϕ_1	(m) =	0 0603		Diameter ϕ_2	(m) =	0 0254	α	Packer	0 12
	Coef rugosidad	n1 =	0 01		Coef rugosidad	n2 =	0 008		Codo	0 008

PRESSURE READING	LOSS PRESSURE	EFECTIVE PRESSURE	INJECTED TIME	WATER VOLUME	FLOOD			SPECIFIC ABSOPTION	LUGEON UNIT	PERMEABILITY COEFICIENT
Po (kg/cm²)	Plo=P1+P2+P3 (kg/cm²)	Pe= Po+Lh - Plo (kg/cm²)	t (min)	Qt (l)	Qo=Qt/t (l/min)	Q1=Q/60000 (m³/s)	Q2=Q*100/6 (cm³/s)	Ae = Q / L (l/min/m)	$UL = \frac{10 * Ae}{Pe}$ UL	$K = \frac{Q2}{2\pi Pe L} * \ln \frac{2L}{D}$ (cm/s)
1 00	0 00686	1.61	10	48.00	4 80	8 00E-05	80 00	0 96	6 0	7 71E-05
5 00	0 07604	5.54	10	160 00	16 00	2 67E-04	266 67	3 20	5 8	7 48E-05
10 00	0 39982	10 22	10	367 00	36.70	6.12E-04	611 67	7 34	7 2	9 30E-05
5 00	0 06160	5 56	10	144 00	14.40	2 40E-04	240 00	2 88	5 2	6.71E-05
1.00	0 00000	1 62	10	0 00	0 00	0 00E+00	0 00	0 00	0 0	0 00E+00

TOTAL LOSS LOAD

$$Pc = Pc_1 + Pc_2 + Pc_3$$

$$P_1 = \frac{10.34 * (n_1)^2 * (Q_1^2) * lt}{(\phi_1^{5.33})}$$

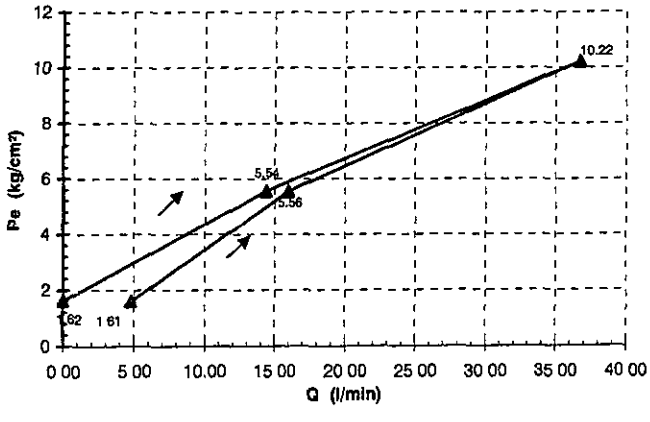
P1= loss load on steel pipe

$$P_2 = \frac{10.34 * (n_2)^2 * (Q_2^2) * lm}{(\phi_2^{5.33})}$$

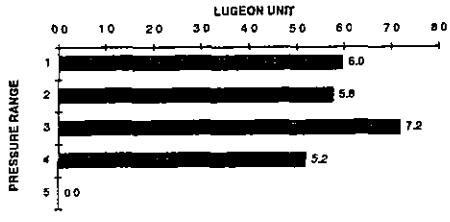
P2= loss load on plastic pipe

$$P_3 = \sum \alpha * (Q_1)$$

P3= loss load on reducciones, valvulas y uniones



VALUES OF LUGEON UNIT



PERMEABILITY (LU) = 7 2

Po = Pressure Reading, Lh = Hydrostatic Load, Plo = Loss Pressure.

PERMEABILITY TEST

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CLIENT. ELECTRIC POWER DEVELOPMENT Co.	DATE: 3-diciembre-2001	LUGEON TEST Nº: 4
PROJECT TOROLA HYDROELECTRIC COMPLEX	SITE. DAM SITE (left margin)	TESTED BY Geols. L.Peréz- R. Alvarado
HOLE No.: CDB-1	ELEVATION 208.84 m.s.l	CHECKED BY: Geol.W. Hernández

Packer type	Neumatic	Length (m) =	0 80	Water pump	Bean Royal 535	Flood (l/min) =	
				Test depth (m) from	15 00	to	20 00
Test length (cm)		L * Cos X ° =	500 00	Depth of hole (m)	20 00	Dip X (°)=	0
Swivel H1 (m)		H1 =	2 80	Diameter of hole D (cm)	7 57	W L Before of test (m)=	4 8
Water level Ha (m)	4 8	Ha * Cos X ° =	4 80	Hydrostatic load (kg/cm2)	Lh= (H1+Ha)/10 =		0 760

Steel pipe.	Length (m) =	1t =	5 00	Plastic Pipe.	Length (m)	1 m = 5 00	Reducciones:	Valv uniones	0 2
	Diameter ϕ_1	(m) =	0 0603		Diameter ϕ_2	(m) = 0 0254	α	Packer	0 12
	Coef rugosidad	n1 =	0 01		Coef rugosidad	n2 = 0 008		Codo	0 008

PRESSURE READING Po (kg/cm²)	LOSS PRESSURE Plo=P1+P2+P3 (kg/cm²)	EFECTIVE PRESSURE Pc = Po+Lh - Plo (kg/cm²)	INJECTED TIME t (min)	WATER VOLUME Qt (l)	FLOOD Qo=Qt/t (l/min)	FLOOD Q1=Q/60000 (m³/s)	FLOOD Q2=Q*100/6 (cm³/s)	SPECIFIC ABSOPTION Ae = Q / L (l/min/m)	LUGEON UNIT $UL = \frac{10 * Ae}{Pe}$ UL	PERMEABILITY COEFICIENT $K = \frac{Q2}{2\pi Pc\ L} * ln\frac{2L}{D}$ (cm/s)
1.00	0 00120	1 76	10	20.00	2 00	3.33E-05	33 33	0 40	2 3	2 95E-05
5 00	0 05576	5.70	10	137 00	13 70	2 28E-04	228 33	2 74	4 8	6 22E-05
10 00	1.42528	9 33	10	693 00	69 30	1 16E-03	1155 00	13 86	14 8	1 92E-04
5 00	0 15436	5 61	10	228 00	22 80	3.80E-04	380 00	4 56	8 1	1 05E-04
1 00	0 00087	1 76	10	17 00	1 70	2 83E-05	28 33	0 34	1 9	2 50E-05

TOTAL LOSS LOAD

$$Pc = Pc_1 + Pc_2 + Pc_3$$

$$P_1 = \frac{10.34 * (n_1)^2 * (Q_1^2) * lt}{(\phi_1^{5.33})}$$

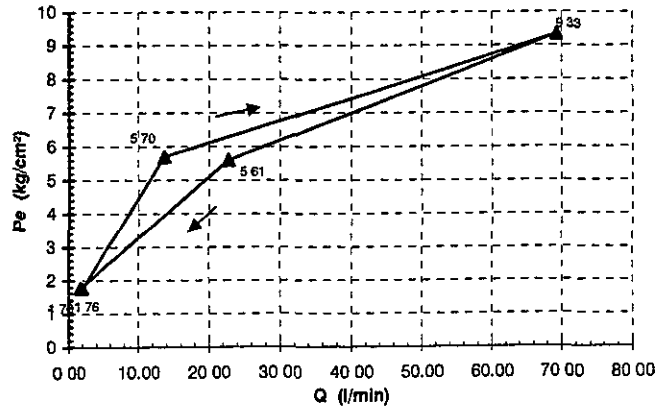
P1= loss load on steel pipe

$$P_2 = \frac{10.34 * (n_2)^2 * (Q_2^2) * lm}{(\phi_2^{5.33})}$$

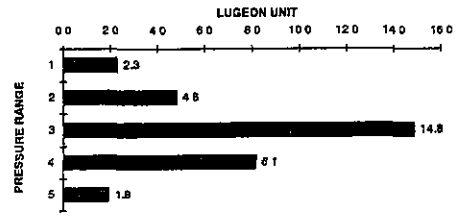
P2= loss load on plastic pipe

$$P_3 = \sum \alpha * (Q_1)$$

P3= loss load on reducciones, valvulas y uniones



VALUES OF LUGEON UNIT



PERMEABILITY (LU) = 14 8

Po = Pressure Reading; Lh = Hydrostatic Load, Plo = Loss Pressure

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PERMEABILITY TEST

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Swissboring Overseas Corporation Ltd.

CLIENT ELECTRIC POWER DEVELOPMENT Co.	DATE: 3-diciembre-2001	LUGEON TEST Nº. 5
PROJECT TOROLA HYDROELECTRIC COMPLEX	SITE DAM SITE (left margin)	TESTED BY Geols. L.Peréz- R. Alvarado
HOLE No. CDB-1	ELEVATION: 208.84 m.s.l	CHECKED BY Geol.W. Hernández

Packer type	Neumatic	Length (m) =	0 80	Water pump	Bean Royal 535	Flood (l/min) =	
				Test depth (m) from	20 00	to	25 00
Test length (cm)		L * Cos X ° =	500 00	Depth of hole (m)	25 00	Dip X (°)=	0
Swivel H1 (m)		H1	= 0 80	Diameter of hole D (cm)	7 57	W L Before of test (m)=	7 7
Water level Ha (m)	7 7	Ha * Cos X ° =	7 70	Hydrostatic load (kg/cm2)	Lh= (H1+Ha)/10	=	0 850

Steel pipe:	Length (m) =	lt	= 5 00	Plastic Pipe	Length (m)	1 m	= 5 00	Reducciones,	Valv uniones	0 2
	Diameter ϕ_1	(m)	= 0 0603		Diameter ϕ_2	(m)	= 0 0254	α	Packer	0 12
	Coef rugosidad	n1	= 0 01		Coef rugosidad	n2	= 0 008		Codo	0 008

PRESSURE READING	LOSS PRESSURE	EFECTIVE PRESSURE	INJECTED TIME	WATER VOLUME	FLOOD			SPECIFIC ABSOPTION	LUGEON UNIT	PERMEABILITY COEFICIENT
Po	Plo=P1+P2+P3	Pe = Po+Lh - Plo	t	Qt	Qo=Qt/t	Q1=Q/60000	Q2=Q*100/6	Ae = Q / L	$UL = \frac{10 * Ae}{Pe}$	$K = \frac{Q2}{2\pi Pe L} * \ln\frac{2L}{D}$
(kg/cm²)	(kg/cm²)	(kg/cm²)	(min)	(l)	(l/min)	(m³/s)	(cm³/s)	(l/min/m)	U L	(cm/s)
1 00	0 00868	1 84	10	54 00	5 40	9 00E-05	90 00	1 08	5.9	7 60E-05
5.00	0 52610	5 32	10	421 00	42 10	7 02E-04	701 67	8 42	15 8	2.05E-04
10.00	1 92313	8 93	10	805 00	80 50	1 34E-03	1341.67	16 10	18 0	2 34E-04
5.00	0 55395	5 30	10	432 00	43 20	7 20E-04	720.00	8 64	16.3	2 11E-04
1 00	0 04495	1.81	10	123 00	12 30	2 05E-04	205 00	2 46	13 6	1 77E-04

TOTAL LOSS LOAD

$$Pc = Pc_1 + Pc_2 + Pc_3$$

$$P_1 = \frac{10.34 * (n_1)^2 * (Q_1^2) * lt}{(\phi_1^{5.33})}$$

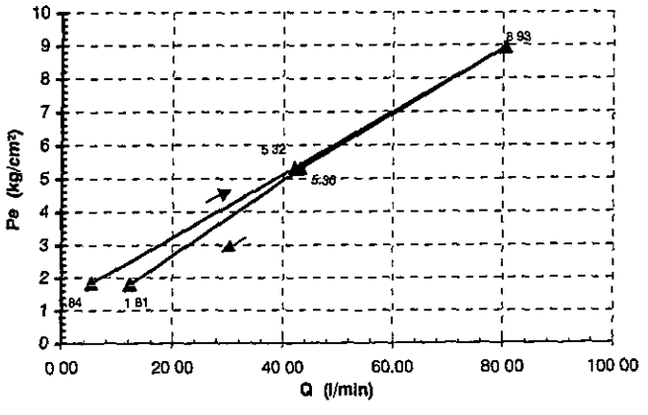
P1= loss load on steel pipe

$$P_2 = \frac{10.34 * (n_2)^2 * (Q_2^2) * lm}{(\phi_2^{5.33})}$$

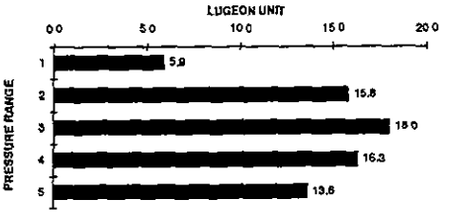
P2= loss load on plastic pipe

$$P_3 = \sum \alpha * (Q_1)$$

P3= loss load on reducciones, valvulas y uniones



VALUES OF LUGEON UNIT



PERMEABILITY (LU) = 18.0

Po = Pressure Reading; Lh = Hydrostatic Load, Plo = Loss Pressure.

PERMEABILITY TEST

swissboring
Swissboring Overseas Corporation Ltd.

CLIENT: ELECTRIC POWER DEVELOPMENT Co.	DATE: 3-diciembre-2001	LUGEON TEST Nº: 6
PROJECT TOROLA HYDROELECTRIC COMPLEX	SITE: DAM SITE (left margin)	TESTED BY Geols. L.Peréz- R. Alvarado
HOLE No.: CDB-1	ELEVATION 208.84 m.s.l	CHECKED BY. Geol.W. Hernández

Packer type	Neumatic	Length (m) =	0 80	Water pump	Bean Royal 535	Flood (l/min) =	
				Test depth (m) from	25 00	to	30 00
Test length (cm)		L * Cos X ° =	500.00	Depth of hole (m)	30 00	Dip X (°)=	0
Swivel H1 (m)		H1 =	0 60	Diameter of hole D (cm)	7 57	W L Before of test (m)=	4 8
Water level Ha (m)	4 8	Ha * Cos X ° =	4 80	Hydrostatic load (kg/cm2)	Lh= (H1+Ha)/10 =		0 540

Steel pipe.	Length (m) =	1t =	5 00	Plastic Pipe.	Length (m)	1 m =	5 00	Reducciones.	Valv uniones	0 2
	Diameter ϕ_1	(m) =	0 0603		Diameter ϕ_2	(m) =	0 0254	α	Packer	0 12
	Coef rugosidad	n1 =	0 01		Coef rugosidad	n2 =	0 008		Codo	0 008

PRESSURE READING	LOSS PRESSURE	EFECTIVE PRESSURE	INJECTED TIME	WATER VOLUME	FLOOD			SPECIFIC ABSOPTION	LUGEON UNIT	PERMEABILITY COERICIENT
Po	Plo=P1+P2+P3	Pe = Po+Lh - Plo	t	Qt	Qo=Qt/t	Q1=Q/60000	Q2=Q*100/6	Ae = Q / L	$UL = \frac{10 * Ae}{Pe}$	$K = \frac{Q2}{2\pi Pe\ L} * \ln\frac{2L}{D}$
(kg/cm²)	(kg/cm²)	(kg/cm²)	(min)	(l)	(l/min)	(m³/s)	(cm³/s)	(l/min/m)	UL	(cm/s)
1.00	0 00000	1.54	10	0 00	0 00	0 00E+00	0 00	0 00	0 0	0 00E+00
5 00	0 00158	5.54	10	23 00	2 30	3 83E-05	38 33	0 46	0 8	1 08E-05
10 00	0 07795	10 46	10	162.00	16 20	2 70E-04	270 00	3.24	3 1	4 01E-05
5 00	0.00868	5.53	10	54 00	5 40	9 00E-05	90 00	1 08	2 0	2 53E-05
1.00	0 00000	1 54	10	0 00	0 00	0 00E+00	0 00	0.00	0 0	0 00E+00

TOTAL LOSS LOAD

$$Pc = Pc_1 + Pc_2 + Pc_3$$

$$P_1 = \frac{10.34 * (n_1)^2 * (Q_1^2) * lt}{(\phi_1^{5.33})}$$

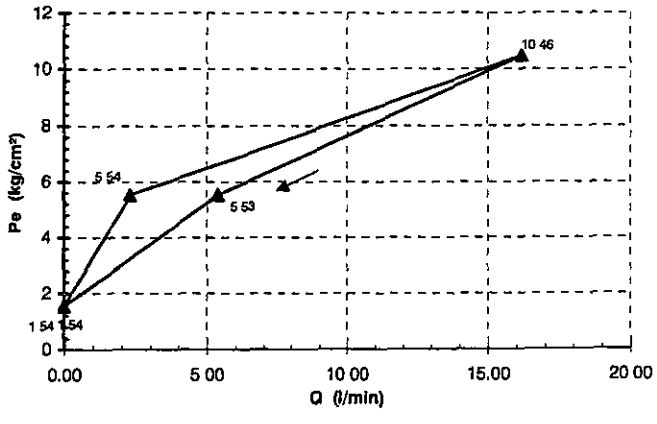
P1= loss load on steel pipe

$$P_2 = \frac{10.34 * (n_2)^2 * (Q_2^2) * lm}{(\phi_2^{5.33})}$$

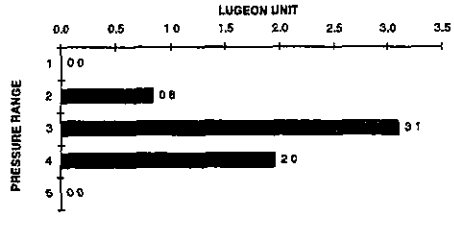
P2= loss load on plastic pipe

$$P_3 = \sum \alpha * (Q_1)$$

P3= loss load on reducciones, valvulas y uniones



VALUES OF LUGEON UNIT



PERMEABILITY (LU) = 3.1

Po = Pressure Reading, Lh = Hydrostatic Load, Plo = Loss Pressure

PERMEABILITY TEST

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CLIENT. ELECTRIC POWER DEVELOPMENT Co.	DATE 3-diciembre-2001	LUGEON TEST N° 7
PROJECT.TOROLA HYDROELECTRIC COMPLEX	SITE DAM SITE (left margin)	TESTED BY Geols. L.Peréz- R. Alvarado
HOLE No · CDB-1	ELEVATION· 208.84 m.s.l	CHECKED BY Geol.W. Hernández

Packer type·	Neumatic	Length (m) =	0 80	Water pump.	Bean Royal 535	Flood (l/min) =	
				Test depth (m) from	30 00	to.	35 00
Test length (cm)		L * Cos X ° =	500 00	Depth of hole (m)	35 00	Dip X (°)=	0
Swivel H1 (m)		H1 =	0 90	Diameter of hole D (cm)	7 57	W L Before of test (m)=	4 75
Water level Ha (m)	4 75	Ha * Cos X ° =	4 75	Hydrostatic load (kg/cm2)	Lh= (H1+Ha)/10 =		0 565

Steel pipe.	Length (m) =	lt	= 5 00	Plastic Pipe.	Length (m)	1 m = 5 00	Reducciones.	Valv uniones	0 2
	Diameter ϕ_1	(m)	= 0.0603		Diameter ϕ_2	(m) = 0 0254	α	Packer	0 12
	Coef rugosidad	n1	= 0 01		Coef rugosidad	n2 = 0 008		Codo	0 008

PRESSURE READING	LOSS PRESSURE	EFECTIVE PRESSURE	INJECTED TIME	WATER VOLUME	FLOOD			SPECIFIC ABSOPTION	LUGEON UNIT	PERMEABILITY COEFICIENT
Po	Plo=P1+P2+P3	Pe= Po+Lh - Plo	t	Qt	Qo=Qt/t	Q1=Q/60000	Q2=Q*100/6	Ae = Q / L	$UL = \frac{10 * Ae}{Pe}$	$K = \frac{Q2}{2 \pi Pe \frac{L}{D}} * ln \frac{2L}{D}$
(kg/cm²)	(kg/cm²)	(kg/cm²)	(min)	(l)	(l/min)	(m³/s)	(cm³/s)	(l/min/m)	UL	(cm/s)
1 00	0 00000	1.57	10	0 00	0 00	0 00E+00	0.00	0 00	0 0	0 00E+00
5 00	0 06863	5 50	10	152 00	15.20	2 53E-04	253 33	3.04	5 5	7 16E-05
10 00	1 90407	8 66	10	801 00	80.10	1 34E-03	1335 00	16 02	18 5	2 40E-04
5 00	0 47970	5 09	10	402 00	40 20	6 70E-04	670.00	8 04	15 8	2 05E-04
1 00	0 03215	1 53	10	104 00	10.40	1 73E-04	173 33	2 08	13 6	1 76E-04

TOTAL LOSS LOAD

$$Pc = Pc_1 + Pc_2 + Pc_3$$

$$P_1 = \frac{10.34 * (n_1)^2 * (Q_1^2) * lt}{(\phi_1^{5.33})}$$

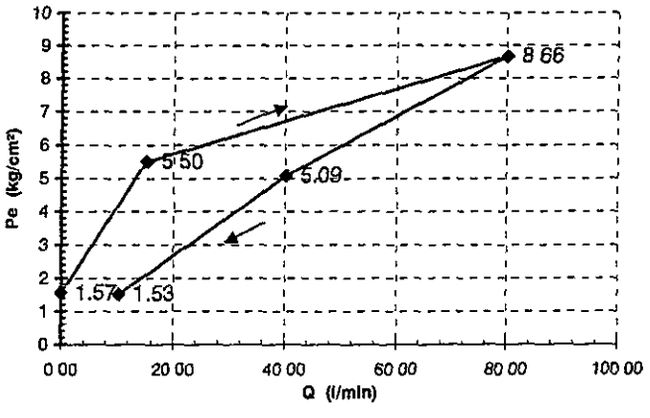
P1= loss load on steel pipe

$$P_2 = \frac{10.34 * (n_2)^2 * (Q_2^2) * lm}{(\phi_2^{5.33})}$$

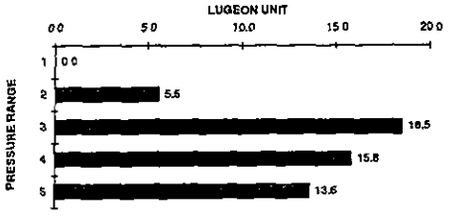
P2= loss load on plastic pipe

$$P_3 = \sum \alpha * (Q_1)$$

P3= loss load on reducciones, valvulas y uniones



VALUES OF LUGEON UNIT



PERMEABILITY (LU) = 18 5

Po = Pressure Reading, Lh = Hydrostatic Load, Plo = Loss Pressure

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PERMEABILITY TEST

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Swissboring Overseas Corporation Ltd.

CLIENT ELECTRIC POWER DEVELOPMENT Co.	DATE. 3-diciembre-2001	LUGEON TEST Nº: 8
PROJECT TOROLA HYDROELECTRIC COMPLEX	SITE DAM SITE (left margin)	TESTED BY Geols. L.Peréz- R. Alvarado
HOLE No CDB-1	ELEVATION 208.84 m.s.l	CHECKED BY Geol.W. Hernández

Packer type	Neumatic	Length (m) =	0 80	Water pump	Bean Royal 535	Flood (l/min) =	
				Test depth (m) from	35 00	to	40 00
Test length (cm)		L * Cos X ° =	500 00	Depth of hole (m)	40 00	Dip X (°)=	0
Swivel H1 (m)		H1	= 1 00	Diameter of hole D (cm)	7 57	W L Before of test (m)=	6 4
Water level Ha (m)	6 4	Ha * Cos X ° =	6 40	Hydrostatic load (kg/cm2)	Lh= (H1+Ha)/10	=	0 740

Steel pipe	Length (m) =	lt	= 5 00	Plastic Pipe	Length (m)	1 m = 5 00	Reducciones	Valv uniones	0 2
	Diameter ϕ_1	(m)	= 0 0603		Diameter ϕ_2	(m) = 0 0254	α	Packer	0.12
	Coef rugosidad	n1	= 0 01		Coef rugosidad	n2 = 0 008		Codo	0 008

PRESSURE READING Po (kg/cm²)	LOSS PRESSURE Plo=P1+P2+P3 (kg/cm²)	EFECTIVE PRESSURE Pe= Po+Lh - Plo (kg/cm²)	INJECTED TIME t (min)	WATER VOLUME Qt (l)	FLOOD Qo=Qt/t (l/min)	FLOOD Q1=Q/60000 (m³/s)	FLOOD Q2=Q*100/6 (cm³/s)	SPECIFIC ABSOPTION Ae = Q / L (l/min/m)	LUGEON UNIT $UL = \frac{10^n Ae}{Pe}$ UL	PERMEABILITY COEFICIENT $K = \frac{Q2}{2 \pi Pe L} * \ln \frac{2L}{D}$ (cm/s)
1 00	0 00306	1 74	10	32 00	3 20	5 33E-05	53 33	0 64	3 7	4.77E-05
5 00	0 78110	4 96	10	513 00	51 30	8 55E-04	855 00	10 26	20 7	2 68E-04
10 00	2 80370	7 94	10	972 00	97 20	1 62E-03	1620 00	19 44	24 5	3 17E-04
5 00	0 79948	4.94	10	519 00	51 90	8 65E-04	865 00	10 38	21 0	2 72E-04
1 00	0.15572	1.58	10	229 00	22 90	3 82E-04	381 67	4 58	28.9	3.74E-04

TOTAL LOSS LOAD

$$Pc = Pc_1 + Pc_2 + Pc_3$$

$$P_1 = \frac{10.34 * (n_1)^2 * (Q_1^2) * lt}{(\phi_1^{5.33})}$$

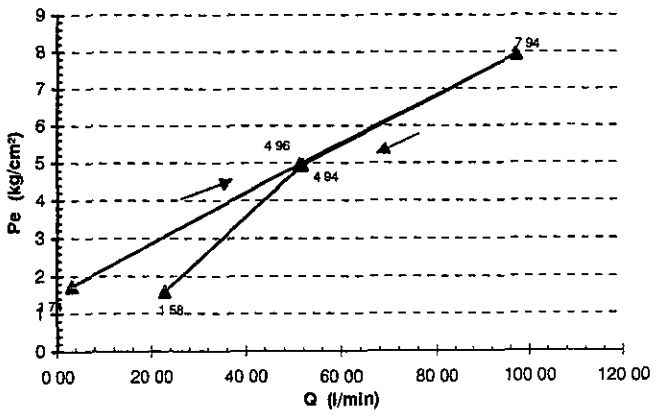
P1= loss load on steel pipe

$$P_2 = \frac{10.34 * (n_2)^2 * (Q_2^2) * lm}{(\phi_2^{5.33})}$$

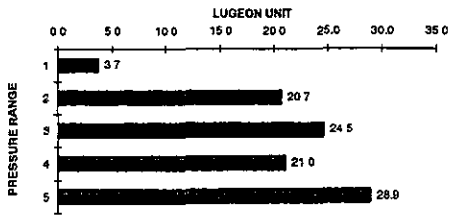
P2= loss load on plastic pipe

$$P_3 = \sum \alpha * (Q_1)$$

P3= loss load on reducciones, valvulas y uniones



VALUES OF LUGEON UNIT



PERMEABILITY (LU) = 24 5

Po = Pressure Reading, Lh = Hydrostatic Load, Plo = Loss Pressure

PERMEABILITY TEST

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CLIENT ELECTRIC POWER DEVELOPMENT Co.	DATE. 4-diciembre-2001	LUGEON TEST Nº. 9
PROJECT.TOROLA HYDROELECTRIC COMPLEX	SITE DAM SITE (left margin)	TESTED BY Geols. L.Peréz- R. Alvarado
HOLE No CDB-1	ELEVATION 208.84 m.s.l	CHECKED BY· Geol.W. Hernández

Packer type: Neumatic — Length (m) = 0 80 — Water pump: Bean Royal 535 — Flood (l/min) =

Test depth (m) from 40 00 to 45 00

Test length (cm) — L * Cos X ° = 500.00 — Depth of hole (m) 45 00 — Dip X (°)= 0

Swivel H1 (m) — H1 = 2 05 — Diameter of hole D (cm) 7 57 — W L Before of test (m)= 20 95

Water level Ha (m) 20 95 — Ha * Cos X ° = 20 95 — Hydrostatic load (kg/cm2) Lh= (H1+Ha)/10 = 2 300

Steel pipe.	Length (m) =	lt = 5 00	Plastic Pipe	Length (m)	1 m = 5 00	Reducciones.	Valv uniones	0 2
	Diameter ϕ_1	(m) = 0 0603		Diameter ϕ_2	(m) = 0 0254	α	Packer.	0 12
	Coef rugosidad	n1 = 0 01		Coef rugosidad	n2 = 0 008		Codo	0 008

PRESSURE READING Po (kg/cm²)	LOSS PRESSURE Plo=P1+P2+P3 (kg/cm²)	EFECTIVE PRESSURE Pc= Po+Lh - Plo (kg/cm²)	INJECTED TIME t (min)	WATER VOLUME Qt (l)	FLOOD Qo=Qt/t (l/min)	FLOOD Q1=Q/60000 (m³/s)	FLOOD Q2=Q*100/6 (cm³/s)	SPECIFIC ABSOPTION Ae = Q / L (l/min/m)	LUGEON UNIT $UL = \frac{10 * Ae}{Pe}$ UL	PERMEABILITY COEFICIENT $K = \frac{Q2}{2\pi Pe L} * \ln \frac{2L}{D}$ (cm/s)
1 00	0 00000	3 30	10	0 00	0 00	0 00E+00	0 00	0 00	0 0	0 00E+00
5 00	0 02972	7 27	10	100 00	10.00	1 67E-04	166 67	2 00	2 8	3 56E-05
10 00	0 99842	11 30	10	580 00	58.00	9 67E-04	966 67	11 60	10 3	1.33E-04
5 00	0 42414	6.88	10	378 00	37.80	6 30E-04	630.00	7 56	11 0	1 42E-04
1 00	0 06419	3 24	10	147 00	14 70	2 45E-04	245 00	2 94	9 1	1 18E-04

TOTAL LOSS LOAD

$$Pc = Pc_1 + Pc_2 + Pc_3$$

$$P_1 = \frac{10.34 * (n_1)^2 * (Q_1^2) * lt}{(\phi_1^{5.33})}$$

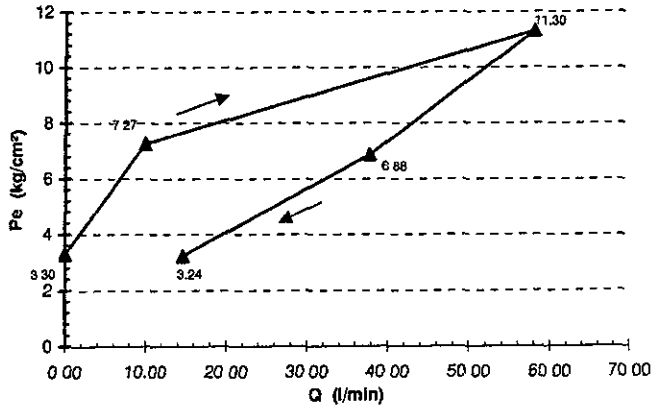
P1= loss load on steel pipe

$$P_2 = \frac{10.34 * (n_2)^2 * (Q_2^2) * lm}{(\phi_2^{5.33})}$$

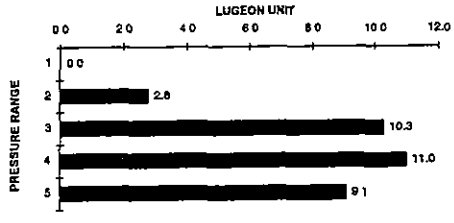
P2= loss load on plastic pipe

$$P_3 = \sum \alpha * (Q_1)$$

P3= loss load on reducciones, valvulas y uniones



VALUES OF LUGEON UNIT



PERMEABILITY (LU) = 10.3

Po = Pressure Reading; Lh = Hydrostatic Load, Plo = Loss Pressure

PERMEABILITY TEST

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CLIENT. ELECTRIC POWER DEVELOPMENT Co.	DATE 4-diciembre-2001	LUGEON TEST Nº. 10
PROJECT TOROLA HYDROELECTRIC COMPLEX	SITE DAM SITE (left margin)	TESTED BY Geols. L.Peréz- R. Alvarado
HOLE No CDB-1	ELEVATION 208.84 m.s.l	CHECKED BY· Geol.W. Hernández

Packer type	Neumatic	Length (m) =	0 80	Water pump	Bean Royal 535	Flood (l/min) =	
				Test depth (m) from	45 00	to	50 00
Test length (cm)		L * Cos X ° =	500 00	Depth of hole (m)	50 00	Dip X (°)=	0
Swivel H1 (m)		H1 =	0 95	Diameter of hole D (cm)	7 57	W L Before of test (m)=	36 15
Water level Ha (m)	36 15	Ha * Cos X ° =	36 15	Hydrostatic load (kg/cm2)	Lh= (H1+Ha)/10 =		3 710

Steel pipe.	Length (m) =	lt	= 5 00	Plastic Pipe.	Length (m)	1 m = 5 00	Reducciones.	Valv uniones	0 2
	Diameter ϕ_1	(m)	= 0 0603		Diameter ϕ_2	(m) = 0 0254	α	Packer	0 12
	Coef rugosidad	n1	= 0 01		Coef rugosidad	n2 = 0 008		Codo	0 008

PRESSURE READING	LOSS PRESSURE	EFECTIVE PRESSURE	INJECTED TIME	WATER VOLUME	FLOOD			SPECIFIC ABSOPTION	LUGEON UNIT	PERMEABILITY COERCIENT
Po	Plo=P1+P2+P3	Pe = Po+Lh - Plo	t	Qt	Qo=Qt/t	Q1=Q/60000	Q2=Q*100/6	Ae = Q / L	$UL = \frac{10 * Ae}{Pe}$	$K = \frac{Q2}{2\pi Pe L} * ln \frac{2L}{D}$
(kg/cm²)	(kg/cm²)	(kg/cm²)	(min)	(l)	(l/min)	(m³/s)	(cm³/s)	(l/min/m)	U L	(cm/s)
1 00	0 07700	4 63	10	161 00	16 10	2 68E-04	268 33	3 22	7 0	9 00E-05
5 00	1 20805	7 50	10	638 00	63 80	1 06E-03	1063 33	12 76	17 0	2.20E-04
10 00	3 61028	10 10	10	1103 00	110 30	1 84E-03	1838 33	22 06	21 8	2 83E-04
5 00	1.84745	6 86	10	789.00	78 90	1.32E-03	1315 00	15.78	23.0	2 98E-04
1 00	0 19764	4 51	10	258 00	25 80	4 30E-04	430 00	5 16	11 4	1 48E-04

TOTAL LOSS LOAD

$$Pc = Pc_1 + Pc_2 + Pc_3$$

$$P_1 = \frac{10.34 * (n_1)^2 * (Q_1^2) * lt}{(\phi_1^{5.33})}$$

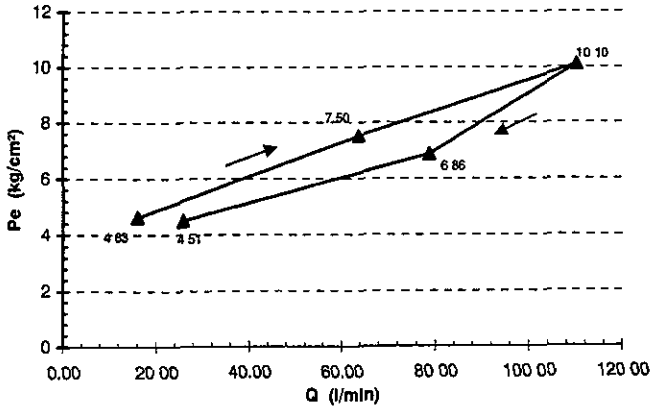
P1= loss load on steel pipe

$$P_2 = \frac{10.34 * (n_2)^2 * (Q_2^2) * lm}{(\phi_2^{5.33})}$$

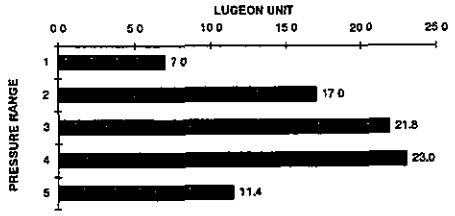
P2= loss load on plastic pipe

$$P_3 = \sum \alpha * (Q_1)$$

P3= loss load on reducciones, valvulas y uniones



VALUES OF LUGEON UNIT



PERMEABILITY (LU) = 21 8

Po = Pressure Reading, Lh = Hydrostatic Load, Plo = Loss Pressure

PERMEABILITY TEST

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Swissboring Overseas Corporation Ltd.

CLIENT ELECTRIC POWER DEVELOPMENT Co.	DATE 4-diciembre-2001	LUGEON TEST N° 11
PROJECT:TOROLA HYDROELECTRIC COMPLEX	SITE DAM SITE (left margin)	TESTED BY Geols. L.Peréz- R. Alvarado
HOLE No CDB-1	ELEVATION 208.84 m.s.l	CHECKED BY Geol.W. Hernández

Packer type	Neumatic	Length (m) =	0 80	Water pump:	Bean Royal 535	Flood (l/min) =	
				Test depth (m) from	50 00	to	55 00
Test length (cm)		L * Cos X ° =	500 00	Depth of hole (m)	55 00	Dip X (°)=	0
Swivel H1 (m)		H1	= 1 35	Diameter of hole D (cm)	7 57	W L. Before of test (m)=	16 7
Water level Ha (m)	16 7	Ha * Cos X ° =	16 70	Hydrostatic load (kg/cm2)	Lh= (H1+Ha)/10	=	1 805

Steel pipe.	Length (m) =	1t	= 5 00	Plastic Pipe.	Length (m)	1 m	= 5 00	Reducciones.	Valv uniones 0 2
	Diameter ϕ_1	(m)	= 0 0603		Diameter ϕ_2	(m)	= 0 0254	α	Packer 0 12
	Coef rugosidad	n1	= 0 01		Coef rugosidad	n2	= 0 008		Codo 0 008

PRESSURE READING Po (kg/cm²)	LOSS PRESSURE Plo=P1+P2+P3 (kg/cm²)	EFECTIVE PRESSURE Pe = Po+Lh - Plo (kg/cm²)	INJECTED TIME t (min)	WATER VOLUME Qt (l)	FLOOD Qo=Qt/t (l/min)	FLOOD Q1=Q/60000 (m³/s)	FLOOD Q2=Q*100/6 (cm³/s)	SPECIFIC ABSOPTION Ae = Q / L (l/min/m)	LUGEON UNIT UL = 10* Ae / Pe UL	PERMEABILITY COEFICIENT $K = \frac{Q2}{2\pi Pe \cdot L} * ln\frac{2L}{D}$ (cm/s)
1 00	0 00000	2 81	10	0 00	0 00	0 00E+00	0 00	0 00	0.0	0 00E+00
5 00	0 27617	6 53	10	305 00	30 50	5 08E-04	508 33	6 10	9 3	1.21E-04
10 00	1 37231	10 43	10	680 00	68 00	1 13E-03	1133 33	13 60	13 0	1.69E-04
5 00	0 66126	6 14	10	472 00	47.20	7.87E-04	786 67	9 44	15 4	1 99E-04
1 00	0.24796	2 56	10	289 00	28 90	4 82E-04	481 67	5 78	22 6	2 93E-04

TOTAL LOSS LOAD

$$Pc = Pc_1 + Pc_2 + Pc_3$$

$$P_1 = \frac{10.34 * (n_1)^2 * (Q_1^2) * lt}{(\phi_1^{5.33})}$$

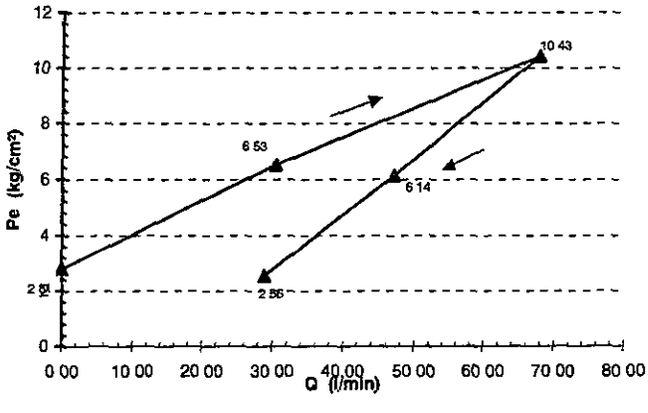
P1= loss load on steel pipe

$$P_2 = \frac{10.34 * (n_2)^2 * (Q_2^2) * lm}{(\phi_2^{5.33})}$$

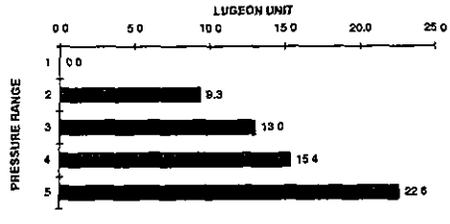
P2= loss load on plastic pipe

$$P_3 = \sum \alpha * (Q_1)$$

P3= loss load on reducciones, valvulas y uniones



VALUES OF LUGEON UNIT



PERMEABILITY (LU) = 13.0

Po = Pressure Reading, Lh = Hydrostatic Load, Plo = Loss Pressure.

PERMEABILITY TEST

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Swissboring Overseas Corporation Ltd.

CLIENT ELECTRIC POWER DEVELOPMENT Co.	DATE: 5-diciembre-2001	LUGEON TEST Nº. 12
PROJECT TOROLA HYDROELECTRIC COMPLEX	SITE: DAM SITE (left margin)	TESTED BY Geols. L.Peréz- R. Alvarado
HOLE No.: CDB-1	ELEVATION 208.84 m.s.l	CHECKED BY: Geol.W. Hernández

Packer type.	Neumatic	Length (m) =	0 80	Water pump	Bean Royal 535	Flood (l/min) =	
				Test depth (m) from	55 00	to	60 00
Test length (cm)		L * Cos X ° =	500 00	Depth of hole (m)	60 00	Dip X (°)=	0
Swivel H1 (m).		H1 =	2 45	Diameter of hole D (cm)	7 57	W L Before of test (m)=	14 8
Water level Ha (m)	14 8	Ha * Cos X ° =	14 80	Hydrostatic load (kg/cm2)	Lh= (H1+Ha)/10 =		1 725

Steel pipe.	Length (m) =	lt	= 5 00	Plastic Pipe.	Length (m)	1 m = 5 00	Reducciones.	Valv uniones	0 2
	Diameter ϕ_1	(m)	= 0 0603		Diameter ϕ_2	(m) = 0 0254	α	Packer	0 12
	Coef rugosidad	n1	= 0 01		Coef rugosidad	n2 = 0 008		Codo	0 008

PRESSURE READING	LOSS PRESSURE	EFECTIVE PRESSURE	INJECTED TIME	WATER VOLUME	FLOOD			SPECIFIC ABSOPTION	LUGEON UNIT	PERMEABILITY COERCIENT
Po	Plo=P1+P2+P3	Pc= Po+Lh - Plo	t	Qt	Qo=Qt/t	Q1=Q/60000	Q2=Q*100/6	Ae = Q / L	$UL = \frac{10^* Ae}{Pe}$	$K = \frac{Q\,2}{2\,\pi\,Pe\;L} * Ln\frac{2L}{D}$
(kg/cm²)	(kg/cm²)	(kg/cm²)	(min)	(l)	(l/min)	(m³/s)	(cm³/s)	(l/min/m)	U L	(cm/s)
1 00	0 00000	2 73	10	0 00	0 00	0 00E+00	0 00	0 00	0.0	0 00E+00
5 00	0 00001	6 72	10	2.00	0.20	3.33E-06	3 33	0.04	0 1	7 71E-07
10 00	0.42414	11 30	10	378 00	37 80	6.30E-04	630 00	7 56	6 7	8 67E-05
5 00	0 07322	6 65	10	157.00	15.70	2 62E-04	261 67	3 14	4 7	6 12E-05
1.00	0 01144	2 71	10	62.00	6.20	1.03E-04	103 33	1 24	4 6	5 92E-05

TOTAL LOSS LOAD

$$Pc = Pc_1 + Pc_2 + Pc_3$$

$$P_1 = \frac{10.34 * (n_1)^2 * (Q_1^2) * lt}{(\phi_1^{5.33})}$$

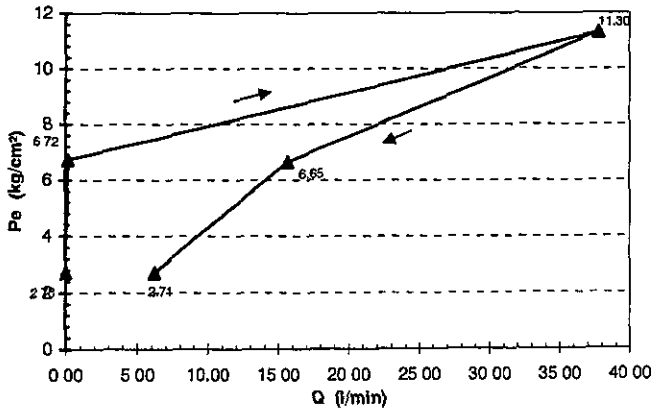
P1= loss load on steel pipe

$$P_2 = \frac{10.34 * (n_2)^2 * (Q_2^2) * lm}{(\phi_2^{5.33})}$$

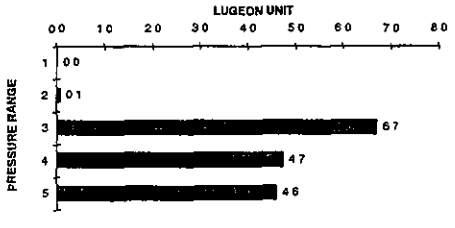
P2= loss load on plastic pipe

$$P_3 = \sum \alpha * (Q_1)$$

P3= loss load on reducciones, valvulas y uniones



VALUES OF LUGEON UNIT



PERMEABILITY (LU) = 6.7

Po = Pressure Reading, Lh = Hydrostatic Load; Plo = Loss Pressure.

7-5-12

PERMEABILITY TEST

swissboring
Swissboring Overseas Corporation Ltd.

CLIENT. ELECTRIC POWER DEVELOPMENT Co.	DATE 5-diciembre-2001	LUGEON TEST N° 13
PROJECT TOROLA HYDROELECTRIC COMPLEX	SITE DAM SITE (left margin)	TESTED BY Geols. L.Peréz- R. Alvarado
HOLE No. CDB-1	ELEVATION 208.84 m.s.l	CHECKED BY: Geol.W. Hernández

Packer type	Neumatic	Length (m) =	0 80	Water pump	Bean Royal 535	Flood (l/min) =	
				Test depth (m) from	60 00	to	65 00
Test length (cm)		L * Cos X ° =	500 00	Depth of hole (m)	65 00	Dip X (°)=	0
Swivel H1 (m)		H1 =	1 10	Diameter of hole D (cm)	7 57	W L Before of test (m)=	28 25
Water level Ha (m)	28 25	Ha * Cos X ° =	28 25	Hydrostatic load (kg/cm2)	Lh= (H1+Ha)/10 =		2 935

Steel pipe	Length (m) =	lt =	5 00	Plastic Pipe	Length (m)	1 m =	5 00	Reducciones	Valv uniches 0 2
	Diameter ϕ_1	(m) =	0 0603		Diameter ϕ_2	(m)	= 0 0254	α	Packer 0 12
	Coef rugosidad	n1 =	0 01		Coef. rugosidad	n2	= 0 008		Codo 0 008

PRESSURE READING Po (kg/cm²)	LOSS PRESSURE Plo=P1+P2+P3 (kg/cm²)	EFECTIVE PRESSURE Pe = Po-Lh - Plo (kg/cm²)	INJECTED TIME 1 (min)	WATER VOLUME Qt (l)	FLOOD Qo=Qt/t (l/min)	FLOOD Q1=Q/60000 (m³/s)	FLOOD Q2=Q*100/6 (cm³/s)	SPECIFIC ABSOPTION Ae = Q / L (l/min/m)	LUGEON UNIT UL = 10* Ae / Pe UL	PERMEABILITY COEFICIENT K = 0 2 / (2 π Pe L) * ln 2L/D (cm/s)
1 00	0.00108	3.93	10	19 00	1 90	3.17E-05	31.67	0 38	1 0	1 25E-05
5.00	0 02740	7 91	10	96 00	9 60	1 60E-04	160 00	1.92	2 4	3.15E-05
10 00	0 00345	12 93	10	34 00	3 40	5 67E-05	56 67	0.68	0 5	6 81E-06
5 00	0 03999	7 90	10	116 00	11 60	1 93E-04	193 33	2 32	2 9	3 81E-05
1 00	0 00218	3 93	10	27 00	2 70	4 50E-05	45 00	0 54	1 4	1 78E-05

TOTAL LOSS LOAD

$$Pc = Pc_1 + Pc_2 + Pc_3$$

$$P_1 = \frac{10.34 * (n_1)^2 * (Q_1^2) * lt}{(\phi_1^{5.33})}$$

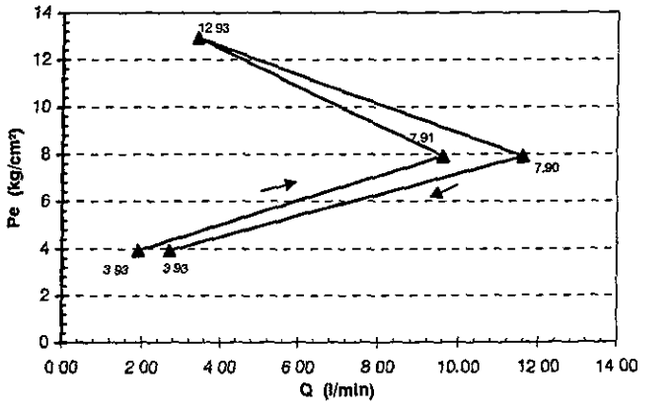
P1= loss load on steel pipe

$$P_2 = \frac{10.34 * (n_2)^2 * (Q_2^2) * lm}{(\phi_2^{5.33})}$$

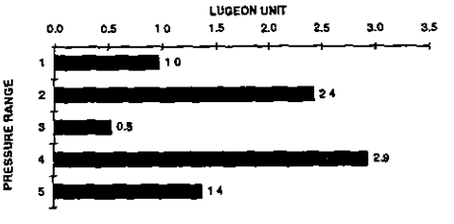
P2= loss load on plastic pipe

$$P_3 = \sum \alpha * (Q_1)$$

P3= loss load on reducciones, *valvulas y uniones*



VALUES OF LUGEON UNIT



PERMEABILITY (LU) = 0.5

Po = Pressure Reading, Lh = Hydrostatic Load, *Plo = Loss Pressure*

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PERMEABILITY TEST

swissboring
Swissboring Overseas Corporation Ltd.

CLIENT: ELECTRIC POWER DEVELOPMENT Co.	DATE 6-diciembre-2001	LUGEON TEST Nº 14
PROJECT.TOROLA HYDROELECTRIC COMPLEX	SITE· DAM SITE (left margin)	TESTED BY Geols. L.Peréz- R. Alvarado
HOLE No.: CDB-1	ELEVATION· 208.84 m.s.l	CHECKED BY Geol.W. Hernández

Packer type	Neumatic	Length (m) =	0 80	Water pump	Bean Royal 535	Flood (l/min) =	
				Test depth (m) from	65 00	to	70 00
Test length (cm)		L * Cos X º =	500 00	Depth of hole (m)	70 00	Dip X (º)=	0
Swivel H1 (m)·		H1 =	1 60	Diameter of hole D (cm)	7 57	W L Before of test (m)=	16 57
Water level Ha (m)	18 57	Ha * Cos X º =	18 57	Hydrostatic load (kg/cm2)	Lh= (H1+Ha)/10 =		2 017

Steel pipe.	Length (m) =	lt	= 5 00	Plastic Pipe.	Length (m)	1 m = 5 00	Reducciones.	Valv uniones	0 2
	Diameter ϕ_1	(m)	= 0 0603		Diameter ϕ_2	(m) = 0.0254	α	Packer	0 12
	Coef rugosidad	n1	= 0 01		Coef rugosidad	n2 = 0 008		Codo	0 008

PRESSURE READING	LOSS PRESSURE	EFECTIVE PRESSURE	INJECTED TIME	WATER VOLUME	FLOOD			SPECIFIC ABSOPTION	LUGEON UNIT	PERMEABILITY COEFICIENT
Po	Plo=P1+P2+P3	Pe= Po+Lh - Plo	t	Qt	Qo=Qt/t	Q1=Q/60000	Q2=Q*100/6	Ae = Q / L	$UL = \frac{10^n Ae}{Pe}$	$K = \frac{Q2}{2\pi Pe\ L} * ln\frac{2L}{D}$
(kg/cm²)	(kg/cm²)	(kg/cm²)	(min)	(l)	(l/min)	(m³/s)	(cm³/s)	(l/min/m)	U L	(cm/s)
1 00	0 00218	3 01	10	27 00	2 70	4 50E-05	45 00	0.54	1.8	2 32E-05
5 00	0 00868	7 01	10	54 00	5 40	9 00E-05	90 00	1 08	1 5	2 00E-05
10 00	0 35744	11 66	10	347 00	34 70	5 78E-04	578 33	6.94	6 0	7.71E-05
5 00	0 08787	6 93	10	172 00	17 20	2 87E-04	286 67	3 44	5.0	6.43E-05
1 00	0 00000	3 02	10	0.00	0.00	0 00E+00	0.00	0 00	0 0	0 00E+00

TOTAL LOSS LOAD

$$Pc = Pc_1 + Pc_2 + Pc_3$$

$$P_1 = \frac{10.34 * (n_1)^2 * (Q_1^2) * lt}{(\phi_1^{5.33})}$$

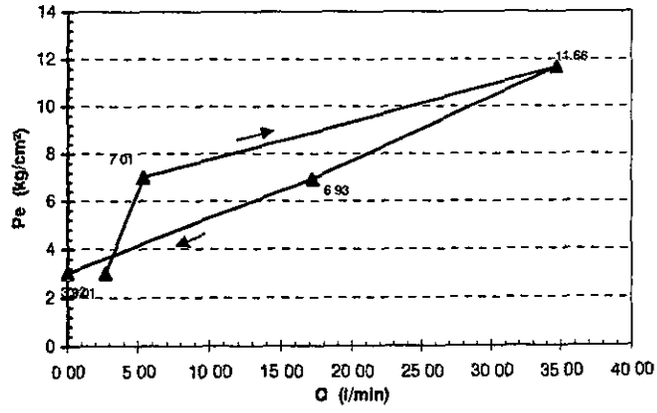
P1= loss load on steel pipe

$$P_2 = \frac{10.34 * (n_2)^2 * (Q_2^2) * lm}{(\phi_2^{5.33})}$$

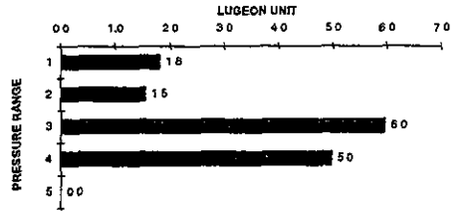
P2= loss load on plastic pipe

$$P_3 = \sum \alpha * (Q_1)$$

P3= loss load on reducciones, valvulas y uniones



VALUES OF LUGEON UNIT



PERMEABILITY (LU) = 6 0

Po = Pressure Reading, Lh = Hydrostatic Load, Plo = Loss Pressure

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PERMEABILITY TEST

swissboring
Swissboring Overseas Corporation Ltd.

CLIENT: ELECTRIC POWER DEVELOPMENT Co.	DATE 8-diciembre-2001	LUGEON TEST Nº 1
PROJECT TOROLA HYDROELECTRIC COMPLEX	SITE: DAM SITE (left margin)	TESTED BY Geols. L.Peréz- R. Alvarado
HOLE No · CDB-2	ELEVATION· 183.95 m.s.l	CHECKED BY: Geol.W. Hernández

Packer type.	Neumatic	Length (m) =	0 80	Water pump	Bean Royal 535	Flood (l/min) =	
				Test depth (m) from	9 75	to	14 75
Test length (cm)		L * Cos X º =	500 00	Depth of hole (m)	14 75	Dip X (º)=	0
Swivel H1 (m)		H1 =	2 60	Diameter of hole D (cm)	7 57	W L Before of test (m)=	3 5
Water level Ha (m)	3 5	Ha * Cos X º =	3 50	Hydrostatic load (kg/cm2)	Lh= (H1+Ha)/10 =		0 610
Steel pipe	Length (m) =	lt =	5 00	Plastic Pipe	Length (m) 1 m =	5 00	Reducciones, Valv uniones 0 2
	Diameter ϕ_1	(m) =	0 0603		Diameter ϕ_2 (m) =	0 0254	α Packer 0 12
	Coef rugosidad	n1 =	0 01		Coef rugosidad n2 =	0 008	Codo 0 008

PRESSURE READING Po (kg/cm²)	LOSS PRESSURE Plo=P1+P2+P3 (kg/cm²)	EFECTIVE PRESSURE Pe =Po +Lh - Plo (kg/cm²)	INJECTED TIME t (min)	WATER VOLUME Qt (l)	FLOOD Qo=Qt/t (l/min)	FLOOD Q1=Q/60000 (m³/s)	FLOOD Q2=Q*100/6 (cm³/s)	SPECIFIC ABSOPTION Ae = Q / L (l/min/m)	LUGEON UNIT $UL = \frac{10 * Ae}{Pe}$ UL	PERMEABILITY COEFICIENT $K = \frac{Q2}{2\pi Pe L} * ln\frac{2L}{D}$ (cm/s)
1 00	0.00000	1 61	10	0 00	0 00	0 00E+00	0 00	0 00	0 0	0 00E+00
3 00	0 00630	3 60	10	46.00	4 60	7 67E-05	76 67	0,92	2 6	3 31E-05
5 00	0 07795	5 53	10	162 00	16 20	2 70E-04	270 00	3 24	5 9	7.59E-05
3 00	0 02571	3 58	10	93.00	9 30	1 55E-04	155 00	1 86	5 2	6 72E-05
1 00	0 00037	1 61	10	11 00	1.10	1 83E-05	18 33	0 22	1 4	1 77E-05

TOTAL LOSS LOAD

$$Pc = Pc_1 + Pc_2 + Pc_3$$

$$P_1 = \frac{10.34 * (n_1)^2 * (Q_1^2) * lt}{(\phi_1^{5.33})}$$

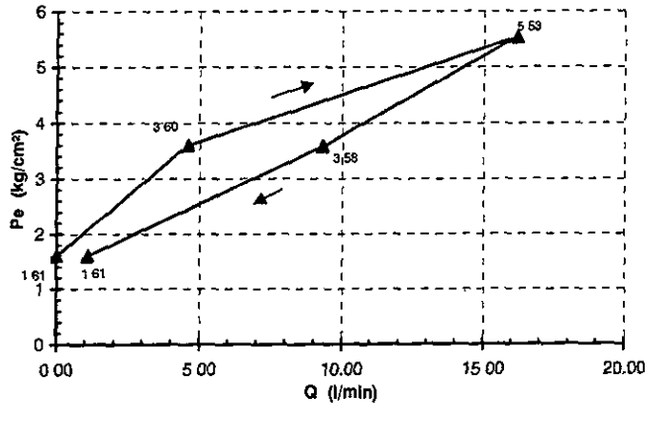
P1= loss load on steel pipe

$$P_2 = \frac{10.34 * (n_2)^2 * (Q_2^2) * lm}{(\phi_2^{5.33})}$$

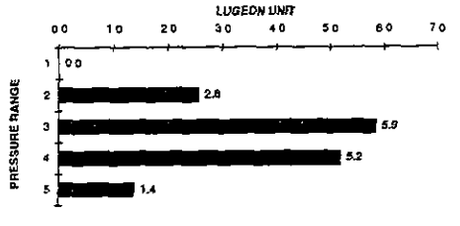
P2= loss load on plastic pipe

$$P_3 = \sum \alpha * (Q_1)$$

P3= loss load on reducciones, valvulas y uniones



VALUES OF LUGEON UNIT



PERMEABILITY (LU) = 5 9

Po = Pressure Reading, Lh = Hydrostatic Load, Plo = Loss Pressure

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PERMEABILITY TEST

swissboring
Swissboring Overseas Corporation Ltd.

CLIENT: ELECTRIC POWER DEVELOPMENT Co.	DATE: 8-diciembre-2001	LUGEON TEST Nº. 2
PROJECT TOROLA HYDROELECTRIC COMPLEX	SITE DAM SITE (left margin)	TESTED BY Geols. L.Peréz- R. Alvarado
HOLE No CDB-2	ELEVATION 183.95 m.s.l	CHECKED BY Geol.W. Hernández

Packer type	Neumatic	Length (m) =	0 80	Water pump	Bean Royal 535	Flood (l/min) =	
				Test depth (m) from	15 00	to	20 00
Test length (cm)		L * Cos X º =	500 00	Depth of hole (m)	20 00	Dip X (º)= 0	
Swivel H1 (m)		H1 =	0 80	Diameter of hole D (cm)	7 57	W L Before of test (m)= 3 95	
Water level Ha (m)	3 95	Ha * Cos X º =	3 95	Hydrostatic load (kg/cm2)	Lh= (H1+Ha)/10 =	0 475	

Steel pipe.	Length (m) =	1t	= 5 00	Plastic Pipe.	Length (m)	1 m = 5 00	Reducciones.	Valv uniones	0 2
	Diameter ϕ_1	(m)	= 0 0603		Diameter ϕ_2	(m) = 0 0254	α	Packer	0 12
	Coef rugosidad	n1	= 0 01		Coef rugosidad	n2 = 0 008		Codo	0 008

PRESSURE READING Po (kg/cm²)	LOSS PRESSURE Plo=P1+P2+P3 (kg/cm²)	EFECTIVE PRESSURE Pe =Po +Lh - Plo (kg/cm²)	INJECTED TIME t (min)	WATER VOLUME Qt (l)	FLOOD Qo=Qt/t (l/min)	FLOOD Q1=Q/60000 (m³/s)	FLOOD Q2=Q*100/6 (cm³/s)	SPECIFIC ABSOPTION Ae = Q / L (l/min/m)	LUGEON UNIT UL = 10* Ae / Pe	PERMEABILITY COEFICIENT $K = \frac{Q2}{2\pi Pe\ L} * \ln\frac{2L}{D}$ (cm/s)
1.00	0 00043	1 47	10	12.00	1.20	2 00E-05	20 00	0 24	1 6	2 11E-05
5.00	0 01585	5 46	10	73.00	7.30	1 22E-04	121 67	1 46	2 7	3.46E-05
10.00	0 19005	10 28	10	253 00	25 30	4 22E-04	421 67	5 06	4 9	6 37E-05
5 00	0 04138	5 43	10	118 00	11 80	1 97E-04	196 67	2 36	4 3	5 63E-05
1.00	0 00077	1 47	10	16 00	1 60	2 67E-05	26 67	0 32	2 2	2.81E-05

TOTAL LOSS LOAD

$$Pc = Pc_1 + Pc_2 + Pc_3$$

$$P_1 = \frac{10.34 * (n_1)^2 * (Q_1^2) * lt}{(\phi_1^{5.33})}$$

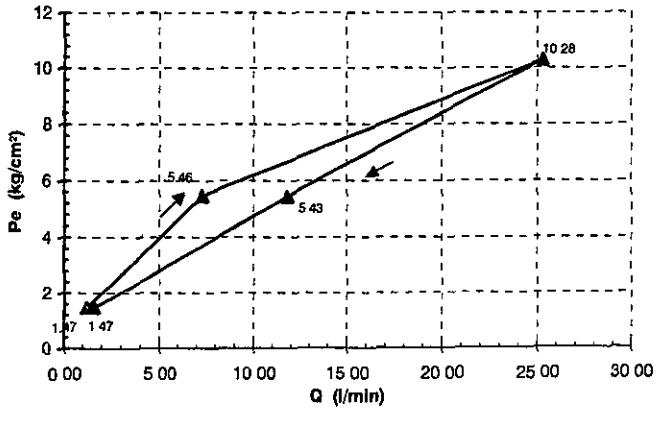
P1= loss load on steel pipe

$$P_2 = \frac{10.34 * (n_2)^2 * (Q_2^2) * lm}{(\phi_2^{5.33})}$$

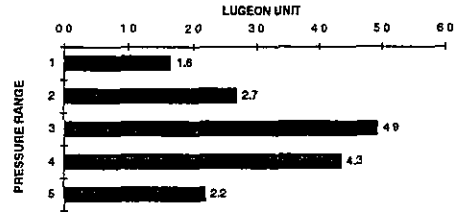
P2= loss load on plastic pipe

$$P_3 = \sum \alpha * (Q_1)$$

P3= loss load on reducciones, valvulas y uniones



VALUES OF LUGEON UNIT



PERMEABILITY (LU) = 4 9

Po = Pressure Reading; Lh = Hydrostatic Load; Plo = Loss Pressure.

PERMEABILITY TEST

swissboring
Swissboring Overseas Corporation Ltd.

CLIENT ELECTRIC POWER DEVELOPMENT Co.	DATE. 8-diciembre-2001	LUGEON TEST Nº. 3
PROJECT.TOROLA HYDROELECTRIC COMPLEX	SITE DAM SITE (left margin)	TESTED BY Geols. L.Peréz- R. Alvarado
HOLE No CDB-2	ELEVATION. 183.95 m.s.l	CHECKED BY Geol.W. Hernández

Packer type	Neumatic	Length (m) =	0 80	Water pump	Bean Royal 535	Flood (l/min) =	
				Test depth (m) from	20 00	to	25 00
Test length (cm)		L * Cos X ° =	500 00	Depth of hole (m)	25 00	Dip X (°)=	0
Swivel H1 (m)		H1 =	0 80	Diameter of hole D (cm),	7 57	W L Before of test (m)=	3.5
Water level Ha (m)	3 5	Ha * Cos X ° =	3 50	Hydrostatic load (kg/cm2)	Lh= (H1+Ha)/10 =		0 430
Steel pipe.	Length (m) =	lt =	5 00	Plastic Pipe. Length (m)	1 m =	5 00	
	Diameter ϕ_1	(m) =	0 0603	Diameter ϕ_2	(m) =	0 0254	
	Coef rugosidad	n1 =	0 01	Coef rugosidad	n2 =	0 008	

Reducciones.		
α	Valv uniones	0 2
	Packer	0 12
	Codo	0 008

PRESSURE READING Po (kg/cm²)	LOSS PRESSURE Plo=P1+P2+P3 (kg/cm²)	EFECTIVE PRESSURE Pe =Po +Lh - Plo (kg/cm²)	INJECTED TIME t (min)	WATER VOLUME Qt (l)	FLOOD Qo=Qt/t (l/min)	FLOOD Q1=Q/60000 (m³/s)	FLOOD Q2=Q*100/6 (cm³/s)	SPECIFIC ABSOPTION Ae = Q / L (l/min/m)	LUGEON UNIT UL = 10* Ae / Pe UL	PERMEABILITY COEFICIENT K = 0 2 / 2 x Pe x L * ln 2L / D (cm/s)
1 00	0.00000	1 43	10	0.00	0 00	0 00E+00	0 00	0.00	0 0	0.00E+00
5 00	0 13983	5 29	10	217 00	21 70	3 62E-04	361 67	4 34	8 2	1.06E-04
10 00	1 06134	9 37	10	598.00	59 80	9 97E-04	996.67	11 96	12 8	1 65E-04
5.00	0 18409	5 25	10	249.00	24 90	4 15E-04	415 00	4 98	9 5	1 23E-04
1 00	0 01999	1 41	10	82 00	8 20	1 37E-04	136 67	1 64	11 6	1 51E-04

TOTAL LOSS LOAD

$$Pc = Pc_1 + Pc_2 + Pc_3$$

$$P_1 = \frac{10.34 * (n_1)^2 * (Q_1^2) * lt}{(\phi_1^{5.33})}$$

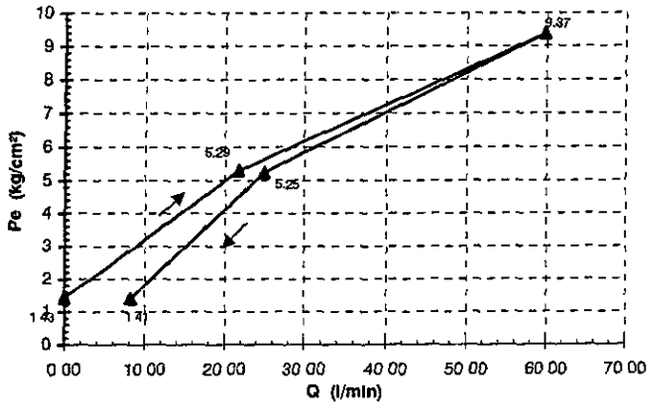
P1= loss load on steel pipe

$$P_2 = \frac{10.34 * (n_2)^2 * (Q_2^2) * lm}{(\phi_2^{5.33})}$$

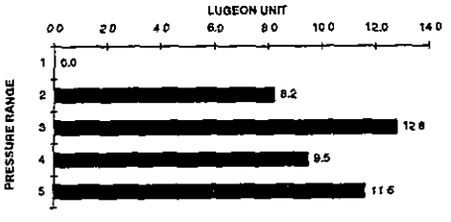
P2= loss load on plastic pipe

$$P_3 = \sum \alpha * (Q_1)$$

P3= loss load on reducciones, valvulas y uniones



VALUES OF LUGEON UNIT



PERMEABILITY (LU) = 12.8

Po = Pressure Reading; Lh = Hydrostatic Load, Plo = Loss Pressure

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PERMEABILITY TEST

swissboring
Swissboring Overseas Corporation Ltd.

CLIENT ELECTRIC POWER DEVELOPMENT Co.	DATE. 9-diciembre-2001	LUGEON TEST Nº: 4
PROJECT TOROLA HYDROELECTRIC COMPLEX	SITE. DAM SITE (left margin)	TESTED BY Geols. L.Peréz- R. Alvarado
HOLE No. CDB-2	ELEVATION 183.95 m.s.l	CHECKED BY Geol.W. Hernández

Packer type	Neumatic	Length (m) =	0 80	Water pump	Bean Royal 535	Flood (l/min) =	
				Test depth (m) from	25 00	to	30 00
Test length (cm)		L * Cos X ° =	500 00	Depth of hole (m)	30 00	Dip X (°)=	0
Swivel Ht (m)		H1 =	1 85	Diameter of hole D (cm)	7 57	W L Before of test (m)=	26 4
Water level Ha (m)	26 4	Ha * Cos X ° =	26 40	Hydrostatic load (kg/cm2)	Lh= (H1+Ha)/10 =		2 825

Steel pipe.	Length (m) =	1t =	5 00	Plastic Pipe.	Length (m)	1 m = 5 00	Reducciones.	Valv uniones	0 2
	Diameter ϕ_1	(m) =	0 0603		Diameter ϕ_2	(m) = 0 0254	α	Packer	0 12
	Coef rugosidad	n1 =	0 01		Coef rugosidad	n2 = 0 008		Codo	0 008

PRESSURE READING Po (kg/cm²)	LOSS PRESSURE Plo=P1+P2+P3 (kg/cm²)	EFECTIVE PRESSURE Pc =Po +Lh - Plo (kg/cm²)	INJECTED TIME t (min)	WATER VOLUME Qt (l)	FLOOD Qo=Qt/t (l/min)	FLOOD Q1=Q/60000 (m³/s)	FLOOD Q2=Q*100/6 (cm³/s)	SPECIFIC ABSOPTION Ae = Q / L (l/min/m)	LUGEON UNIT UL = 10* Ae / Pe UL	PERMEABILITY COEFICIENT K = Q 2 / 2 π Pe L * ln 2 L / D (cm/s)
1 00	0 10721	3 72	10	190 00	19 00	3 17E-04	316 67	3 80	10 2	1 32E-04
5 00	2 06912	5 76	10	835 00	83 50	1.39E-03	1391 67	16 70	29 0	3 76E-04
10 00	3 92448	8 90	10	1150.00	115 00	1 92E-03	1916 67	23 00	25 8	3 35E-04
5 00	2 89090	4 93	10	987 00	98 70	1 65E-03	1645 00	19 74	40 0	5 18E-04
1 00	0 81185	3 01	10	523 00	52 30	8 72E-04	871 67	10 46	34 7	4 50E-04

TOTAL LOSS LOAD

$$Pc = Pc_1 + Pc_2 + Pc_3$$

$$P_1 = \frac{10.34 * (n_1)^2 * (Q_1^2) * lt}{(\phi_1^{5.33})}$$

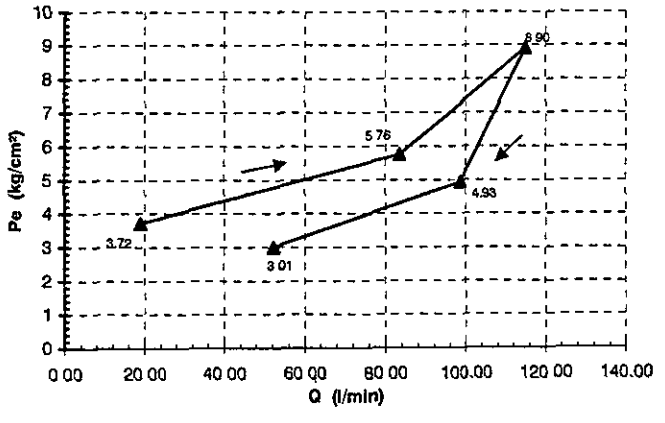
P1= loss load on steel pipe

$$P_2 = \frac{10.34 * (n_2)^2 * (Q_2^2) * lm}{(\phi_2^{5.33})}$$

P2= loss load on plastic pipe

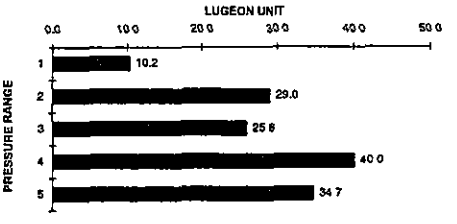
$$P_3 = \sum \alpha * (Q_1)$$

P3= loss load on reducciones, valvulas y uniones



Po = Pressure Reading, Lh = Hydrostatic Load, Plo = Loss Pressure

VALUES OF LUGEON UNIT



PERMEABILITY (LU) = 25 8

PERMEABILITY TEST

swissboring
Swissboring Overseas Corporation Ltd.

CLIENT: ELECTRIC POWER DEVELOPMENT Co.	DATE. 9-diciembre-2001	LUGEON TEST N°. 5
PROJECT TOROLA HYDROELECTRIC COMPLEX	SITE DAM SITE (left margin)	TESTED BY Geols. L.Peréz- R. Alvarado
HOLE No.. CDB-2	ELEVATION 183.95 m.s.l	CHECKED BY Geol.W. Hernández

Packer type	Neumatic	Length (m) =	0 80	Water pump	Bean Royal 535	Flood (l/min) =	
				Test depth (m) from	30 00	to	35 00
Test length (cm)		L * Cos X ° =	500 00	Depth of hole (m)	35.00	Dip X (°)=	0
Swivel H1 (m).		H1 =	1 05	Diameter of hole D (cm)	7 57	W L Before of test (m)=	28 6
Water level Ha (m)	28 6	Ha * Cos X ° =	28 60	Hydrostatic load (kg/cm2)	Lh= (H1+Ha)/10 =		2 965
Steel pipe.	Length (m) =	lt =	5 00	Plastic Pipe. Length (m)	1 m = 5 00	Reducciones.	Valv uniones 0 2
	Diameter ϕ_1 (m)	=	0 0603	Diameter ϕ_2 (m)	= 0 0254	α	Packer 0 12
	Coef rugosidad	n1 =	0 01	Coef rugosidad	n2 = 0 008		Codo: 0 008

PRESSURE READING Po (kg/cm²)	LOSS PRESSURE Plo=P1+P2+P3 (kg/cm²)	EFECTIVE PRESSURE Pe =Po +Lh - Plo (kg/cm²)	INJECTED TIME t (min)	WATER VOLUME Qt (l)	FLOOD Qo=Q/t (l/min)	FLOOD Q1=Q/60000 (m³/s)	FLOOD Q2=Q*100/6 (cm³/s)	SPECIFIC ABSORPTION Ae = Q / L (l/min/m)	LUGEON UNIT UL = 10* Ae / Pe UL	PERMEABILITY COEFICIENT K = Q 2 / 2 π Pe L * ln 2 L / D (cm/s)
1.00	0.04208	3 92	10	119 00	11 90	1 98E-04	198 33	2.38	6 1	7 86E-05
5 00	0.77806	7 19	10	512 00	51 20	8.53E-04	853 33	10.24	14 2	1 85E-04
10 00	3 02719	9 94	10	1010 00	101 00	1 68E-03	1683 33	20.20	20 3	2 63E-04
5 00	1 33623	6 63	10	671 00	67 10	1 12E-03	1118 33	13.42	20 2	2 62E-04
1 00	0 27799	3 69	10	306 00	30 60	5 10E-04	510 00	6 12	16 6	2 15E-04

TOTAL LOSS LOAD

$$Pc = Pc_1 + Pc_2 + Pc_3$$

$$P_1 = \frac{10.34 * (n_1)^2 * (Q_1^2) * lt}{(\phi_1^{5.33})}$$

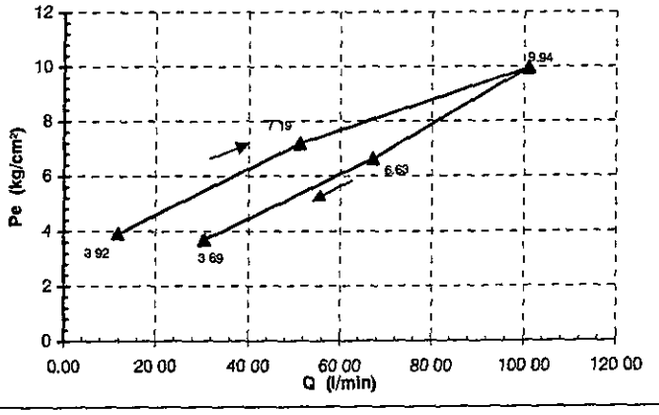
P1= loss load on steel pipe

$$P_2 = \frac{10.34 * (n_2)^2 * (Q_2^2) * lm}{(\phi_2^{5.33})}$$

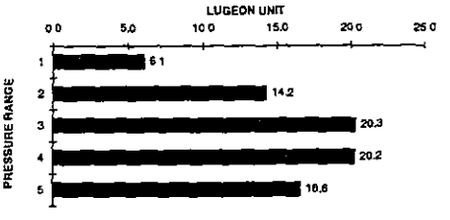
P2= loss load on plastic pipe

$$P_3 = \sum \alpha * (Q_1)$$

P3= loss load on reducciones, valvulas y uniones



VALUES OF LUGEON UNIT



PERMEABILITY (LU) = 20 3

Po = Pressure Reading, Lh = Hydrostatic Load, Plo = Loss Pressure

PERMEABILITY TEST

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CLIENT. ELECTRIC POWER DEVELOPMENT Co.	DATE 3-diciembre-2001	LUGEON TEST N°. 6
PROJECT.TOROLA HYDROELECTRIC COMPLEX	SITE DAM SITE (left margin)	TESTED BY Geols. L.Peréz- R. Alvarado
HOLE No CDB-2	ELEVATION· 183.95 m.s.l	CHECKED BY Geol.W. Hernández

Packer type	Neumatic	Length (m) =	0 80	Water pump	Bean Royal 535	Ffood (l/min) =	
				Test depth (m) from	35 00	to	40 00
Test length (cm)		L * Cos X ° =	500 00	Depth of hole (m)	40 00	Dip X (°)=	0
Swivel H1 (m)		H1 =	0 98	Diameter of hole D (cm)	7 57	W L Before of test (m)=	29 1
Water level Ha (m)	29 1	Ha * Cos X ° =	29 10	Hydrostatic load (kg/cm2)	Lh= (H1+Ha)/10 =		3 008

Steel pipe	Length (m) =	lt	= 5 00	Plastic Pipe	Length (m)	1 m	= 5 00	Reducciones.	Valv uniones 0 2
	Diameter ϕ_1	(m)	= 0 0603		Diameter ϕ_2	(m)	= 0 0254	α	Packer 0 12
	Coef rugosidad	n1	= 0 01		Coef rugosidad	n2	= 0 008		Codo 0 008

PRESSURE READING	LOSS PRESSURE	EFECTIVE PRESSURE	INJECTED TIME	WATER VOLUME	FLOOD			SPECIFIC ABSOPTION	LUGEON UNIT	PERMEABILITY COEFICIENT
Po	Plo=P1+P2+P3	Pe =Po +Lh - Plo	t	Qt	Qo=Qt/t	Q1=Q/60000	Q2=Q*100/6	Ae = Q / L	$UL = \frac{10 * Ae}{Pe}$	$K = \frac{Q2}{2 \pi Pc L} * \ln \frac{2L}{D}$
(kg/cm²)	(kg/cm²)	(kg/cm²)	(min)	(l)	(l/min)	(m³/s)	(cm³/s)	(l/min/m)	UL	(cm/s)
1 00	0 02913	3 98	10	99 00	9 90	1.65E-04	165 00	1.98	5 0	6 45E-05
5 00	0 54374	7 46	10	428 00	42 80	7 13E-04	713 33	8 56	11 5	1 49E-04
10 00	1 92313	11 08	10	805 00	80 50	1.34E-03	1341 67	16 10	14 5	1 88E-04
5 00	0 96768	7 04	10	571 00	57 10	9 52E-04	951 67	11 42	16 2	2 10E-04
1 00	0 12602	3 88	10	206 00	20 60	3 43E-04	343 33	4 12	10 6	1 37E-04

TOTAL LOSS LOAD

$$Pc = Pc_1 + Pc_2 + Pc_3$$

$$P_1 = \frac{10.34 * (n_1)^2 * (Q_1^2) * lt}{(\phi_1^{5.33})}$$

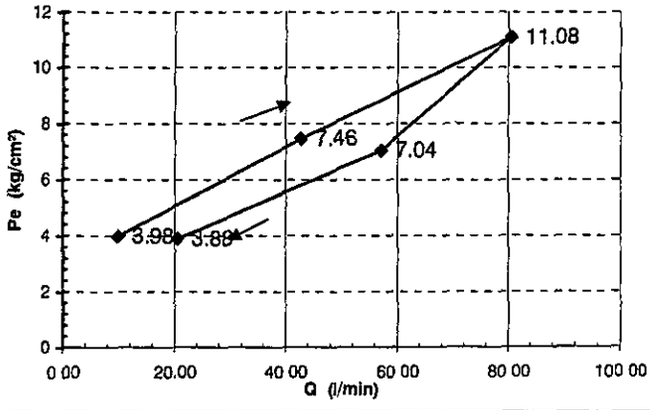
P1= loss load on steel pipe

$$P_2 = \frac{10.34 * (n_2)^2 * (Q_2^2) * lm}{(\phi_2^{5.33})}$$

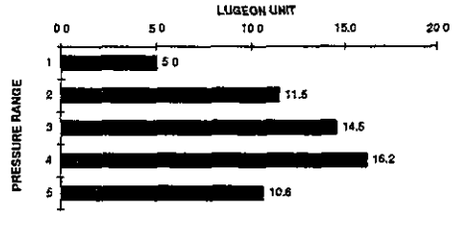
P2= loss load on plastic pipe

$$P_3 = \sum \alpha * (Q_1)$$

P3= loss load on reducciones, valvulas y uniones



VALUES OF LUGEON UNIT



PERMEABILITY (LU) = 14 5

Po = Pressure Reading, Lh = Hydrostatic Load, Plo = Loss Pressure

PERMEABILITY TEST

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Swissboring Overseas Corporation Ltd.

CLIENT ELECTRIC POWER DEVELOPMENT Co.	DATE 10-diciembre-2001	LUGEON TEST Nº. 7
PROJECT TOROLA HYDROELECTRIC COMPLEX	SITE- *DAM SITE (left margin)*	TESTED BY *Geols. L.Peréz- R. Alvarado*
HOLE No. CDB-2	ELEVATION 183.95 m.s.l	CHECKED BY Geol.W. Hernández

Packer type	Neumatic	Length (m) =	0 80	Water pump	Bean Royal 535	Flood (l/min) =	
				Test depth (m) from	40 00	to	45 00
Test length (cm)		L * Cos X ° =	500 00	Depth of hole (m)	45 00	Dip X (°)=	0
Swivel H1 (m)		H1 =	2 20	Diameter of hole D (cm)	7 57	W L Before of test (m)=	38 2
Water level Ha (m)	38 2	Ha * Cos X ° =	38 20	Hydrostatic load (kg/cm2)	Lh= (H1+Ha)/10 =		4 040

Steel pipe.	Length (m) =	l1	=	5 00	Plastic Pipe.	Length (m)	1 m =	5 00	Reducciones.	Valv uniones 0 2
	Diameter ϕ_1	(m)	=	0 0603		Diameter ϕ_2	(m) =	0 0254	α	Packer 0 12
	Coef rugosidad	n1	=	0 01		Coef rugosidad	n2 =	0 008		Codo 0 008

PRESSURE READING Po (kg/cm²)	LOSS PRESSURE Plo=P1+P2+P3 (kg/cm²)	EFECTIVE PRESSURE Pe = Po + Lh - Plo (kg/cm²)	INJECTED TIME t (min)	WATER VOLUME Qt (l)	FLOOD Qo=Qt/t (l/min)	FLOOD Q1=Q/60000 (m³/s)	FLOOD Q2=Q*100/6 (cm³/s)	SPECIFIC ABSOPTION Ae = Q / L (l/min/m)	LUGEON UNIT UL = 10* Ae / Pe UL	PERMEABILITY COEFICIENT $K = \frac{Q2}{2\pi Pe\ L} * \ln\frac{2L}{D}$ (cm/s)
1 00	0 11177	4 93	10	194 00	19 40	3 23E-04	323 33	3 88	7.9	1 02E-04
5 00	0 29645	8 74	10	316 00	31 60	5 27E-04	526 67	6 32	7 2	9 36E-05
10 00	1.63833	12 40	10	743 00	74 30	1 24E-03	1238 33	14 86	12 0	1.55E-04
5 00	0 69243	8 35	10	483 00	48 30	8 05E-04	805 00	9 66	11 6	1 50E-04
1 00	0 21325	4 83	10	268 00	26 80	4 47E-04	446 67	5 36	11.1	1 44E-04

TOTAL LOSS LOAD

$$Pc = Pc_1 + Pc_2 + Pc_3$$

$$P_1 = \frac{10.34 * (n_1)^2 * (Q_1^2) * lt}{(\phi_1^{5.33})}$$

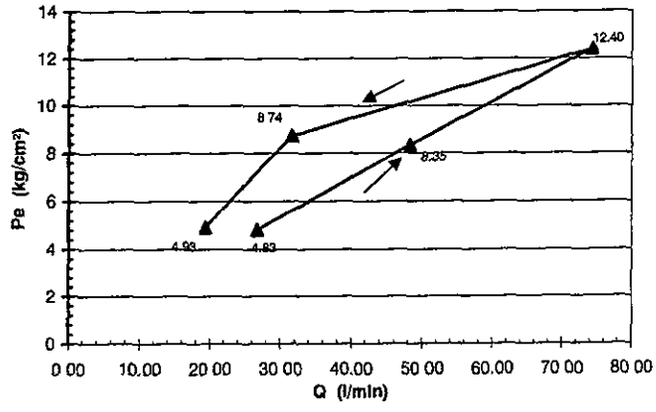
P1= loss load on steel pipe

$$P_2 = \frac{10.34 * (n_2)^2 * (Q_2^2) * lm}{(\phi_2^{5.33})}$$

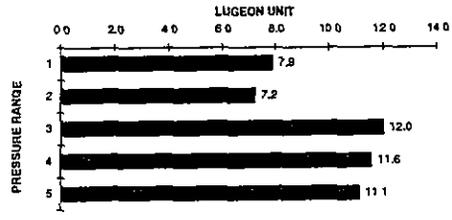
P2= loss load on plastic pipe

$$P_3 = \sum \alpha * (Q_1)$$

P3= loss load on reducciones, valvulas y uniones



VALUES OF LUGEON UNIT



PERMEABILITY (LU) = 12.0

Po = Pressure Reading, Lh = Hydrostatic Load, Plo = Loss Pressure

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PERMEABILITY TEST

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CLIENT: ELECTRIC POWER DEVELOPMENT Co.	DATE 10-diciembre-2001	LUGEON TEST Nº: 8
PROJECT TOROLA HYDROELECTRIC COMPLEX	SITE: DAM SITE (left margin)	TESTED BY Geols. L.Peréz- R. Alvarado
HOLE No CDB-2	ELEVATION 183.95 m.s.l	CHECKED BY: Geol.W. Hernández

Packer type	Neumatic	Length (m) =	0 80	Water pump	Bean Royal 535	Flood (l/min) =	
				Test depth (m) from	45 00	to	50 00
Test length (cm)		L * Cos X ° =	500 00	Depth of hole (m)	50 00	Dip X (°)=	0
Swivel H1 (m)		H1 =	0 45	Diameter of hole D (cm)	7 57	W L Before of test (m)=	27 75
Water level Ha (m)	27 75	Ha * Cos X ° =	27 75	Hydrostatic load (kg/cm2)	Lh= (H1+Ha)/10 =		2 820

Steel pipe.	Length (m) =	lt	= 5 00	Plastic Pipe.	Length (m)	1 m = 5 00	Reducciones.	Valv uniones	0 2
	Diameter ϕ_1	(m)	= 0 0603		Diameter ϕ_2	(m) = 0 0254	α	Packer	0 12
	Coef rugosidad	n1	= 0 01		Coef rugosidad	n2 = 0 008		Codo	0 008

PRESSURE READING	LOSS PRESSURE	EFECTIVE PRESSURE	INJECTED TIME	WATER VOLUME	FLOOD			SPECIFIC ABSOPTION	LUGEON UNIT	PERMEABILITY COEFICIENT
Po	Plo=P1+P2+P3	Pe =Po +Lh - Plo	t	Qt	Qo=Qt/t	Q1=Q/60000	Q2=Q*100/6	Ae = Q / L	$UL = \frac{10 * Ae}{Pe}$	$K = \frac{Q2}{2\pi Pe L} * \ln \frac{2L}{D}$
(kg/cm²)	(kg/cm²)	(kg/cm²)	(min)	(l)	(l/min)	(m³/s)	(cm³/s)	(l/min/m)	U L	(cm/s)
1 00	0 00000	3 82	10	0 00	0 00	0 00E+00	0 00	0 00	0 0	0 00E+00
5 00	0 00000	7 82	10	0.00	0 00	0 00E+00	0 00	0 00	0 0	0 00E+00
10 00	0.00269	12 82	10	30.00	3 00	5 00E-05	50 00	0 60	0 5	6 06E-06
5 00	0 00019	7 82	10	8 00	0 80	1 33E-05	13 33	0 16	0 2	2 65E-06
1 00	0 00000	3 82	10	0 00	0 00	0 00E+00	0 00	0 00	0 0	0 00E+00

TOTAL LOSS LOAD

$$Pc = Pc_1 + Pc_2 + Pc_3$$

$$P_1 = \frac{10.34 * (n_1)^2 * (Q_1^2) * lt}{(\phi_1^{5.33})}$$

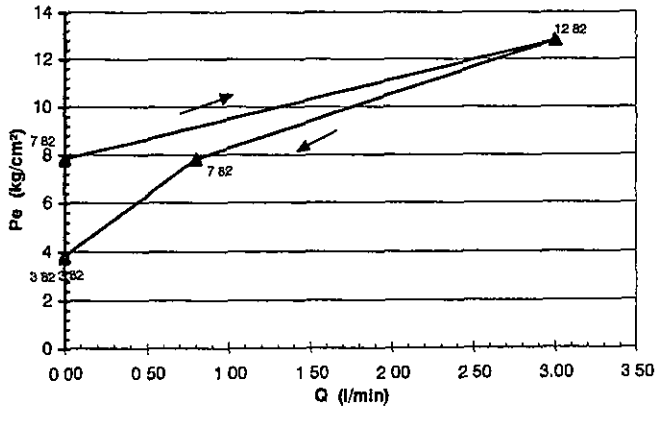
P1= loss load on steel pipe

$$P_2 = \frac{10.34 * (n_2)^2 * (Q_2^2) * lm}{(\phi_2^{5.33})}$$

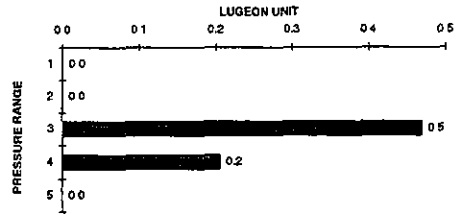
P2= loss load on plastic pipe

$$P_3 = \sum \alpha * (Q_1)$$

P3= loss load on reducciones, valvulas y uniones



VALUES OF LUGEON UNIT



PERMEABILITY (LU) = 0.5

Po = Pressure Reading, Lh = Hydrostatic Load, Plo = Loss Pressure.

PERMEABILITY TEST

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Swissboring Overseas Corporation Ltd.

CLIENT ELECTRIC POWER DEVELOPMENT Co.	DATE 10-diciembre-2001	LUGEON TEST Nº 9
PROJECT TOROLA HYDROELECTRIC COMPLEX	SITE: DAM SITE (left margin)	TESTED BY Geols. L.Peréz- R. Alvarado
HOLE No CDB-2	ELEVATION: 183.95 m.s.l	CHECKED BY: Geol.W. Hernández

Packer type	Neumatic	Length (m) =	0 80	Water pump	Bean Royal 535	Flood (l/min) =	
				Test depth (m) from	50 00	to	55 00
Test length (cm)		L * Cos X ° =	500 00	Depth of hole (m).	55 00	Dip X (°)=	0
Swivel H1 (m)		H1 =	1 25	Diameter of hole D (cm)	7 57	W L Before of test (m)=	26 75
Water level Ha (m)	26 75	Ha * Cos X ° =	26 75	Hydrostatic load (kg/cm2):	Lh= (H1+Ha)/10 =		2 800

Steel pipe.	Length (m) =	lt =	5 00	Plastic Pipe.	Length (m)	l m = 5 00	Reducciones.	Valv uniones	0 2
	Diameter ϕ_1	(m) =	0 0603		Diameter ϕ_2	(m) = 0 0254	α	Packer	0 12
	Coef rugosidad	n1 =	0 01		Coef rugosidad	n2 = 0 009		Codo	0 008

PRESSURE READING	LOSS PRESSURE	EFECTIVE PRESSURE	INJECTED TIME	WATER VOLUME	FLOOD			SPECIFIC ABSOPTION	LUGEON UNIT	PERMEABILITY COERCIENT
Po	Plo=P1+P2+P3	Pe =Po +Lh - Plo	t	Qt	Qo=Qt/t	Q1=Q/60000	Q2=Q*100/6	Ae = Q / L	$UL = \frac{10 * Ae}{Pe}$	$K = \frac{Q2}{2\pi Pe L} * ln \frac{2L}{D}$
(kg/cm²)	(kg/cm²)	(kg/cm²)	(min)	(l)	(l/min)	(m³/s)	(cm³/s)	(l/min/m)	U L	(cm/s)
1 00	0 01458	3 79	10	70 00	7 00	1 17E-04	116 67	1 40	3 7	4 79E-05
5 00	0 06419	7 74	10	147 00	14 70	2 45E-04	245 00	2 94	3 8	4 92E-05
10 00	0 38046	12 42	10	358 00	35 80	5 97E-04	596 67	7.16	5 8	7 47E-05
5 00	0 09623	7 70	10	180 00	18 00	3 00E-04	300 00	3.60	4 7	6 05E-05
1 00	0 02462	3 78	10	91 00	9 10	1 52E-04	151 67	1 82	4 8	6 24E-05

TOTAL LOSS LOAD

$$Pc = Pc_1 + Pc_2 + Pc_3$$

$$P_1 = \frac{10.34 * (n_1)^2 * (Q_1^2) * lt}{(\phi_1^{5.33})}$$

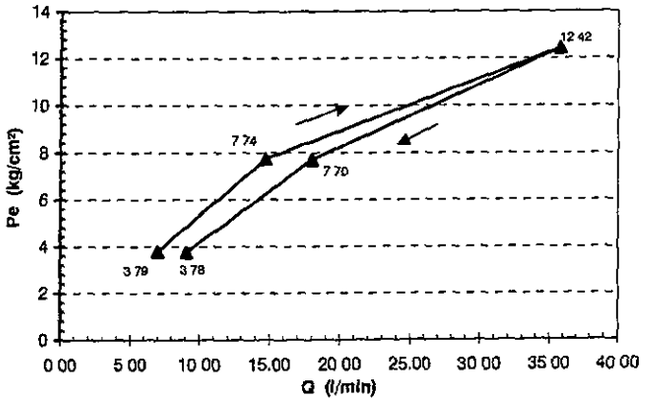
P1= loss load on steel pipe

$$P_2 = \frac{10.34 * (n_2)^2 * (Q_2^2) * lm}{(\phi_2^{5.33})}$$

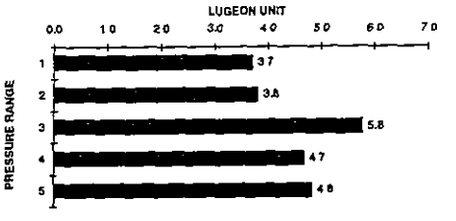
P2= loss load on plastic pipe

$$P_3 = \sum \alpha * (Q_1)$$

P3= loss load on reducciones, valvulas y uniones



VALUES OF LUGEON UNIT



PERMEABILITY (LU) = 5 8

Po = Pressure Reading, Lh = Hydrostatic Load, Plo = Loss Pressure

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PERMEABILITY TEST

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Swissboring Overseas Corporation Ltd.

CLIENT ELECTRIC POWER DEVELOPMENT Co.	DATE: 10-diciembre-2001	LUGEON TEST Nº 10
PROJECT TOROLA HYDROELECTRIC COMPLEX	SITE: DAM SITE (left margin)	TESTED BY Geols. L.Peréz- R. Alvarado
HOLE No CDB-2	ELEVATION. 183.95 m.s.l	CHECKED BY Geol.W. Hernández

Packer type	Neumatic	Length (m) =	0 80	Water pump	Bean Royal 535	Flood (l/min) =	
				Test depth (m) from	55 00	to	60 00
Test length (cm)		L * Cos X ° =	500 00	Depth of hole (m)	60 00	Dip X (°)=	0
Swivel H1 (m)		H1 =	0 98	Diameter of hole D (cm)	7 57	W L Before of test (m)=	31 4
Water level Ha (m)	31 4	Ha * Cos X ° =	31 40	Hydrostatic load (kg/cm2)	Lh= (H1+Ha)/10 =		3 238

Steel pipe.	Length (m) =	lt	= 5 00	Plastic Pipe.	Length (m)	1 m = 5 00	Reducciones.	Valv uniones,	0 2
	Diameter ϕ_1	(m)	= 0 0603		Diameter ϕ_2	(m) = 0 0254	α	Packer	0 12
	Coef rugosidad	n1	= 0 01		Coef rugosidad	n2 = 0 008		Codo	0 008

PRESSURE READING Po (kg/cm²)	LOSS PRESSURE Plo=P1+P2+P3 (kg/cm²)	EFECTIVE PRESSURE Pc =Po +Lh - Plo (kg/cm²)	INJECTED TIME t (min)	WATER VOLUME Qt (l)	FLOOD Qo=Qt/t (l/min)	FLOOD Q1=Q/60000 (m³/s)	FLOOD Q2=Q*100/6 (cm³/s)	SPECIFIC ABSOPTION Ae = Q / L (l/min/m)	LUGEON UNIT UL = 10* Ae / Po UL	PERMEABILITY COEFICIENT K = Q 2 / 2 π Pc L * ln 2 L / D (cm/s)
1.00	0 00008	4 24	10	5 00	0 50	8 33E-06	8.33	0 10	0 2	3 06E-06
5 00	0 12238	8 12	10	203 00	20 30	3 38E-04	338 33	4 06	5 0	6 48E-05
10 00	1 12984	12 11	10	617 00	61 70	1 03E-03	1028 33	12 34	10 2	1 32E-04
5 00	0 35951	7 88	10	348 00	34.80	5 80E-04	580 00	6 96	8 8	1 14E-04
1.00	0 04208	4.20	10	119 00	11 90	1 98E-04	198 33	2 38	5 7	7.35E-05

TOTAL LOSS LOAD

$$Pc = Pc_1 + Pc_2 + Pc_3$$

$$P_1 = \frac{10.34 * (n_1)^2 * (Q_1^2) * lt}{(\phi_1^{5.33})}$$

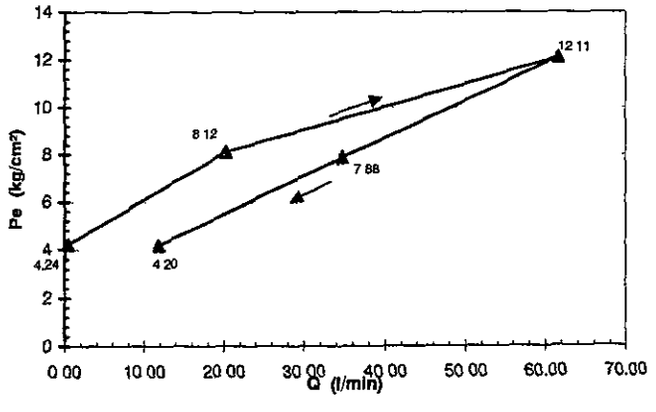
P1= loss load on steel pipe

$$P_2 = \frac{10.34 * (n_2)^2 * (Q_2^2) * lm}{(\phi_2^{5.33})}$$

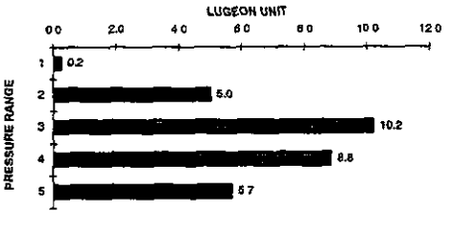
P2= loss load on plastic pipe

$$P_3 = \sum \alpha * (Q_1)$$

P3= loss load on reducciones, valvulas y uniones



VALUES OF LUGEON UNIT



PERMEABILITY (LU) = 10 2

Po = Pressure Reading, Lh = Hydrostatic Load, Plo = Loss Pressure

PERMEABILITY TEST

swissboring
Swissboring Overseas Corporation Ltd.

CLIENT: ELECTRIC POWER DEVELOPMENT Co.	DATE: 10-diciembre-2002	LUGEON TEST Nº: 1
PROJECT TOROLA HYDROELECTRIC COMPLEX	SITE: DAM SITE (right margin)	TESTED BY ERNESTO HERRERA
HOLE No.: CDB-3	ELEVATION: 131.6 m.s.l	CHECKED BY: Geol.W. Hernández

Packer type	Neumatic	Length (m) =	0.80	Water pump	Bean Royal 535	Flood (l/min) =	
				Test depth (m) from	10 00	to	15 00
Test length (cm).		L * Cos X º =	500 00	Depth of hole (m)	15 00	Dip X (º)=	0
Swivel H1 (m)		H1 =	2 50	Diameter of hole D (cm)	7 57	W.L Before of test (m)=	4 7
Water level Ha (m)	4 7	Ha * Cos X º =	4 70	Hydrostatic load (kg/cm2).	Lh= (H1+Ha)/10 =		0 720

Steel pipe:	Length (m) =	lt =	11 30	Plastic Pipe :	Length (m)	lm =	5 00	Reducers.	Valv cuopling 0.2
	Diameter ϕ_1	(m) =	0.0603		Diameter ϕ_2	(m) =	0.0254	α	Packer 0 12
	Roughness index	n1 =	0.01		Roughness index	n2 =	0 008		Union elbow: 0.008

PRESSURE READING Po (kg/cm²)	LOSS PRESSURE Plo=P1+P2+P3 (kg/cm²)	EFECTIVE PRESSURE Pe =Po +Lh- Plo (kg/cm²)	INJECTED TIME t (min)	WATER VOLUME Qt (l)	FLOOD Q=Qt/t (l/min)	FLOOD Q1=Q/60000 (m³/s)	FLOOD Q2=Q*100/6 (cm³/s)	SPECIFIC ABSORPTION Ae = Q / L (l/min/m)	LUGEON UNIT $UL = \frac{10 * Ae}{Pe}$ UL	PERMEABILITY COEFICIENT $K = \frac{Q2}{2\pi Pe\ L} * \ln\frac{2L}{D}$ (cm/s)
1 00	0.03214	1.69	10	103.00	10.30	1.72E-04	171.67	2.06	12.2	1.58E-04
5 00	1.05667	4 66	10	591.00	59.10	9 85E-04	985.00	11 82	25 3	3.28E-04
10.00	2 05889	8 66	10	825.00	82.50	1.38E-03	1375.00	16.50	19 1	2 47E-04
5 00	1.08184	4 64	10	598.00	59.80	9 97E-04	996.67	11 96	25 8	3 34E-04
1.00	0.11629	1.60	10	196 00	19.60	3.27E-04	326 67	3.92	24 4	3 17E-04

TOTAL LOSS LOAD

$$Pc = Pc_1 + Pc_2 + Pc_3$$

$$P_1 = \frac{10.34 * (n_1)^2 * (Q_1^2) * lt}{(\phi_1^{5.33})}$$

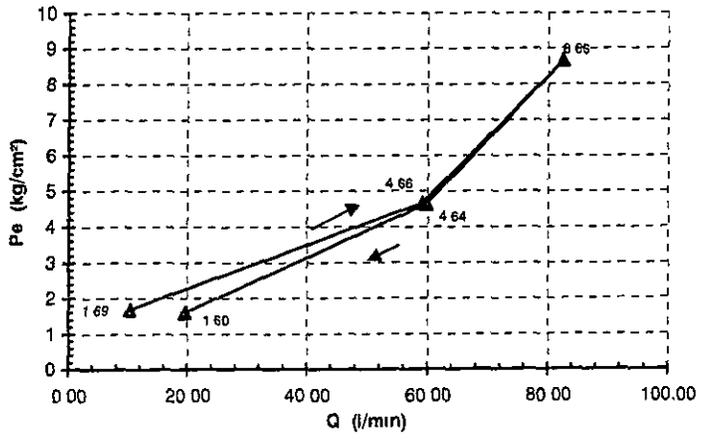
P1= loss load on steel pipe

$$P_2 = \frac{10.34 * (n_2)^2 * (Q_2^2) * lm}{(\phi_2^{5.33})}$$

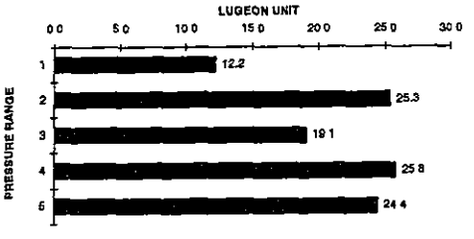
P2= loss load on plastic pipe

$$P_3 = \sum \alpha * (Q_1)$$

P3= loss load on couplings, valvles and packer



VALUES OF LUGEON UNIT



PERMEABILITY (LU) = 19.1

Po = Pressure Reading, Lh = Hydrostatic Load; Plo = Loss Pressure.

PERMEABILITY TEST

swissboring
Swissboring Overseas Corporation Ltd.

CLIENT: ELECTRIC POWER DEVELOPMENT Co.	DATE: 10-diciembre-2002	LUGEON TEST Nº: 2
PROJECT: TOROLA HYDROELECTRIC COMPLEX	SITE: DAM SITE (right margin)	TESTED BY JULIO RIVERA
HOLE No.: CDB-3	ELEVATION: 131.6 m.s.l	CHECKED BY: Geol.W. Hernández

Packer type:	Neumatic	Length (m) =	0 80	Water pump	Bean Royal 535	Flood (l/min) =	
				Test depth (m) from	18 00	to.	23 00
Test length (cm).		L * Cos X° =	500.00	Depth of hole (m):	23 00	Dip X (°)=	0
Swivel H1 (m):		H1 =	2 50	Diameter of hole D (cm)	7 57	W L Before of test (m)=	2 3
Water level Ha (m)	2 3	Ha * Cos X° =	2 30	Hydrostatic load (kg/cm2)	Lh= (H1+Ha)/10 =		0 480
Steel pipe:	Length (m) =	lt =	19 70	Plastic Pipe. Length (m)	lm =	5 00	Reducers. Valv cuopling	0.2
	Diameter ϕ_1	(m) =	0 0603	Diameter ϕ_2	(m) =	0 0254	α Packer:	0 12
	Roughness index	n1 =	0 01	Roughness index n2:		0 008	Union elbow	0.008

PRESSURE READING Po (kg/cm²)	LOSS PRESSURE Plo=P1+P2+P3 (kg/cm²)	EFECTIVE PRESSURE Pe =Po +Lh- Plo (kg/cm²)	INJECTED TIME t (min)	WATER VOLUME Qt (l)	FLOOD Q=Qt/t (l/min)	FLOOD Q1=Q/60000 (m³/s)	FLOOD Q2=Q*100/6 (cm³/s)	SPECIFIC ABSOPTION Ae = Q / L (l/min/m)	LUGEON UNIT $UL = \frac{10 * Ae}{Pe}$ UL	PERMEABILITY COEFICIENT $K = \frac{Q2}{2\pi Pe L} * \ln\frac{2L}{D}$ (cm/s)
1.00	0.00659	1 47	10	46 00	4 60	7.67E-05	76.67	0.92	6 2	8.09E-05
5 00	0.09834	5.38	10	178.00	17.80	2.97E-04	296 67	3 56	6.6	8 57E-05
10.00	0.36926	10.11	10	345.00	34.50	5 75E-04	575.00	6 90	6 8	8.84E-05
5.00	0.05247	5.43	10	130.00	13 00	2 17E-04	216.67	2.60	4 8	6.21E-05
1 00	0.00000	1 48	10	0 00	0 00	0 00E+00	0.00	0 00	0.0	0 00E+00

TOTAL LOSS LOAD

$$Pc = Pc_1 + Pc_2 + Pc_3$$

$$P_1 = \frac{10.34 * (n_1)^2 * (Q_1^2) * lt}{(\phi_1^{5.33})}$$

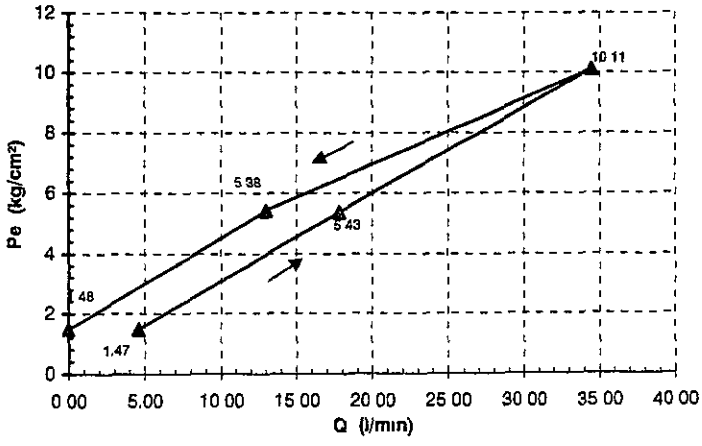
P1= loss load on steel pipe

$$P_2 = \frac{10.34 * (n_2)^2 * (Q_2^2) * lm}{(\phi_2^{5.33})}$$

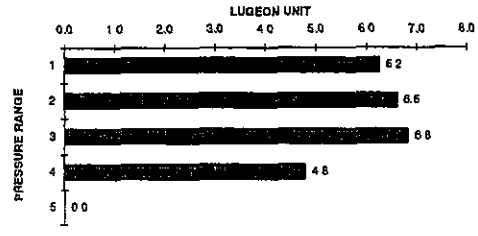
P2= loss load on plastic pipe

$$P_3 = \sum \alpha * (Q_1)$$

P3= loss load on couplings, valvles and packer



VALUES OF LUGEON UNIT



PERMEABILITY (LU) = 6.8

Po = Pressure Reading; Lh = Hydrostatic Load; Plo = Loss Pressure

PERMEABILITY TEST

swissboring
Swissboring Overseas Corporation Ltd.

CLIENT: ELECTRIC POWER DEVELOPMENT Co.	DATE. 11-diciembre-2002	LUGEON TEST Nº: 3
PROJECT:TOROLA HYDROELECTRIC COMPLEX	SITE: DAM SITE (right margin)	TESTED BY ERNESTO HERRERA
HOLE No.: CDB-3	ELEVATION: 131.6 m.s.l	CHECKED BY. Geol.W. Hernández

Packer type: Neumatic Length (m) = 0 80 Water pump Bean Royal 535 Flood (l/min) =

Test depth (m) from. 26 00 to: 31 00

Test length (cm). L * Cos X º = 500 00 Depth of hole (m). 31 00 Dip X (º)= 0

Swivel H1 (m) H1 = 2 00 Diameter of hole D (cm): 7 57 W L Before of test (m)= 1 15

Water level Ha (m) 1 15 Ha * Cos X º = 1 15 Hydrostatic load (kg/cm2) Lh= (H1+Ha)/10 = 0 315

Steel pipe.	Length (m) =	lt = 27 20	Plastic Pipe.	Length (m)	l m = 5.00	Reducers.	Valvle, cuoplings	0.2
	Diameter ϕ_1 (m) = 0.0603			Diameter ϕ_2 (m) = 0 0254		α	Packer:	0 12
	Roughness index	n1 = 0 01		Roughness index n2:	0.008		Union elbow:	0.008

PRESSURE READING Po (kg/cm²)	LOSS PRESSURE Plo=P1+P2+P3 (kg/cm²)	EFECTIVE PRESSURE Pe = Po + Lh - Plo (kg/cm²)	INJECTED TIME t (min)	WATER VOLUME Qt (l)	FLOOD Q=Qt/t (l/min)	FLOOD Q1=Q/60000 (m³/s)	FLOOD Q2=Q*100/6 (cm³/s)	SPECIFIC ABSOPTION Ae = Q / L (l/min/m)	LUGEON UNIT $UL = \frac{10 * Ae}{Pe}$ UL	PERMEABILITY COEFICIENT $K = \frac{Q2}{2\pi Pe\ L} * \ln\frac{2L}{D}$ (cm/s)
1.00	0.00535	1.31	10	41.00	4 10	6 83E-05	68.33	0.82	6.3	8.11E-05
5 00	0 02865	5.29	10	95 00	9 50	1.58E-04	158 33	1 90	3.6	4.66E-05
10 00	0 15631	10.16	10	222.00	22 20	3.70E-04	370 00	4 44	4.4	5.66E-05
5.00	0.02572	5.29	10	90.00	9 00	1.50E-04	150.00	1.80	3 4	4 41E-05
1.00	0.00000	1 32	10	0.00	0 00	0.00E+00	0 00	0.00	0.0	0.00E+00

TOTAL LOSS LOAD

$$Pc = Pc_1 + Pc_2 + Pc_3$$

$$P_1 = \frac{10.34 * (n_1)^2 * (Q_1^2) * lt}{(\phi_1^{5.33})}$$

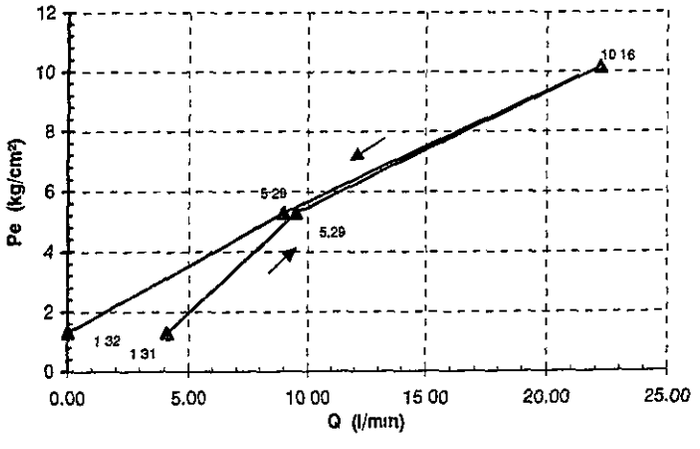
P1= loss load on steel pipe

$$P_2 = \frac{10.34 * (n_2)^2 * (Q_2^2) * lm}{(\phi_2^{5.33})}$$

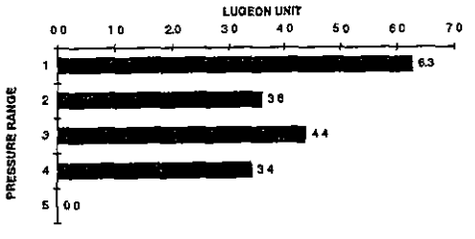
P2= loss load on plastic pipe

$$P_3 = \sum \alpha * (Q_1)$$

P3= loss load on couplings, valvles and packer



VALUES OF LUGEON UNIT



PERMEABILITY (LU) = 4.4

Po = Pressure Reading; Lh = Hydrostatic Load, Plo = Loss Pressure.

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PERMEABILITY TEST

swissboring
Swissboring Overseas Corporation Ltd.

CLIENT: ELECTRIC POWER DEVELOPMENT Co.	DATE: 11-diciembre-2002	LUGEON TEST Nº: 4
PROJECT: TOROLA HYDROELECTRIC COMPLEX	SITE: DAM SITE (right margin)	TESTED BY ERNESTO HERRERA
HOLE No.: CDB-3	ELEVATION: 131.6 m.s.l	CHECKED BY: Geol.W. Hernández

Packer type.	Neumatic	Length (m) =	0 80	Water pump	Bean Royal 535	Flood (l/min) =	
				Test depth (m) from	31.00	to.	36 00
Test length (cm):		L * Cos X º =	500.00	Depth of hole (m):	36.00	Dip X (º)=	0
Swivel H1 (m):		H1 =	0 00	Diameter of hole D (cm):	7 57	W L Before of test (m)=	1 2
Water level Ha (m)	1 2	Ha * Cos X º =	1.20	Hydrostatic load (kg/cm2):	Lh= (H1+Ha)/10 =		0 120

Steel pipe:	Length (m) =	lt =	35 20	Plastic Pipe:	Length (m)	lm =	5 00	Reducers:	Valv. cuopling 0 2
	Diameter ϕ_1	(m) =	0 0603		Diameter ϕ_2	(m) =	0 0254	α	Packer. 0 12
	Roughness index	n1 =	0 01		Roughness index	n2. =	0 008		Union elbow 0 008

PRESSURE READING	LOSS PRESSURE	EFECTIVE PRESSURE	INJECTED TIME	WATER VOLUME	FLOOD			SPECIFIC ABSOPTION	LUGEON UNIT	PERMEABILITY COEFICIENT
Po (kg/cm²)	Plo=P1+P2+P3 (kg/cm²)	Pe =Po +Lh- Plo (kg/cm²)	t (min)	Qt (l)	Q=Qt/t (l/min)	Q1=Q/60000 (m³/s)	Q2=Q*100/6 (cm³/s)	Ae = Q / L (l/min/m)	$UL = \frac{10 * Ae}{Pe}$ UL	$K = \frac{Q2}{2\pi Pe L} * \ln\frac{2L}{D}$ (cm/s)
1.00	0 00084	1.12	10	16 00	1 60	2.67E-05	26 67	0 32	2 9	3.70E-05
5.00	0 00630	5.11	10	44 00	4 40	7 33E-05	73,33	0 88	1 7	2,23E-05
10 00	0 02347	10 10	10	85 00	8 50	1,42E-04	141 67	1 70	1 7	2,18E-05
5.00	0 00000	5 12	10	0.00	0.00	0 00E+00	0 00	0.00	0.0	0 00E+00
1.00	0 00000	1.12	10	0 00	0 00	0.00E+00	0.00	0 00	0 0	0 00E+00

TOTAL LOSS LOAD

$$Pc = Pc_1 + Pc_2 + Pc_3$$

$$P_1 = \frac{10.34 * (n_1)^2 * (Q_1^2) * lt}{(\phi_1^{5.33})}$$

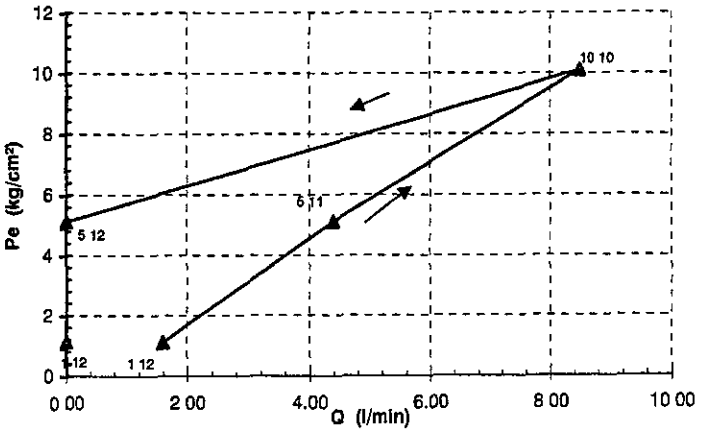
P1= loss load on steel pipe

$$P_2 = \frac{10.34 * (n_2)^2 * (Q_2^2) * lm}{(\phi_2^{5.33})}$$

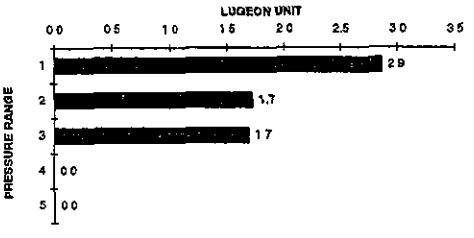
P2= loss load on plastic pipe

$$P_3 = \sum \alpha * (Q_1)$$

P3= loss load on couplings, valvles and packer



VALUES OF LUGEON UNIT



PERMEABILITY (LU) = 1.7

Po = Pressure Reading; Lh = Hydrostatic Load; Plo = Loss Pressure.

PERMEABILITY TEST

swissboring
Swissboring Overseas Corporation Ltd.

CLIENT: *ELECTRIC POWER DEVELOPMENT Co.*	DATE: 11-diciembre-2002	LUGEON TEST Nº: 5
PROJECT.TOROLA HYDROELECTRIC COMPLEX	SITE: DAM SITE (right margin)	TESTED BY ERNESTO HERRERA
HOLE No.: CDB-3	ELEVATION: 131.6 m.s.l	CHECKED BY: Geol.W. Hernández

Packer type:	Neumatic	Length (m) =	0.80	Water pump.	Bean Royal 535	Flood (l/min) =	
				Test depth (m) from:	40.00	to:	45 00
Test length (cm):		L * Cos X ° =	500 00	Depth of hole (m).	45.00	Dip X (°)=	0
Swivel H1 (m):		H1 =	0 50	Diameter of hole D (cm)	7.57	W.L Before of test (m)=	1 25
Water level Ha (m)	1 25	Ha * Cos X ° =	1 25	Hydrostatic load (kg/cm2):	Lh= (H1+Ha)/10 =		0 175

Steel pipe.	Length (m) =	lt	= 39 70	Plastic Pipe.	Length (m)	1 m = 5 00	Reducers.	Valv. cuopling	0 2
	Diameter ϕ_1	(m)	= 0.0603		Diameter ϕ_2	(m) = 0 0254	α	Packer:	0.12
	Roughness index	n1	= 0.01		Roughness index	n2: 0 008		Union elbow	0 008

PRESSURE READING Po (kg/cm²)	LOSS PRESSURE Plo=P1+P2+P3 (kg/cm²)	EFECTIVE PRESSURE Pe =Po +Lh- Plo (kg/cm²)	INJECTED TIME t (min)	WATER VOLUME Qt (l)	FLOOD Q=Qt/t (l/min)	FLOOD Q1=Q/60000 (m³/s)	FLOOD Q2=Q*100/6 (cm³/s)	SPECIFIC ABSOPTION Ae = Q / L (l/min/m)	LUGEON UNIT $UL = \frac{10 * Ae}{Pe}$ UL	PERMEABILITY COEFICIENT $K = \frac{Q2}{2\pi Pe \frac{L}{L}} * \ln \frac{2L}{D}$ (cm/s)
1.00	0 01033	1.16	10	56.00	5.60	9 33E-05	93.33	1.12	9.6	1.25E-04
5 00	0.17835	5 00	10	233.00	23 30	3 88E-04	388.33	4.66	9.3	1.21E-04
10.00	0.73472	9 44	10	473.00	47 30	7 88E-04	788.33	9 46	10.0	1 30E-04
5 00	0.28585	4 89	10	295.00	29 50	4 92E-04	491.67	5.90	12.1	1 56E-04
1.00	0.00609	1 17	10	43.00	4 30	7 17E-05	71.67	0.86	7 4	9 53E-05

TOTAL LOSS LOAD

$$Pc = Pc_1 + Pc_2 + Pc_3$$

$$P_1 = \frac{10.34 * (n_1)^2 * (Q_1^2) * lt}{(\phi_1^{5.33})}$$

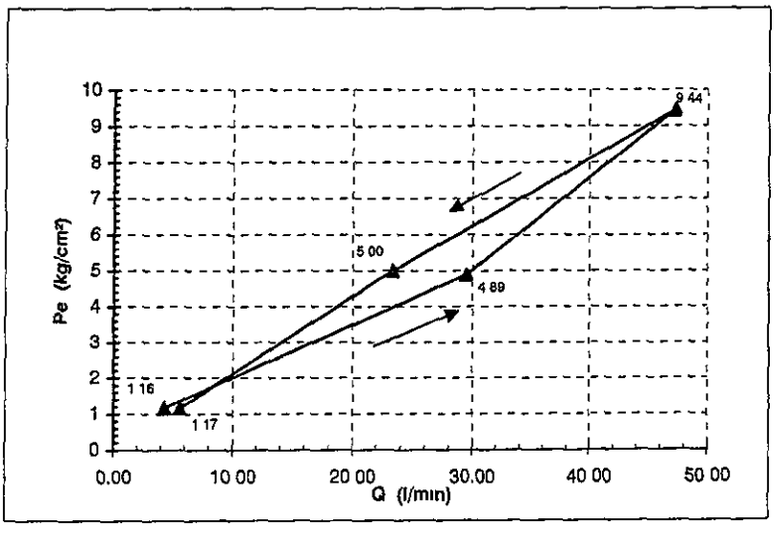
P1= loss load on steel pipe

$$P_2 = \frac{10.34 * (n_2)^2 * (Q_2^2) * lm}{(\phi_2^{5.33})}$$

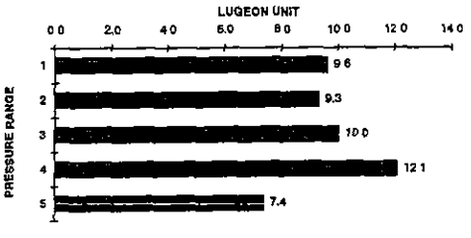
P2= loss load on plastic pipe

$$P_3 = \sum \alpha * (Q_1)$$

P3= loss load on couplings, valvles and packer



VALUES OF LUGEON UNIT



PERMEABILITY (LU) = 10.0

Po = Pressure Reading, Lh = Hydrostatic Load; Plo = Loss Pressure

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PERMEABILITY TEST

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Swissboring Overseas Corporation Ltd.

CLIENT: ELECTRIC POWER DEVELOPMENT Co.	DATE: 12-diciembre-2002	LUGEON TEST N°: 6
PROJECT: TOROLA HYDROELECTRIC COMPLEX	SITE: DAM SITE (right margin)	TESTED BY ERNESTO ALVARADO
HOLE No.: CDB-3	ELEVATION: 131.6 m.s.l	CHECKED BY. Geol.W. Hernández

Packer type:	Neumatic	Length (m) =	0 80	Water pump	Bean Royal 535	Flood (l/min) =	
				Test depth (m) from:	45 00	to	50 00
Test length (cm):		L * Cos X° =	500 00	Depth of hole (m)	50.00	Dip X (°)=	0
Swivel H1 (m):		H1 =	0 50	Diameter of hole D (cm):	7 57	W L Before of test (m)=	1
Water level Ha (m)	1	Ha * Cos X° =	1.00	Hydrostatic load (kg/cm2)	Lh= (Ht+Ha)/10 =		0 150

Steel pipe,	Length (m) =	lt	=	44.70	Plastic Pipe,	Length (m)	lm =	5.00	Reducers,	Valv cuopling 0 2
	Diameter ϕ_1	(m)	=	0 0603		Diameter ϕ_2	(m) =	0 0254	α	Packer 0 12
	Roughness index	n1	=	0 01		Roughness index	n2:	0 008		Union elbow 0 008

PRESSURE READING	LOSS PRESSURE	EFECTIVE PRESSURE	INJECTED TIME	WATER VOLUME	FLOOD			SPECIFIC ABSOPTION	LUGEON UNIT	PERMEABILITY COEFICIENT
Po (kg/cm²)	Plo=P1+P2+P3 (kg/cm²)	Pe =Po +Lh- Plo (kg/cm²)	t (min)	Qt (l)	Q=Qt/t (l/min)	Q1=Q/60000 (m³/s)	Q2=Q*100/6 (cm³/s)	Ae = Q / L (l/min/m)	$UL = \frac{10 * Ae}{Pe}$ UL	$K = \frac{Q2}{2\pi Pe\ L} * \ln\frac{2L}{D}$ (cm/s)
1 00	0.00177	1 15	10	23.00	2.30	3.83E-05	38 33	0 46	4.0	5.19E-05
5.00	0 02582	5.12	10	88.00	8.80	1 47E-04	146.67	1 76	3 4	4 45E-05
10.00	0.19184	9 96	10	240.00	24.00	4.00E-04	400 00	4 80	4 8	6 24E-05
5.00	0 01635	5.13	10	70.00	7.00	1 17E-04	116.67	1.40	2 7	3 53E-05
1.00	0 00097	1.15	10	17.00	1.70	2.83E-05	28.33	0.34	3 0	3.83E-05

TOTAL LOSS LOAD

$$Pc = Pc_1 + Pc_2 + Pc_3$$

$$P_1 = \frac{10.34 * (n_1)^2 * (Q_1^2) * lt}{(\phi_1^{5.33})}$$

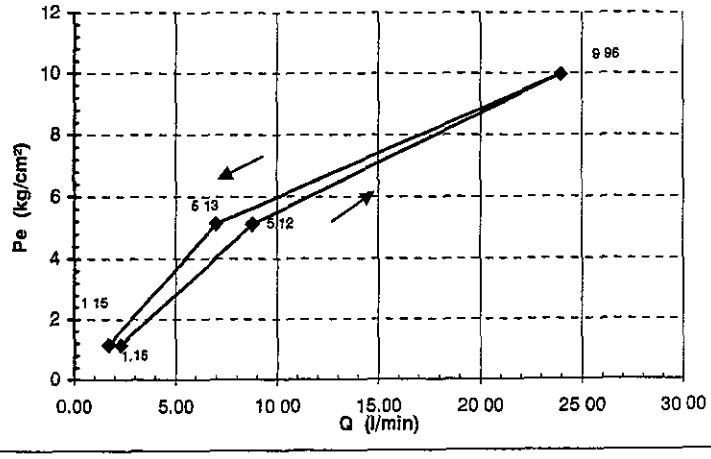
P1= loss load on steel pipe

$$P_2 = \frac{10.34 * (n_2)^2 * (Q_2^2) * lm}{(\phi_2^{5.33})}$$

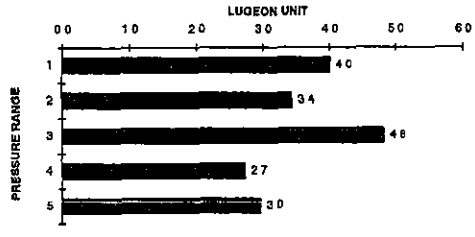
P2= loss load on plastic pipe

$$P_3 = \sum \alpha * (Q_1)$$

P3= loss load on couplings, valvles and packer



VALUES OF LUGEON UNIT



PERMEABILITY (LU) = 4 8

Po = Pressure Reading, Lh = Hydrostatic Load, Plo = Loss Pressure

PERMEABILITY TEST

swissboring
Swissboring Overseas Corporation Ltd.

CLIENT: *ELECTRIC POWER DEVELOPMENT Co.*	DATE: *22-noviembre-2002*	LUGEON TEST Nº: 1
PROJECT.TOROLA HYDROELECTRIC COMPLEX	SITE: DAM SITE (right margin)	TESTED BY: A. Cortéz
HOLE No.: CDB-4	ELEVATION: 211.99 m.s.l	CHECKED BY: Geol.W. Hernández

Packer type	Neumatic	Length (m) =	0.80	Water pump	Bean Royal 535	Flood (l/min) =	
				Test depth (m) from.	15.00	to:	22 00
Test length (cm).		L * Cos X ° =	700 00	Depth of hole (m)·	22.00	Dip X (°)=	0
Swivel Ht (m)		Ht =	1 10	Hole Diameter D (cm)·	7 57	W.L Before of test (m)=	18 5
Water level Ha (m)	18 5	Ha * Cos X ° =	18.50	Hydrostatic load (kg/cm2)·	Lh= (Ht+Ha)/10 =		1.960
Steel pipe.	Length (m) =	lt =	14.70	Plastic Pipe : Length (m)	lm =	5 00	Reducers. Valv cuopling: 0 2
	Diameter ϕ_1	(m) =	0.0603	Diameter ϕ_2	(m) =	0 0254	α Packer 0 12
	Roughness index	n1 =	0 01	Roughness index	n2	0 008	Union elbow. 0 008

PRESSURE READING Po (kg/cm²)	LOSS PRESSURE Plo=P1+P2+P3 (kg/cm²)	EFECTIVE PRESSURE Pe ±Po +Lh -Plo (kg/cm²)	INJECTED TIME t (min)	WATER VOLUME Qt (l)	FLOOD Q=Qt/t (l/min)	FLOOD Q1=Q/60000 (m³/s)	FLOOD Q2=Q*100/6 (cm³/s)	SPECIFIC ABSOPTION Ae = Q / L (l/min/m)	LUGEON UNIT $UL = \frac{10 * Ae}{Pe}$ UL	PERMEABILITY COEFICIENT $K = \frac{Q\,2}{2\pi Pe\ L} * \ln \frac{2L}{D}$ (cm/s)
1.00	0 44839	2.51	10	383.00	38.30	6.38E-04	638.33	5.47	21 8	3.02E-04
5.00	1 12976	5 83	10	608.00	60.80	1 01E-03	1013 33	8.69	14.9	2 06E-04
10 00	2.40429	9 56	10	887 00	88.70	1.48E-03	1478 33	12.67	13 3	1 84E-04
5 00	1 01399	5 95	10	576 00	57.60	9.60E-04	960 00	8.23	13.8	1.92E-04
1 00	0 34306	2.62	10	335.00	33 50	5 58E-04	558 33	4 79	18 3	2 53E-04

TOTAL LOSS LOAD

$$Pc = Pc_1 + Pc_2 + Pc_3$$

$$P_1 = \frac{10.34 * (n_1)^2 * (Q_1^2) * lt}{(\phi_1^{5.33})}$$

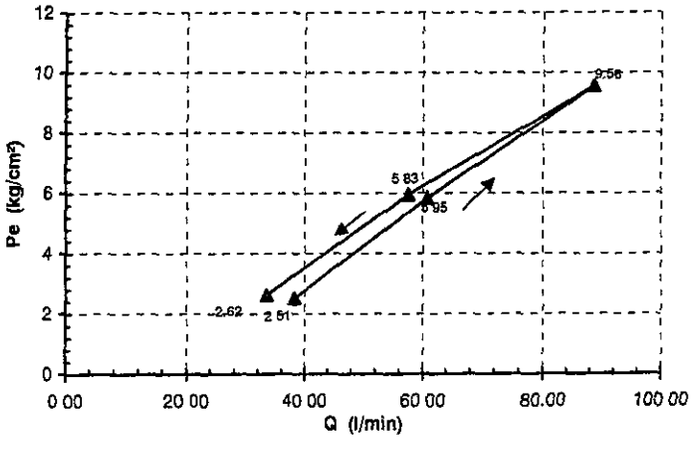
P1= loss load on steel pipe

$$P_2 = \frac{10.34 * (n_2)^2 * (Q_2^2) * lm}{(\phi_2^{5.33})}$$

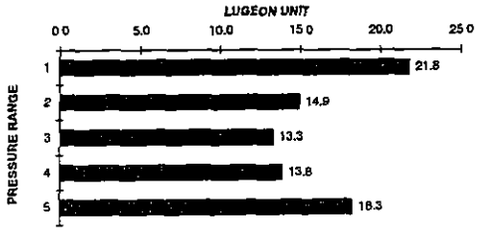
P2= loss load on plastic pipe

$$P_3 = \sum \alpha * (Q_1)$$

P3= loss load on couplings, valvles and packer



VALUES OF LUGEON UNIT



PERMEABILITY (LU) = 13.3

Po = Pressure Reading, Lh = Hydrostatic Load; Plo = Loss Pressure.

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PERMEABILITY TEST

swissboring
Swissboring Overseas Corporation Ltd.

CLIENT: ELECTRIC POWER DEVELOPMENT Co.	DATE: 23-noviembre-2002	LUGEON TEST Nº: 2
PROJECT: TOROLA HYDROELECTRIC COMPLEX	SITE: DAM SITE (right margin)	TESTED BY: Julio Rivera
HOLE No.: CDB-4	ELEVATION 211.99 m.s.l	CHECKED BY: Geol.W. Hernández

Packer type:	Neumatic	Length (m) =	0 80	Water pump:	Bean Royal 535	Flood (l/min) =	
				Test depth (m) from	22.00	to:	27 00
Test length (cm).		L * Cos X° =	500 00	Depth of hole (m):	27,00	Dip X (°)=	0
Swivel H1 (m):		H1 =	1 10	Hole Diameter D (cm):	7 57	W.L Before of test (m)=	22 5
Water level Ha (m)	22.5	Ha * Cos X° =	22 50	Hydrostatic load (kg/cm2).	Lh= (H1+Ha)/10 =		2 360

Steel pipe:	Length (m) =	lt	= 22 30	Plastic Pipe.	Length (m)	lm = 5 00	Reducers.	Valv cuoplings	0 2
	Diameter ϕ_1	(m)	= 0 0603		Diameter ϕ_2	(m) = 0 0254	α	Packer:	0 12
	Roughness index	n1	= 0 01		Roughness index	n2 0.008		Union elbow	0 008

PRESSURE READING Po (kg/cm²)	LOSS PRESSURE Plo=P1+P2+P3 (kg/cm²)	EFECTIVE PRESSURE Pe = Po +Lh -Plo (kg/cm²)	INJECTED TIME t (min)	WATER VOLUME Qt (l)	FLOOD Q=Qt/t (l/min)	FLOOD Q1=Q/60000 (m³/s)	FLOOD Q2=Q*100/6 (cm³/s)	SPECIFIC ABSOPTION Ae = Q / L (l/min/m)	LUGEON UNIT UL = 10* Ae / Pe UL	PERMEABILITY COEFICIENT K = Q 2 / 2 π Pe L * ln 2L / D (cm/s)
1.00	0.69045	2 67	10	470.00	47.00	7 83E-04	783 33	9 40	35.2	4 56E-04
5 00	1.12513	6 23	10	600.00	60.00	1 00E-03	1000 00	12 00	19.2	2 49E-04
10 00	2.02517	10.33	10	805.00	80.50	1 34E-03	1341 67	16 10	15 6	2 02E-04
5 00	1.02259	6 34	10	572.00	57.20	9.53E-04	953.33	11.44	18 1	2 34E-04
1.00	0.47544	2.68	10	390.00	39.00	6.50E-04	650 00	7.80	27 0	3.50E-04

TOTAL LOSS LOAD

$$Pc = Pc_1 + Pc_2 + Pc_3$$

$$P_1 = \frac{10.34 * (n_1)^2 * (Q_1^2) * lt}{(\phi_1^{5.33})}$$

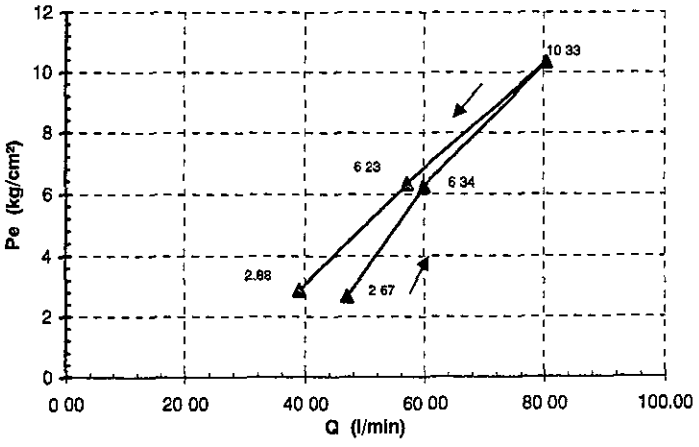
P1= loss load on steel pipe

$$P_2 = \frac{10.34 * (n_2)^2 * (Q_2^2) * lm}{(\phi_2^{5.33})}$$

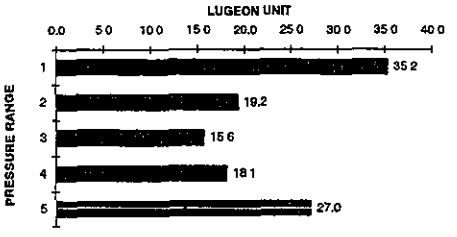
P2= loss load on plastic pipe

$$P_3 = \sum \alpha * (Q_1)$$

P3= loss load on couplings, valvles and packer



VALUES OF LUGEON UNIT



PERMEABILITY (LU) = 15.6

Po = Pressure Reading, Lh = Hydrostatic Load, Plo = Loss Pressure

PERMEABILITY TEST

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Swissboring Overseas Corporation Ltd.

CLIENT: *ELECTRIC POWER DEVELOPMENT Co.*	DATE: *23-noviembre-2002*	LUGEON TEST Nº. 3
PROJECT:TOROLA HYDROELECTRIC COMPLEX	SITE: *DAM SITE (right margin)*	TESTED BY *JULIO RIVERA*
HOLE No.: **CDB-4**	ELEVATION: **211.99 m.s.l**	CHECKED BY: **Geol.W. Hernández**

Packer type:	Neumatic	Length (m) =	0 80	Water pump.	Bean Royal 535	Flood (l/min) =	
				Test depth (m) from	27 00	to:	32 00
Test length (cm):		L * Cos X ° =	500 00	Depth of hole (m).	32 00	Dip X (°)=	0
Swivel H1 (m).		H1 =	2 50	Hole Diameter D (cm)	7 57	W L Before of test (m)=	29 5
Water level Ha (m)	29.5	Ha * Cos X ° =	29.50	Hydrostatic load (kg/cm2):	Lh= (H1+Ha)/10 =		3.200

Steel pipe:	Length (m) =	lt	= 28.70	Plastic Pipe.	Length (m)	lm	= 5 00	Reducers.	Valv cuopling: 0.2
	Diameter ϕ_1	(m)	= 0 0603		Diameter ϕ_2	(m)	= 0 0254	α	Packer. 0 12
	Roughness index	n1	= 0.01		Roughness index	n2.	0.008		Union elbow 0 008

PRESSURE READING Po (kg/cm²)	LOSS PRESSURE Plo=P1+P2+P3 (kg/cm²)	EFECTIVE PRESSURE Pe Po ±Lh Plo (kg/cm²)	INJECTED TIME t (min)	WATER VOLUME Qt (l)	FLOOD Q=Qt/t (l/min)	FLOOD Q1=Q/60000 (m³/s)	FLOOD Q2=Q*100/6 (cm³/s)	SPECIFIC ABSOPTION Ae = Q / L (l/min/m)	LUGEON UNIT $UL = \frac{10 * Ae}{Pe}$ UL	PERMEABILITY COEFICIENT $K = \frac{Q2}{2\pi Pe\ L} * \ln\frac{2L}{D}$ (cm/s)
1.00	0.89431	3.31	10	530 00	53 00	8.83E-04	883.33	10.60	32.1	4.15E-04
5.00	1 65031	6 55	10	720.00	72.00	1 20E-03	1200.00	14.40	22.0	2 85E-04
10.00	3.18326	10 02	10	1000.00	100 00	1.67E-03	1666.67	20.00	20 0	2 59E-04
5.00	1.14610	7.05	10	600 00	60.00	1 00E-03	1000.00	12.00	17.0	2.20E-04
1 00	0 50945	3 69	10	400.00	40 00	6.67E-04	666 67	8 00	21.7	2 81E-04

TOTAL LOSS LOAD

$$Pc = Pc_1 + Pc_2 + Pc_3$$

$$P_1 = \frac{10.34 * (n_1)^2 * (Q_1^2) * lt}{(\phi_1^{5.33})}$$

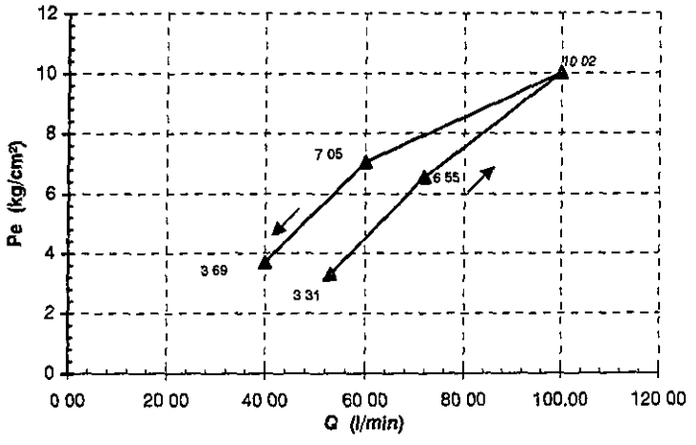
P1= loss load on steel pipe

$$P_2 = \frac{10.34 * (n_2)^2 * (Q_2^2) * lm}{(\phi_2^{5.33})}$$

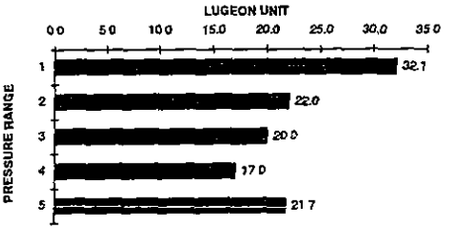
P2= loss load on plastic pipe

$$P_3 = \sum \alpha * (Q_1)$$

P3= loss load on couplings, valvles and packer



VALUES OF LUGEON UNIT



PERMEABILITY (LU) = 20.0

Po = Pressure Reading; Lh = Hydrostatic Load; Plo = Loss Pressure

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PERMEABILITY TEST

swissboring
Swissboring Overseas Corporation Ltd.

CLIENT: ELECTRIC POWER DEVELOPMENT Co.	DATE: 24-noviembre-2002	LUGEON TEST Nº: 4
PROJECT: TOROLA HYDROELECTRIC COMPLEX	SITE: DAM SITE (right margin)	TESTED BY JULIO RIVERA
HOLE No.: CDB-4	ELEVATION: 211.99 m.s.l	CHECKED BY: Geol.W. Hernández

Packer type.	Neumatic	Length (m) =	0.80	Water pump.	Bean Royal 535	Flood (l/min) =	
				Test depth (m) from	32 00	to:	37 00
Test length (cm)		L * Cos X º =	500 00	Depth of hole (m).	37.00	Dip X (º)=	0
Swivel H1 (m):		H1 =	2 50	Hole Diameter D (cm).	7 57	W L. Before of test (m)=	34 5
Water level Ha (m):	34 5	Ha * Cos X º =	34 50	Hydrostatic load (kg/cm2).	Lh= (H1+Ha)/10 =		3 700

Steel pipe:	Length (m) =	lt	= 34 50	Plastic Pipe.	Length (m)	lm	= 5 00	Reducers.	Valv cuopling: 0.2
	Diameter ϕ_1	(m)	= 0 0603		Diameter ϕ_2	(m)	= 0 0254	α	Packer: 0 12
	Roughness index	n1	= 0 01		Roughness index	n2:	0.008		Union elbow 0 008

PRESSURE READING	LOSS PRESSURE	EFECTIVE PRESSURE	INJECTED TIME	WATER VOLUME	FLOOD			SPECIFIC ABSOPTION	LUGEON UNIT	PERMEABILITY COEFICIENT
Po (kg/cm²)	Plo=P1+P2+P3 (kg/cm²)	Pe = Po + Lh - Plo (kg/cm²)	t (min)	Qt (l)	Q=Qt/t (l/mn)	Q1=Q/60000 (m³/s)	Q2=Q*100/6 (cm³/s)	Ae = Q / L (l/mln/m)	$UL = \frac{10 * Ae}{Pe}$ UL	$K = \frac{Q2}{2\pi Pe\ L} * \ln\frac{2L}{D}$ (cm/s)
1.00	0.33149	4 37	10	320.00	32.00	5 33E-04	533.33	6.40	14.7	1 90E-04
5.00	1 61308	7.09	10	706 00	70.60	1 18E-03	1176.67	14 12	19 9	2 58E-04
10 00	2.63875	11.06	10	903.00	90 30	1 51E-03	1505 00	18.06	16 3	2.12E-04
5.00	1 65446	7.05	10	715.00	71.50	1.19E-03	1191 67	14.30	20 3	2 63E-04
1.00	0 69985	4 00	10	465.00	46 50	7 75E-04	775.00	9.30	23.2	3 01E-04

TOTAL LOSS LOAD

$$Pc = Pc_1 + Pc_2 + Pc_3$$

$$P_1 = \frac{10.34 * (n_1)^2 * (Q_1^2) * lt}{(\phi_1^{5.33})}$$

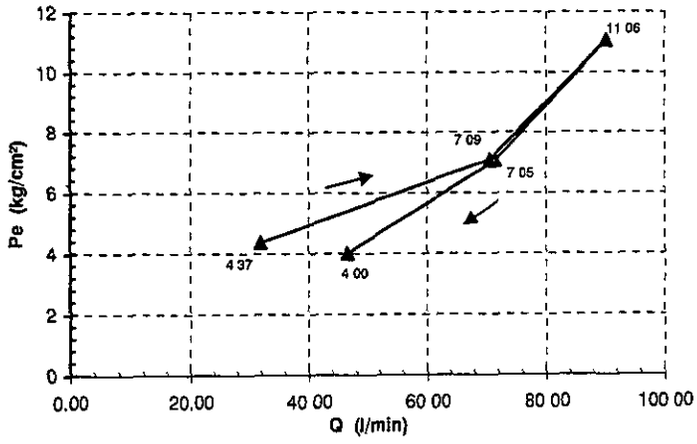
P1= loss load on steel pipe

$$P_2 = \frac{10.34 * (n_2)^2 * (Q_2^2) * lm}{(\phi_2^{5.33})}$$

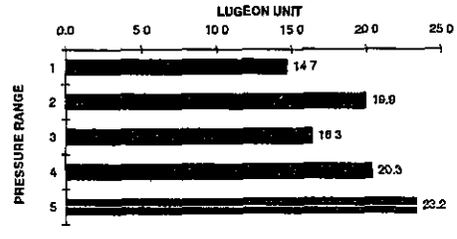
P2= loss load on plastic pipe

$$P_3 = \sum \alpha * (Q_1)$$

P3= loss load on couplings, valvles and packer



VALUES OF LUGEON UNIT



PERMEABILITY (LU) = 16.3

Po = Pressure Reading; Lh = Hydrostatic Load; Plo = Loss Pressure

300

PERMEABILITY TEST

swissboring
Swissboring Overseas Corporation Ltd.

CLIENT: *ELECTRIC POWER DEVELOPMENT Co.*	DATE: *24-noviembre-2002*	LUGEON TEST Nº: 5
PROJECT.TOROLA HYDROELECTRIC COMPLEX	SITE: DAM SITE (right margin)	TESTED BY ERNESTO HERRERA
HOLE No.: CDB-4	ELEVATION: 211.99 m.s.l	CHECKED BY: Geol.W. Hernández

Packer type	Neumatic	Length (m) =	0.80	Water pump	Bean Royal 535	Flood (l/min) =	
				Test depth (m) from.	37 00	to:	42 00
Test length (cm)		L * Cos X º =	500 00	Depth of hole (m)·	42.00	Dip X (º)=	0
Swivel H1 (m)		H1 =	2 50	Hole Diameter D (cm)	7 57	W L Before of test (m)=	39 5
Water level Ha (m)	39 5	Ha * Cos X º =	39 50	Hydrostatic load (kg/cm2)·	Lh= (H1+Ha)/10 =		4 200

Steel pipe.	Length (m) =	lt	= 38 70	Plastic Pipe.	Length (m)	lm	= 5 00	Reducers:	Valv cuopling: 0.2
	Diameter ϕ_1 (m)		= 0 0603		Diameter ϕ_2 (m)		= 0.0254	α	Packer. 0 12
	Roughness index	n1	= 0 01		Roughness Index	n2.	0 008		Union elbow. 0 008

PRESSURE READING	LOSS PRESSURE	EFECTIVE PRESSURE	INJECTED TIME	WATER VOLUME	FLOOD			SPECIFIC ABSOPTION	LUGEON UNIT	PERMEABILITY COEFICIENT
Po (kg/cm²)	Plo=P1+P2+P3 (kg/cm²)	Pe Po +Lh -Plo (kg/cm²)	t (min)	Qt (l)	Q=Qt/t (l/min)	Q1=Q/60000 (m³/s)	Q2=Q*100/6 (cm³/s)	Ae = Q / L (l/min/m)	$UL = \frac{10^* Ae}{Pe}$ UL	$K = \frac{Q2}{2 \pi Pe L} * \ln \frac{2L}{D}$ (cm/s)
1.00	0.52402	4.68	10	400.00	40.00	6.67E-04	666.67	8.00	17 1	2 22E-04
5.00	1 17887	8.02	10	600.00	60.00	1 00E-03	1000 00	12.00	15.0	1.94E-04
10.00	2.53566	11.66	10	880.00	88.00	1 47E-03	1466 67	17.60	15.1	1.95E-04
5.00	1.46994	7.73	10	670.00	67.00	1.12E-03	1116.67	13 40	17 3	2 25E-04
1 00	0.57772	4 62	10	420.00	42.00	7.00E-04	700.00	8 40	18.2	2 35E-04

TOTAL LOSS LOAD

$$Pc = Pc_1 + Pc_2 + Pc_3$$

$$P_1 = \frac{10.34 * (n_1)^2 * (Q_1^2) * lt}{(\phi_1^{5.33})}$$

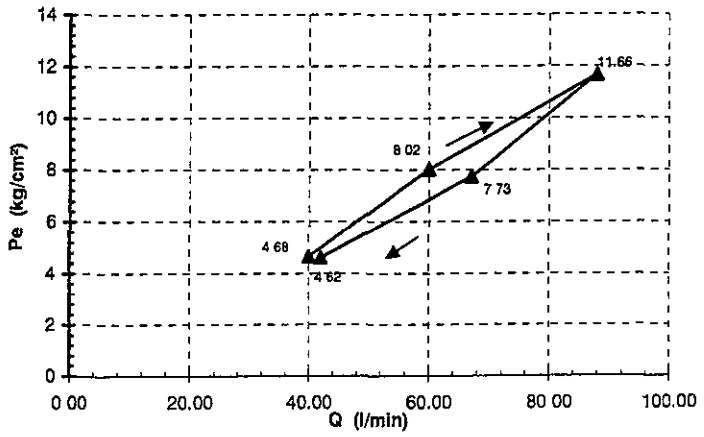
P1= loss load on steel pipe

$$P_2 = \frac{10.34 * (n_2)^2 * (Q_2^2) * lm}{(\phi_2^{5.33})}$$

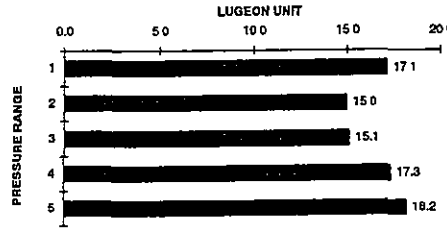
P2= loss load on plastic pipe

$$P_3 = \sum \alpha * (Q_1)$$

P3= loss load on couplings, valvles and packer



VALUES OF LUGEON UNIT



PERMEABILITY (LU) = 15.1

Po = Pressure Reading, Lh = Hydrostatic Load, Plo = Loss Pressure

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PERMEABILITY TEST

swissboring
Swissboring Overseas Corporation Ltd.

CLIENT. ELECTRIC POWER DEVELOPMENT Co.	DATE 26-noviembre-2002	LUGEON TEST N°. 6
PROJECT:TOROLA HYDROELECTRIC COMPLEX	SITE. DAM SITE (right margin)	TESTED BY ERNESTO HERRERA
HOLE No.: CDB-4	ELEVATION: 211.99 m.s.l	CHECKED BY: Geol.W. Hernández

Packer type: Neumatic Length (m) = 0.80 Water pump. Bean Royal 535 Flood (l/min) =

Test depth (m) from: 41 00 to 48 00

Test length (cm): L * Cos X° = 700 00 Depth of hole (m) 48 00 Dip X (°)= 0

Swivel H1 (m): H1 = 2 20 Hole Diameter D (cm) 7 57 W.L Before of test (m)= 44.5

*Water level Ha (m) 44 5 Ha * Cos X° = 44 50 Hydrostatic load (kg/cm2) Lh= (H1+Ha)/10 = 4 670*

Steel pipe, Length (m) = lt = 42 40 Plastic Pipe, Length (m) lm = 5 00 Reducers, Valv cuopling: 0 2

Diameter ϕ_1 (m) = 0 0603 Diameter ϕ_2 (m) = 0 0254 α Packer: 0.12

Roughness index n1 = 0.01 Roughness index n2 0 008 Union elbow 0 008

PRESSURE READING Po (kg/cm²)	LOSS PRESSURE Plo=P1+P2+P3 (kg/cm²)	EFECTIVE PRESSURE Pe = Po +Lh - Plo (kg/cm²)	INJECTED TIME t (min)	WATER VOLUME Qt (l)	FLOOD Q=Qt/t (l/min)	FLOOD Q1=Q/60000 (m³/s)	FLOOD Q2=Q*100/6 (cm³/s)	SPECIFIC ABSOPTION Ae = Q / L (l/min/m)	LUGEON UNIT $UL = \frac{10 * Ae}{Pe}$ UL	PERMEABILITY COEFICIENT $K = \frac{Q2}{2\pi Pe\ L} * ln\frac{2L}{D}$ (cm/s)
1.00	0 76865	4 90	10	482.00	48 20	8.03E-04	803.33	6 89	14 0	1.95E-04
5.00	1.91077	7.76	10	760.00	76 00	1.27E-03	1266 67	10 86	14 0	1.94E-04
10.00	3.11247	11.56	10	970 00	97 00	1.62E-03	1616.67	13.86	12.0	1 66E-04
5 00	1 91077	7.76	10	760 00	76 00	1 27E-03	1266.67	10 86	14 0	1 94E-04
1 00	1 27171	4.40	10	620.00	62 00	1.03E-03	1033.33	8.86	20.1	2 79E-04

TOTAL LOSS LOAD

$$Pc = Pc_1 + Pc_2 + Pc_3$$

$$P_1 = \frac{10.34 * (n_1)^2 * (Q_1^2) * lt}{(\phi_1^{5.33})}$$

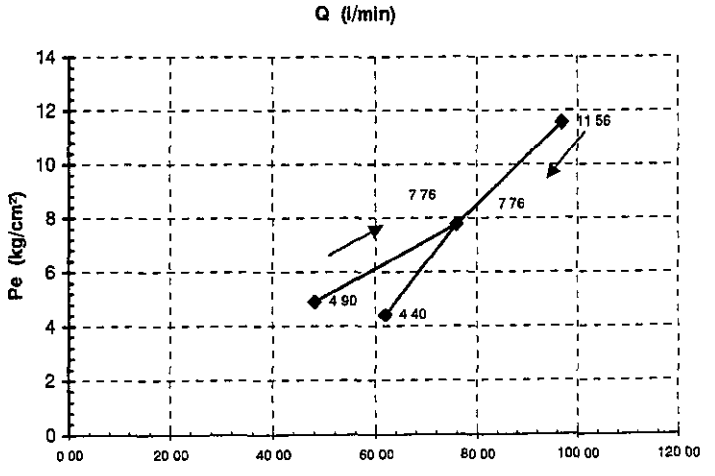
$$P_2 = \frac{10.34 * (n_2)^2 * (Q_2^2) * lm}{(\phi_2^{5.33})}$$

$$P_3 = \sum \alpha * (Q_1)$$

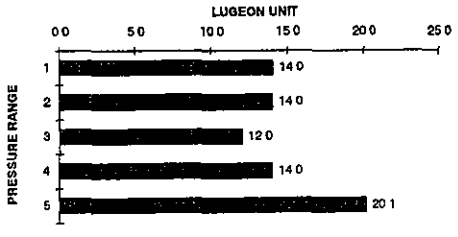
P1= loss load on steel pipe

P2= loss load on plastic pipe

P3= loss load on couplings, valvles and packer



VALUES OF LUGEON UNIT



PERMEABILITY (LU) = 12.0

Po = Pressure Reading; Lh = Hydrostatic Load; Plo = Loss Pressure.

PERMEABILITY TEST

swissboring
Swissboring Overseas Corporation Ltd.

CLIENT: ELECTRIC POWER DEVELOPMENT Co.	DATE: 28-noviembre-2002	LUGEON TEST Nº 7
PROJECT: TOROLA HYDROELECTRIC COMPLEX	SITE: DAM SITE (right margin)	TESTED BY JULIO RIVERA
HOLE No.: CDB-4	ELEVATION: 211.99 m.s.l	CHECKED BY: Geol.W. Hernández

Packer type:	Neumatic	Length (m) =	0 80	Water pump:	Bean Royal 535	Flood (l/min) =	
				Test depth (m) from	65.00	to:	70 00
Test length (cm)		L * Cos X º =	500 00	Depth of hole (m)	70 00	Dip X (º)=	0
Swivel H1 (m)		H1 =	2 50	Hole Diameter D (cm)	7.57	W L Before of test (m)=	67 5
Water level Ha (m)	67 5	Ha * Cos X º =	67 50	Hydrostatic load (kg/cm2)	Lh= (H1+Ha)/10 =		7 000

Steel pipe:	Length (m) =	lt	= 66 70	Plastic Pipe.	Length (m)	lm	= 5 00	Reducers.	Valv. cuopling: 0 2
	Diameter ϕ_1	(m)	= 0.0603		Diameter ϕ_2	(m)	= 0 0254	α	Packer: 0 12
	Roughness index	n1	= 0.01		Roughness index	n2:	0 008		Union elbow 0.008

PRESSURE READING	LOSS PRESSURE	EFECTIVE PRESSURE	INJECTED TIME	WATER VOLUME	FLOOD			SPECIFIC ABSOPTION	LUGEON UNIT	PERMEABILITY COEFICIENT
Po	Plo=P1+P2+P3	Pe Po +Lh -Plo	t	Qt	Q=Qt/t	Q1=Q/60000	Q2=Q*100/6	Ae = Q / L	$UL = \frac{10 * Ae}{Pe}$	$K = \frac{Q\,2}{2\pi Pe\ L} * \ln\frac{2L}{D}$
(kg/cm²)	(kg/cm²)	(kg/cm²)	(min)	(l)	(l/min)	(m³/s)	(cm³/s)	(l/min/m)	U L	(cm/s)
1.00	0 62267	7.38	10	420.00	42.00	7.00E-04	700.00	8 40	11 4	1.47E-04
5 00	1.27062	10.73	10	600.00	60.00	1 00E-03	1000 00	12 00	11.2	1 45E-04
10.00	2.54986	14 45	10	850 00	85 00	1.42E-03	1416.67	17.00	11 8	1 52E-04
5 00	1 63199	10.37	10	680.00	68 00	1 13E-03	1133 33	13.60	13.1	1 70E-04
1 00	0.81325	7 19	10	480.00	48 00	8 00E-04	800 00	9.60	13 4	1.73E-04

TOTAL LOSS LOAD

$$Pc = Pc_1 + Pc_2 + Pc_3$$

$$P_1 = \frac{10.34 * (n_1)^2 * (Q_1^2) * lt}{(\phi_1^{5.33})}$$

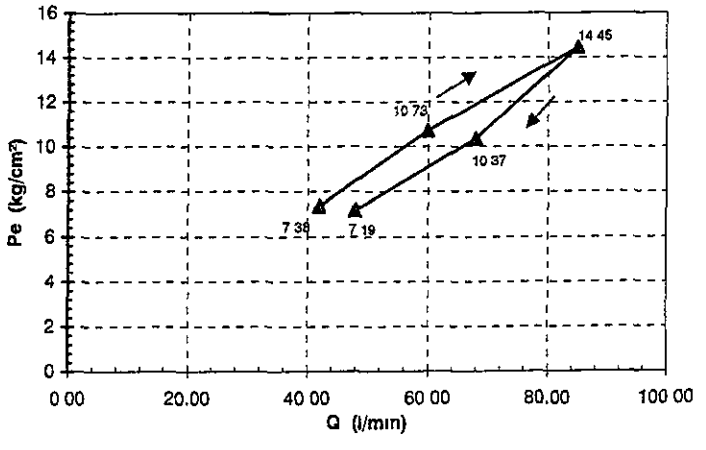
P1= loss load on steel pipe

$$P_2 = \frac{10.34 * (n_2)^2 * (Q_2^2) * lm}{(\phi_2^{5.33})}$$

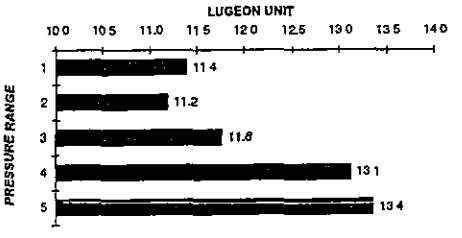
P2= loss load on plastic pipe

$$P_3 = \sum \alpha * (Q_1)$$

P3= loss load on couplings, valvles and packer



VALUES OF LUGEON UNIT



PERMEABILITY (LU) = 11.8

Po = Pressure Reading, Lh = Hydrostatic Load, Plo = Loss Pressure

303

PERMEABILITY TEST

swissboring
Swissboring Overseas Corporation Ltd.

CLIENT: ELECTRIC POWER DEVELOPMENT Co.	DATE: 28-noviembre-2002	LUGEON TEST Nº. 8
PROJECT: TOROLA HYDROELECTRIC COMPLEX	SITE: DAM SITE (right margin)	TESTED BY JULIO RIVERA
HOLE No.: CDB-4	ELEVATION: 211.99 m.s.l	CHECKED BY: Geol.W. Hernández

Packer type:	Neumatic	Length (m) =	0 80	Water pump.	Bean Royal 535	Flood (l/min) =	
				Test depth (m) from	70 00	to:	75 00
Test length (cm).		L * Cos X° =	500 00	Depth of hole (m).	75.00	Dip X (°)=	0
Swivel H1 (m)		H1 =	2.50	Hole Diameter D (cm).	7 57	W L Before of test (m)=	72 5
Water level Ha (m)	72 5	Ha * Cos X° =	72.50	Hydrostatic load (kg/cm2):	Lh= (H1+Ha)/10 =		7 500
Steel pipe.	Length (m) =	lt =	71 70	Plastic Pipe.	Length (m) lm =	5 00	
	Diameter ϕ_1 (m) =		0 0603		Diameter ϕ_2 (m) =	0.0254	
	Roughness index	n1 =	0 01		Roughness index n2	0 008	

Reducers.		
α	Valv cuopling:	0.2
	Packer	0,12
	Union elbow	0.008

PRESSURE READING	LOSS PRESSURE	EFECTIVE PRESSURE	INJECTED TIME	WATER VOLUME	FLOOD			SPECIFIC ABSOPTION	LUGEON UNIT	PERMEABILITY COEFICIENT
Po	Plo=P1+P2+P3	Pe Po +Lh -Plo	t	Qt	Q=Qt/t	Q1=Q/60000	Q2=Q*100/6	Ae = Q / L	$UL = \frac{10 * Ae}{Pe}$	$K = \frac{Q\,2}{2\,\pi\,Pe\;L} * \ln\frac{2L}{D}$
(kg/cm²)	(kg/cm²)	(kg/cm²)	(min)	(l)	(l/min)	(m³/s)	(cm³/s)	(l/min/m)	U L	(cm/s)
1.00	1 20264	7.30	10	580.00	58 00	9 67E-04	966.67	11 60	15.9	2.06E-04
5.00	1.70200	10 80	10	690 00	69.00	1 15E-03	1150 00	13.80	12 8	1 66E-04
10.00	2 91484	14.59	10	903.00	90 30	1 51E-03	1505 00	18 06	12.4	1 60E-04
5.00	1 95757	10.54	10	740 00	74.00	1.23E-03	1233.33	14 80	14.0	1.82E-04
1 00	1.41890	7 08	10	630 00	63 00	1.05E-03	1050.00	12 60	17.8	2 31E-04

TOTAL LOSS LOAD

$$Pc = Pc_1 + Pc_2 + Pc_3$$

$$P_1 = \frac{10.34 * (n_1)^2 * (Q_1^2) * lt}{(\phi_1^{5.33})}$$

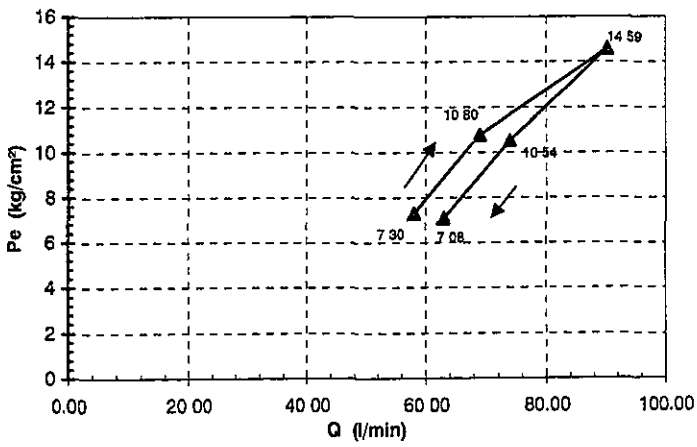
P1= loss load on steel pipe

$$P_2 = \frac{10.34 * (n_2)^2 * (Q_2^2) * lm}{(\phi_2^{5.33})}$$

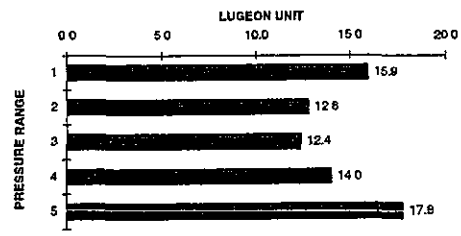
P2= loss load on plastic pipe

$$P_3 = \sum \alpha * (Q_1)$$

P3= loss load on couplings, valvles and packer



VALUES OF LUGEON UNIT



PERMEABILITY (LU) = 12.4

Po = Pressure Reading, Lh = Hydrostatic Load; Plo = Loss Pressure

PERMEABILITY TEST

swissboring
Swissboring Overseas Corporation Ltd.

CLIENT: ELECTRIC POWER DEVELOPMENT Co.	DATE: 30-noviembre-2002	LUGEON TEST Nº. 9
PROJECT.TOROLA HYDROELECTRIC COMPLEX	SITE: DAM SITE (right margin)	TESTED BY ERNESTO HERRERA
HOLE No.: CDB-4	ELEVATION: 211.99 m.s.l	CHECKED BY. Geol.W. Hernández

Packer type.	Neumatic	Length (m) =	0 80	Water pump	Bean Royal 535	Flood (l/min) =	
				Test depth (m) from.	73 00	to:	80 00
Test length (cm)		L * Cos X º =	700.00	Depth of hole (m)	80 00	Dip X (º)=	0
Swivel H1 (m)		H1 =	2 50	Hole Diameter D (cm):	7 57	W.L. Before of test (m)=	76 5
Water level Ha (m)	76 5	Ha * Cos X º =	76 50	Hydrostatic load (kg/cm2):	Lh= (H1+Ha)/10 =		7 900

Steel pipe:	Length (m) =	lt =	74 70	Plastic Pipe.	Length (m)	lm =	5 00	Reducers.	Valv cuopling:	0 2
	Diameter ϕ_1 (m)	=	0 0603		Diameter ϕ_2 (m)	=	0 0254	α	Packer	0.12
	Roughness index	n1 =	0 01		Roughness index	n2:	0 008		Union elbow	0 008

PRESSURE READING	LOSS PRESSURE	EFECTIVE PRESSURE	INJECTED TIME	WATER VOLUME	FLOOD			SPECIFIC ABSOPTION	LUGEON UNIT	PERMEABILITY COEFICIENT
Po	Plo=P1+P2+P3	Pe = Po ±Lh -Plo	t	Qt	Q=Qt/t	Q1=Q/60000	Q2=Q*100/6	Ae = Q / L	$UL = \frac{10 * Ae}{Pe}$	$K = \frac{Q\,2}{2\pi\,Pe\,L} * ln\frac{2L}{D}$
(kg/cm²)	(kg/cm²)	(kg/cm²)	(min)	(l)	(l/min)	(m³/s)	(cm³/s)	(l/min/m)	U L	(cm/s)
1.00	0.79580	8.10	10	470.00	47.00	7.83E-04	783.33	6.71	8 3	1.15E-04
5.00	2.05330	10.85	10	755.00	75.50	1.26E-03	1258 33	10.79	9.9	1.38E-04
10.00	3.50890	14 39	10	987.00	98.70	1.65E-03	1645 00	14.10	9.8	1.36E-04
5.00	1.89338	11.01	10	725.00	72.50	1.21E-03	1208 33	10.36	9.4	1.30E-04
1.00	0.76231	8.14	10	460.00	46.00	7.67E-04	766 67	6.57	8 1	1 12E-04

TOTAL LOSS LOAD

$$Pc = Pc_1 + Pc_2 + Pc_3$$

$$P_1 = \frac{10.34 * (n_1)^2 * (Q_1^2) * lt}{(\phi_1^{5.33})}$$

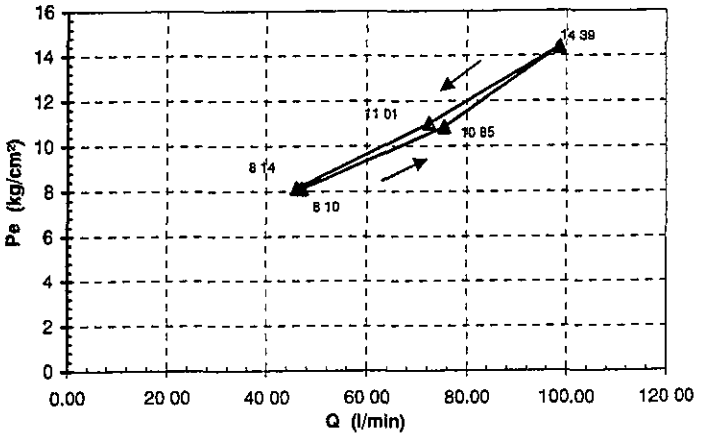
P1= loss load on steel pipe

$$P_2 = \frac{10.34 * (n_2)^2 * (Q_2^2) * lm}{(\phi_2^{5.33})}$$

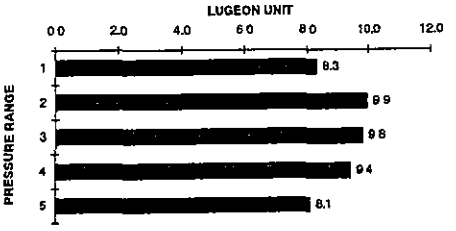
P2= loss load on plastic pipe

$$P_3 = \sum \alpha * (Q_1)$$

P3= loss load on couplings, valvles and packer



VALUES OF LUGEON UNIT



PERMEABILITY (LU) = 9.8

Po = Pressure Reading; Lh = Hydrostatic Load, Plo = Loss Pressure

305

PERMEABILITY TEST

swissboring
Swissboring Overseas Corporation Ltd.

CLIENT ELECTRIC POWER DEVELOPMENT Co.	DATE. 7-febrero-2003	LUGEON TEST Nº: 1
PROJECT.TOROLA HYDROELECTRIC COMPLEX	SITE: DAM SITE (left margin)	TESTED BY: MELVIN PAZ
HOLE No CDB-5A	ELEVATION. 217.25 m.s.l	CHECKED BY LUIS ZAVALA

Packer type	Neumatic	Length (m) =	0 80	Water pump	Bean Royal 535	Flood (l/min) =	
				Test depth (m) from	16 00	to	20 00
Test length (cm)		L * Cos X° =	400 00	Depth of hole (m)	20 00	Dip X (°)=	0
Swivel H1 (m)·		H1 =	2 10	Hole diameter D (cm)	9 60	W L Before of test (m)=	18 1
Water level Ha (m)	18 1	Ha * Cos X° =	18 10	Hydrostatic load (kg/cm2)	Lh= (H1+Ha)/10 =		2 020

Steel pipe.	Length (m) =	lt =	17 30	Plastic Pipe	Length (m)	l m =	5 00	Reducers.	Valv cuoplings 0 2
	Diameter ϕ_1	(m) =	0 0778		Diameter ϕ_2	(m) =	0 0254	α	Packer 0 12
	Roughness index	n1 =	0 01		Roughness index	n2.	0 008		Union elbow 0 008

PRESSURE READING Po (kg/cm²)	LOSS PRESSURE Plo=P1+P2+P3 (kg/cm²)	EFECTIVE PRESSURE Pe =Po +Lh-Plo (kg/cm²)	INJECTED TIME t (min)	WATER VOLUME Qt (l)	FLOOD Q=Qt/t (l/min)	FLOOD Q1=Q/60000 (m³/s)	FLOOD Q2=Q*100/6 (cm³/s)	SPECIFIC ABSOPTION Ae = Q / L (l/min/m)	LUGEON UNIT $UL = \frac{10 * Ae}{Pe}$ UL	PERMEABILITY COEFICIENT $K = \frac{Q2}{2\pi Pe L} * ln \frac{2L}{D}$ (cm/s)
1.00	0 01965	3.00	10	690 00	69.00	1.15E-03	1150 00	17.25	57.5	6.75E-04
5 00	0 06193	6 96	10	1230 00	123 00	2.05E-03	2050 00	30.75	44.2	5 18E-04
7 00	0.09438	8 93	10	1520.00	152 00	2 53E-03	2533 33	38 00	42.6	4 99E-04
5.00	0.06324	6 96	10	1243.00	124 30	2 07E-03	2071 67	31 08	44.7	5 24E-04
1 00	0 01960	3.00	10	689.00	68.90	1 15E-03	1148 33	17.23	57 4	6 74E-04

Nota· No se toma en cuenta la pérdida de carga en las mangueras porque dan valores muy altos debido al gran caudal.

No Se puede subir la presión de inyección a más de 7 kg/cm2 debido al grado de fracturamiento y mala calidad de la roca

TOTAL LOSS LOAD

$$Pc = Pc_1 + Pc_2 + Pc_3$$

$$P_1 = \frac{10.34 * (n_1)^2 * (Q_1^2) * lt}{(\phi_1^{5.33})}$$

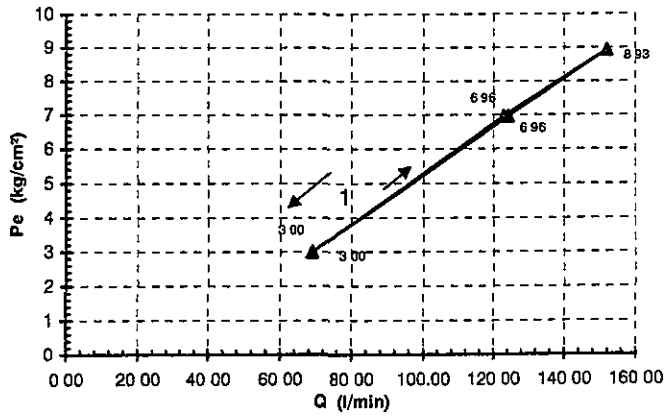
P1= loss load on steel pipe

$$P_2 = \frac{10.34 * (n_2)^2 * (Q_2^2) * lm}{(\phi_2^{5.33})}$$

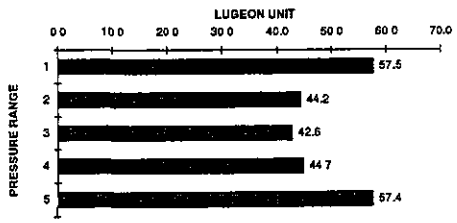
P2= loss load on plastic pipe

$$P_3 = \sum \alpha * (Q_1)$$

P3= loss load on couplings, valvles and packer



VALUES OF LUGEON UNIT



PERMEABILITY (LU) = 42.6

Po = Pressure Reading, Lh = Hydrostatic Load, Plo = Loss Pressure.

306

PERMEABILITY TEST

swissboring
Swissboring Overseas Corporation Ltd.

CLIENT: ELECTRIC POWER DEVELOPMENT Co.	DATE: 8-febrero-2003	LUGEON TEST Nº: 2
PROJECT TOROLA HYDROELECTRIC COMPLEX	SITE: DAM SITE (left margin)	TESTED BY JOSE VALLECILLOS
HOLE No.: CDB-5A	ELEVATION: 217.25 m.s.l	CHECKED BY: LUIS ZAVALA

Packer type	Neumatic	Length (m) =	0 80	Water pump.	Bean Royal 535	Flood (l/min) =	
				Test depth (m) from	20 00	to	25 00
Test length (cm)		L * Cos X° =	500 00	Depth of hole (m)	25 00	Dip X (°)=	0
Swivel H1 (m)		H1 =	2 10	Hole diameter D (cm)	9 60	W L Before of test (m)=	24 7
Water level Ha (m)	24 7	Ha * Cos X° =	24 70	Hydrostatic load (kg/cm2).	Lh= (H1+Ha)/10 =		2 680

Steel pipe.	Length (m) =	lt =	21 30	Plastic Pipe.	Length (m)	lm =	6 00	Reducers.	Valv cuoplings 0 2
	Diameter ϕ_1	(m) =	0 0778		Diameter ϕ_2	(m)	= 0 0254	α	Packer 0 12
	Roughness index	n1 =	0 01		Roughness index	n2 =	0 008		Union elbow 0 008

PRESSURE READING Po (kg/cm²)	LOSS PRESSURE Plo=P1+P2+P3 (kg/cm²)	EFECTIVE PRESSURE Pe =Po +Lh-Plo (kg/cm²)	INJECTED TIME t (min)	WATER VOLUME Qt (l)	FLOOD Qo=Qt/t (l/min)	FLOOD Q1=Q/60000 (m³/s)	FLOOD Q2=Q*100/6 (cm³/s)	SPECIFIC ABSOPTION Ae = Q / L (l/min/m)	LUGEON UNIT UL = 10* Ae / Pe UL	PERMEABILITY COEFICIENT K = Q 2 / 2 π Pe L * ln 2L / D (cm/s)
1 00	0 05397	3 63	10	1035.00	103.50	1.73E-03	1725 00	20 70	57 1	7.04E-04
4 00	0 08998	6 59	10	1338.00	133 80	2 23E-03	2230.00	26 76	40 6	5 00E-04
4 00	0 08971	6.59	10	1336 00	133.60	2 23E-03	2226 67	26 72	40 5	5 00E-04
1.00	0 07377	3.61	10	1211 00	121.10	2 02E-03	2018.33	24.22	67.2	8 28E-04

Nota No se toma en cuenta la pérdida de carga en las mangueras porque dan valores muy altos debido al gran caudal No Se puede subir la presión de inyección a más de 4 kg/cm2 debido al grado de fracturamiento y mala calidad de la roca

TOTAL LOSS LOAD

$$Pc = Pc_1 + Pc_2 + Pc_3$$

$$P_1 = \frac{10.34 * (n_1)^2 * (Q_1^2) * lt}{(\phi_1^{5.33})}$$

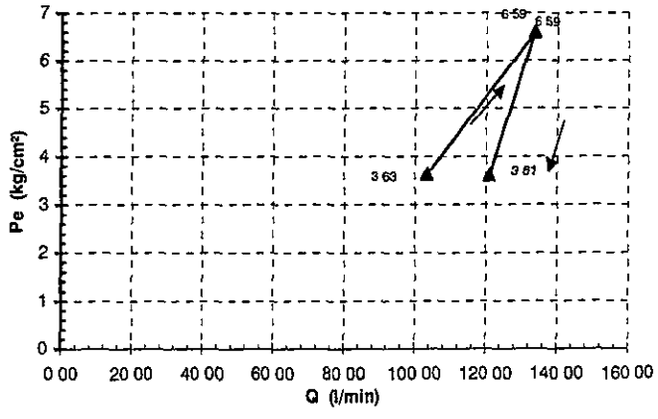
P1= loss load on steel pipe

$$P_2 = \frac{10.34 * (n_2)^2 * (Q_2^2) * lm}{(\phi_2^{5.33})}$$

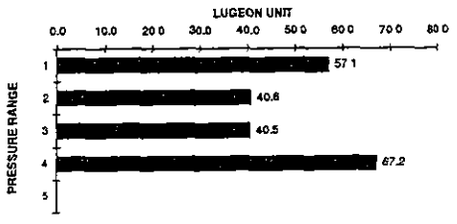
P2= loss load on plastic pipe

$$P_3 = \sum \alpha * (Q_1)$$

P3= loss load on couplings, valvles and packer



VALUES OF LUGEON UNIT 57 1



PERMEABILITY (LU) = 42.3

Po = Pressure Reading, Lh = Hydrostatic Load, Plo = Loss Pressure

PERMEABILITY TEST

swissboring
Swissboring Overseas Corporation Ltd.

CLIENT: ELECTRIC POWER DEVELOPMENT Co.	DATE. 9-febrero-2003	LUGEON TEST Nº: 3
PROJECT.TOROLA HYDROELECTRIC COMPLEX	SITE. DAM SITE (left margin)	TESTED BY JOSE VALLECILLOS
HOLE No.: CDB-5A	ELEVATION. 217.25 m.s.l	CHECKED BY: LUIS ZAVALA

Packer type	Neumatic	Length (m) =	0 80	Water pump	Bean Royal 535	Flood (l/min) =	
				Test depth (m) from	25 00	to:	30 00
Test length (cm)		L * Cos X º =	500 00	Depth of hole (m)	30 00	Dip X (º)=	0
Swivel H1 (m)		H1 =	1 15	Hole diameter D (cm)	9 60	W L Before of test (m)=	23 12
Water level Ha (m).	23 12	Ha * Cos X º =	23 12	Hydrostatic load (kg/cm2)	Lh= (H1+Ha)/10 =		2 427

Steel pipe.	Length (m) =	lt =	25 35	Plastic Pipe :	Length (m)	lm =	6 00	Reducers:	Valv cuoplings 0 2
	Diameter ϕ_1	(m) =	0 0778		Diameter ϕ_2	(m) =	0 0254	α	Packer 0 12
	Roughness index	n1 =	0 01		Roughness index	n2 =	0 008		Union elbow 0 008

PRESSURE READING Po (kg/cm²)	LOSS PRESSURE Plo=P1+P2+P3 (kg/cm²)	EFECTIVE PRESSURE Pe =Po +Lh-Plo (kg/cm²)	INJECTED TIME t (min)	WATER VOLUME Qt (l)	FLOOD Q=Qt/t (l/min)	FLOOD Q1=Q/60000 (m³/s)	FLOOD Q2=Q*100/6 (cm³/s)	SPECIFIC ABSOPTION Ae = Q / L (l/min/m)	LUGEON UNIT $UL=\frac{10*Ae}{Pe}$ UL	PERMEABILITY COEFICIENT $K=\frac{Q2}{2\pi Pe\ L}*ln\frac{2L}{D}$ (cm/s)
1.00	0 05881	3 37	10	991 00	99.10	1.65E-03	1651.67	19 82	58.8	7.25E-04
5 00	0 10727	7 32	10	1340.00	134 00	2.23E-03	2233.33	26.80	36 6	4 51E-04
5 00	0 10695	7 32	10	1338 00	133 80	2 23E-03	2230 00	26 76	36 6	4 51E-04
1 00	0 05406	3.37	10	950 00	95 00	1.58E-03	1583.33	19 00	56 3	6 94E-04

Nota No se toma en cuenta la pérdida de carga en las mangueras porque dan valores muy altos debido al gran caudal No Se puede subir la presión de inyección a más de 5 kg/cm2 debido al grado de fracturamiento y mala calidad de la roca

TOTAL LOSS LOAD

$$Pc = Pc_1 + Pc_2 + Pc_3$$

$$P_1 = \frac{10.34 * (n_1)^2 * (Q_1^2) * lt}{(\phi_1^{5.33})}$$

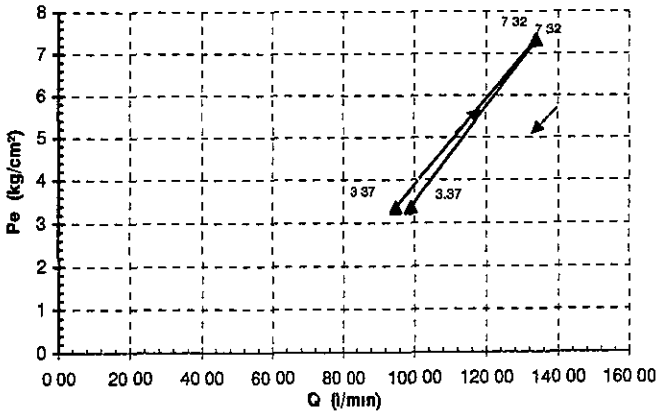
P1= loss load on steel pipe

$$P_2 = \frac{10.34 * (n_2)^2 * (Q_2^2) * lm}{(\phi_2^{5.33})}$$

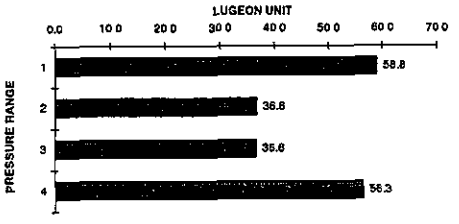
P2= loss load on plastic pipe

$$P_3 = \sum \alpha * (Q_1)$$

P3= loss load on couplings, valvles and packer



VALUES OF LUGEON UNIT



PERMEABILITY (LU) = 36.6

Po = Pressure Reading; Lh = Hydrostatic Load, Plo = Loss Pressure.

PERMEABILITY TEST

swissboring
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CLIENT. ELECTRIC POWER DEVELOPMENT Co.	DATE. 10-febrero-2003	LUGEON TEST N°: 4
PROJECT:TOROLA HYDROELECTRIC COMPLEX	SITE: DAM SITE (left margin)	TESTED BY JOSE VALLECILLOS
HOLE No.: CDB-5A	ELEVATION. 217.25 m.s.l	CHECKED BY: LUIS ZAVALA

Packer type	Neumatic	Length (m) =	0 80	Water pump:	Bean Royal 535	Flood (l/min) =	
				Test depth (m) from	30 00	to	35 00
Test length (cm)		L * Cos X° =	500.00	Depth of hole (m)	35 00	Dip X (°)=	0
Swivel H1 (m)		H1 =	1 50	Hole diameter D (cm)	9 60	W L Before of test (m)=	32 5
Water level Ha (m)	32 5	Ha * Cos X° =	32 50	Hydrostatic load (kg/cm2).	Lh= (H1+Ha)/10 =		3 400

Steel pipe.	Length (m) =	lt =	30 70	Plastic Pipe.	Length (m)	lm =	6 00	Reducers.	Valv cuopling: 0 2
	Diameter ϕ_1	(m) =	0 0778		Diameter ϕ_2	(m) =	0 0254	α	Packer 0 12
	Roughness index	n1 =	0 01		Roughness index	n2 =	0 008		Union elbow 0 008

PRESSURE READING Po (kg/cm²)	LOSS PRESSURE Plo=P1+P2+P3 (kg/cm²)	EFECTIVE PRESSURE Pe =Po +Lh-Plo (kg/cm²)	INJECTED TIME t (min)	WATER VOLUME Qt (l)	FLOOD Q=Qt/t (l/min)	FLOOD Q1=Q/60000 (m³/s)	FLOOD Q2=Q*100/6 (cm³/s)	SPECIFIC ABSOPTION Ae = Q / L (l/min/m)	LUGEON UNIT $UL = \frac{10 * Ae}{Pe}$ UL	PERMEABILITY COEFICIENT $K = \frac{Q2}{2\pi Pe L} * \ln \frac{2L}{D}$ (cm/s)
1 00	0 08897	4.31	10	1109 00	110 90	1.85E-03	1848.33	22,18	51 4	6 34E-04
3 00	0 13779	6 26	10	1381.00	138.10	2 30E-03	2301.67	27 62	44 1	5,44E-04
3 00	0 13858	6 26	10	1385.00	138 50	2,31E-03	2308 33	27 70	44 2	5 45E-04
1 00	0 10656	4,29	10	1214.00	121 40	2.02E-03	2023.33	24 28	56 6	6 97E-04

Nota No se toma en cuenta la pérdida de carga en las mangueras porque dan valores muy altos debido al gran caudal. No Se puede subir la presión de inyección a más de 3 kg/cm2 debido al grado de fracturamiento y mala calidad de la roca

TOTAL LOSS LOAD

$$Pc = Pc_1 + Pc_2 + Pc_3$$

$$P_1 = \frac{10.34 * (n_1)^2 * (Q_1^2) * lt}{(\phi_1^{5.33})}$$

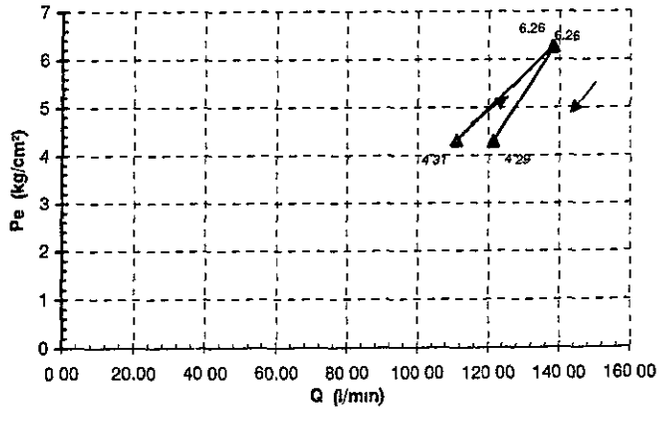
P1= loss load on steel pipe

$$P_2 = \frac{10.34 * (n_2)^2 * (Q_2^2) * lm}{(\phi_2^{5.33})}$$

P2= loss load on plastic pipe

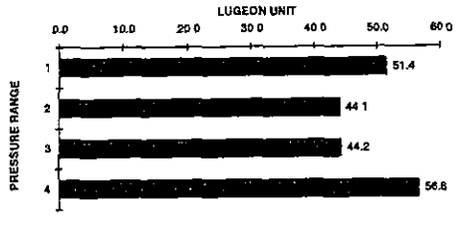
$$P_3 = \sum \alpha * (Q_1)$$

P3= loss load on couplings, valvles and packer



Po = Pressure Reading, Lh = Hydrostatic Load, Plo = Loss Pressure

VALUES OF LUGEON UNIT



PERMEABILITY (LU) = 44.2

PERMEABILITY TEST

swissboring
Swissboring Overseas Corporation Ltd.

CLIENT: ELECTRIC POWER DEVELOPMENT Co.	DATE: 10-febrero-2003	LUGEON TEST Nº: 5
PROJECT TOROLA HYDROELECTRIC COMPLEX	SITE: DAM SITE (left margin)	TESTED BY JOSE VALLECILLOS
HOLE No.: CDB-5A	ELEVATION: 217.25 m.s.l	CHECKED BY: LUIS ZAVALA

Packer type	Neumatic	Length (m) =	0 80	Water pump	Bean Royal 535	Flood (l/min) =	
				Test depth (m) from	35 00	to	40 00
Test length (cm)		L * Cos X° =	500 00	Depth of hole (m)	40 00	Dip X (°)=	0
Swivel H1 (m)		H1 =	0 90	Hole diameter D (cm)	9 60	W L Before of test (m)=	35
Water level Ha (m)	35	Ha * Cos X° =	35 00	Hydrostatic load (kg/cm2)	Lh= (H1+Ha)/10 =		3 590

Steel pipe.	Length (m) =	lt	= 35 10	Plastic Pipe.	Length (m)	lm	= 6 00	Reducers.	Valv cuoplings 0 2
	Diameter ϕ_1	(m)	= 0 0778		Diameter ϕ_2	(m)	= 0 0254	α	Packer 0 12
	Roughness index	n1	= 0 01		Roughness index	n2	0 008		Union elbow 0 008

PRESSURE READING	LOSS PRESSURE	EFECTIVE PRESSURE	INJECTED TIME	WATER VOLUME	FLOOD			SPECIFIC ABSOPTION	LUGEON UNIT	PERMEABILITY COEFICIENT
Po	Plo=P1+P2+P3	Pe =Po +Lh-Plo	t	Qt	Q=Qt/t	Q1=Q/60000	Q2=Q*100/6	Ae = Q / L	$UL = \frac{10 * Ae}{Pe}$	$K = \frac{Q2}{2\pi Pe L} * \ln \frac{2L}{D}$
(kg/cm²)	(kg/cm²)	(kg/cm²)	(min)	(l)	(l/min)	(m³/s)	(cm³/s)	(l/min/m)	UL	(cm/s)
1 00	0.01879	4 57	10	475.00	47 50	7 92E-04	791.67	9.50	20 8	2 56E-04
5 00	0 08519	8.50	10	1015 00	101 50	1.69E-03	1691.67	20 30	23.9	2 94E-04
7 00	0.14105	10.45	10	1307.00	130.70	2 18E-03	2178 33	26 14	25 0	3 08E-04
5 00	0 08687	8 50	10	1025.00	102.50	1 71E-03	1708 33	20 50	24 1	2 97E-04
1 00	0 02024	4.57	10	493 00	49 30	8 22E-04	821.67	9.86	21 6	1 48E-01

TOTAL LOSS LOAD

$$Pc = Pc_1 + Pc_2 + Pc_3$$

$$P_1 = \frac{10.34 * (n_1)^2 * (Q_1^2) * lt}{(\phi_1^{5.33})}$$

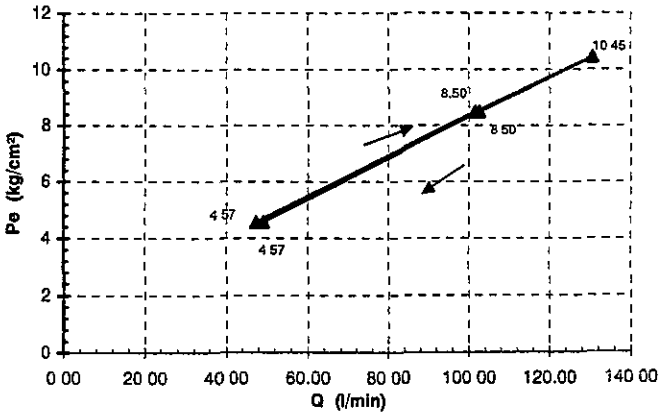
P1= loss load on steel pipe

$$P_2 = \frac{10.34 * (n_2)^2 * (Q_2^2) * lm}{(\phi_2^{5.33})}$$

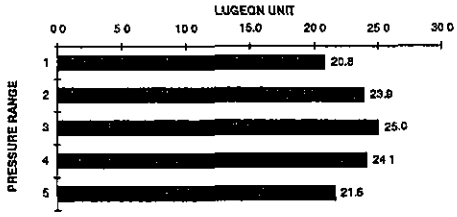
P2= loss load on plastic pipe

$$P_3 = \sum \alpha * (Q_1)$$

P3= loss load on couplings, valvles and packer



VALUES OF LUGEON UNIT



PERMEABILITY (LU) = 25 0

Po = Pressure Reading, Lh = Hydrostatic Load, Plo = Loss Pressure

PERMEABILITY TEST

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CLIENT. ELECTRIC POWER DEVELOPMENT Co.	DATE: 11-febrero-2003	LUGEON TEST Nº: 6
PROJECT.TOROLA HYDROELECTRIC COMPLEX	SITE. DAM SITE (left margin)	TESTED BY JOSE VALLECILLOS
HOLE No.: CDB-5A	ELEVATION 217.25 m.s.l	CHECKED BY: LUIS ZAVALA

Packer type.	*Neumatic*	*Length (m) =*	0 80	Water pump	Bean Royal 535	Flood (l/min) =	
				Test depth (m) from	40 00	to	45 00
Test length (cm)		L * Cos X° =	500 00	Depth of hole (m)	45 00	*Dip X (°)=*	*0*
Swivel H1 (m)		H1 =	1 70	Hole diameter D (cm)	9 60	W L Before of test (m)=	39 55
Water level Ha (m)	39 55	Ha * Cos X° =	39 55	Hydrostatic load (kg/cm2)	Lh= (H1+Ha)/10 =		4 125

Steel pipe.	Length (m) =	lt =	40 90	Plastic Pipe :	Length (m)	lm =	6 00	Reducers.	Valv cuoplings 0 2
	Diameter ϕ_1	(m) =	0 0778		Diameter ϕ_2	(m) =	0 0254	α	Packer. 0 12
	Roughness index	n1 =	0 01		Roughness index	n2 =	0 008		Union elbow 0 008

PRESSURE READING	LOSS PRESSURE	EFECTIVE PRESSURE	INJECTED TIME	WATER VOLUME	FLOOD			SPECIFIC ABSOPTION	LUGEON UNIT	PERMEABILITY COEFICIENT
Po	Plo=P1+P2+P3	Pe =Po +Lh-Plo	t	Qt	Q=Qt/t	Q1=Q/60000	Q2=Q*100/6	Ae = Q / L	$UL = \frac{10 * Ae}{Pe}$	$K = \frac{Q 2}{2 \pi Pe L} * \ln \frac{2L}{D}$
(kg/cm²)	(kg/cm²)	(kg/cm²)	(min)	(l)	(l/min)	(m³/s)	(cm³/s)	(l/min/m)	U L	(cm/s)
1.00	0 03678	5 09	10	617 00	61.70	1 03E-03	1028 33	12 34	24 3	2 99E-04
5.00	0 16149	8 96	10	1296 00	129 60	2.16E-03	2160 00	25 92	28.9	3 56E-04
6 00	0.18517	9 94	10	1388 00	138 80	2 31E-03	2313.33	27.76	27 9	3 44E-04
5 00	0 14408	8 98	10	1224.00	122 40	2.04E-03	2040.00	24.48	27 3	3 36E-04
1 00	0.03364	5 09	10	590.00	59 00	9 83E-04	983 33	11 80	23.2	8 40E-02

TOTAL LOSS LOAD

$$Pc = Pc_1 + Pc_2 + Pc_3$$

$$P_1 = \frac{10.34 * (n_1)^2 * (Q_1^2) * lt}{(\phi_1^{5.33})}$$

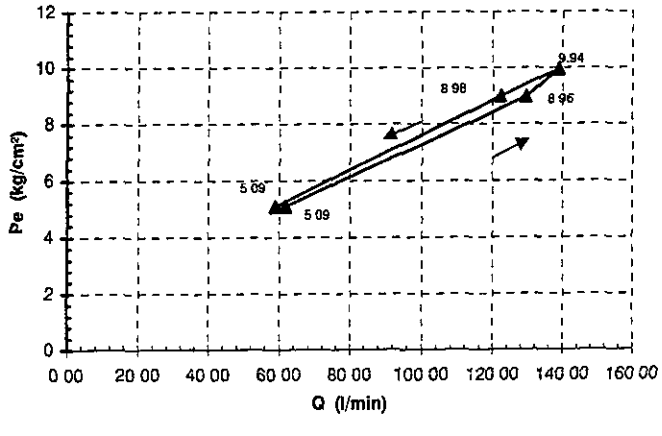
P1= loss load on steel pipe

$$P_2 = \frac{10.34 * (n_2)^2 * (Q_2^2) * lm}{(\phi_2^{5.33})}$$

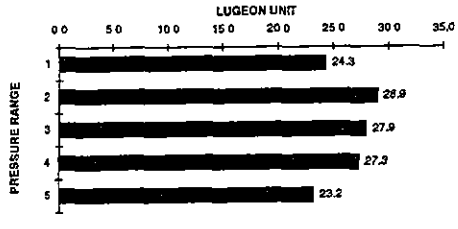
P2= loss load on plastic pipe

$$P_3 = \sum \alpha * (Q_1)$$

P3= loss load on couplings, valvies and packer



VALUES OF LUGEON UNIT



PERMEABILITY (LU) = 27.9

Po = Pressure Reading, Lh = Hydrostatic Load, Plo = Loss Pressure

PERMEABILITY TEST

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Swissboring Overseas Corporation Ltd.

CLIENT: ELECTRIC POWER DEVELOPMENT Co.	DATE: 11-febrero-2003	LUGEON TEST Nº. 7
PROJECT:TOROLA HYDROELECTRIC COMPLEX	SITE: DAM SITE (left margin)	TESTED BY JOSE VALLECILLOS
HOLE No : CDB-5A	ELEVATION. 217.25 m.s.l	CHECKED BY: LUIS ZAVALA

Packer type	Neumatic	Length (m) =	0 80	Water pump	Bean Royal 595	Flood (l/min) =	
				Test depth (m) from	45 00	to	50 00
Test length (cm)		L * Cos X° =	500 00	Depth of hole (m)	50 00	Dip X (°)=	0
Swivel H1 (m).		H1 =	1.30	Hole diameter D (cm):	9 60	W L Before of test (m)=	39 4
Water level Ha (m)	39 4	Ha * Cos X° =	39 40	Hydrostatic load (kg/cm2)	Lh= (H1+Ha)/10 =		4 070

Steel pipe.	Length (m) =	lt	=	45 50	Plastic Pipe.	Length (m)	lm = 6 00	Reducers:	Valv cuoplings 0 2
	Diameter ϕ_1	(m)	=	0 0778		Diameter ϕ_2	(m) = 0 0254	α	Packer 0 12
	Roughness index	n1	=	0 01		Roughness index	n2 0,008		Union elbow 0 008

PRESSURE READING Po (kg/cm²)	LOSS PRESSURE Plo=P1+P2+P3 (kg/cm²)	EFECTIVE PRESSURE Pe = Po + Lh - Plo (kg/cm²)	INJECTED TIME t (min)	WATER VOLUME Qt (l)	FLOOD Q=Qt/t (l/min)	FLOOD Q1=Q/60000 (m³/s)	FLOOD Q2=Q*100/6 (cm³/s)	SPECIFIC ABSOPTION Ae = Q / L (l/min/m)	LUGEON UNIT $UL = \frac{10 * Ae}{Pe}$ UL	PERMEABILITY COEFICIENT $K = \frac{Q2}{2\pi Pe\ L} * \ln\frac{2L}{D}$ (cm/s)
1 00	0 00171	5 07	10	124.00	12 40	2 07E-04	206 67	2 48	4.9	6.03E-05
5 00	0 00762	9.06	10	265.00	26,50	4 42E-04	441.67	5 30	5 8	7.21E-05
10.00	0 08108	13 99	10	870.00	87 00	1.45E-03	1450 00	17.40	12.4	1.53E-04
5 00	0.02998	9 04	10	528 00	52 80	8 80E-04	880 00	10 56	11.7	1.44E-04
1.00	0 01101	5.06	10	319.00	31,90	5 32E-04	531 67	6 38	12 6	5 98E-02

TOTAL LOSS LOAD

$$Pc = Pc_1 + Pc_2 + Pc_3$$

$$P_1 = \frac{10.34 * (n_1)^2 * (Q_1^2) * lt}{(\phi_1^{5.33})}$$

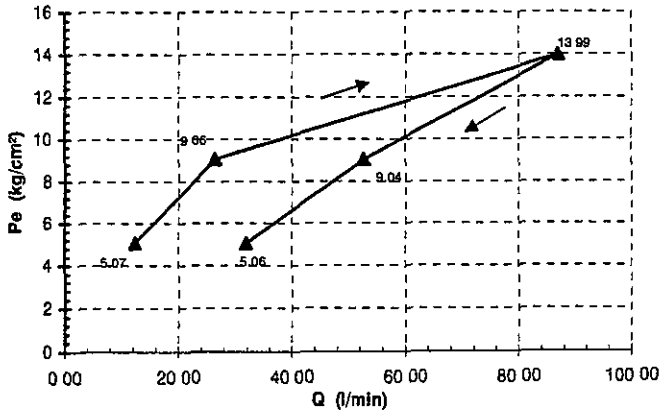
P1= loss load on steel pipe

$$P_2 = \frac{10.34 * (n_2)^2 * (Q_2^2) * lm}{(\phi_2^{5.33})}$$

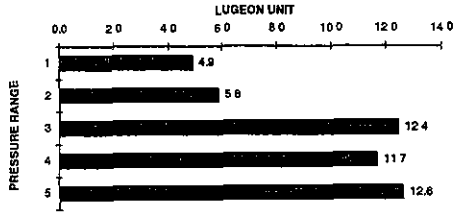
P2= loss load on plastic pipe

$$P_3 = \sum \alpha * (Q_1)$$

P3= loss load on couplings, valvles and packer



VALUES OF LUGEON UNIT



PERMEABILITY (LU) = 12.4

Po = Pressure Reading, Lh = Hydrostatic Load; Plo = Loss Pressure

PERMEABILITY TEST

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Swissboring Overseas Corporation Ltd.

CLIENT: ELECTRIC POWER DEVELOPMENT Co.	DATE: 12-febrero-2003	LUGEON TEST Nº: 8
PROJECT.TOROLA HYDROELECTRIC COMPLEX	SITE DAM SITE (left margin)	TESTED BY JOSE VALLECILLOS
HOLE No.. CDB-5A	ELEVATION: 217.25 m.s.l	CHECKED BY. LUIS ZAVALA

Packer type	Neumatic	Length (m) =	0 80	Water pump:	Bean Royal 535	Flood (l/min) =	
				Test depth (m) from	50 00	to	55 00
Test length (cm)		L * Cos X º =	500 00	Depth of hole (m)	55 00	Dip X (º)=	0
Swivel H1 (m)		H1 =	1 50	Hole diameter D (cm)	9 60	W L. Before of test (m)=	49 1
Water level Ha (m)	49 1	Ha * Cos X º =	49 10	Hydrostatic load (kg/cm2)	Lh= (H1+Ha)/10 =		5 060

Steel pipe.	Length (m) =	lt	=	50 70	Plastic Pipe : Length (m)	lm	= 6 00	Reducers.	Valv cuoplings 0 2
	Diameter ϕ_1	(m)	=	0 0778	Diameter ϕ_2	(m)	= 0 0254	α	Packer 0 12
	Roughness index	n1	=	0 01	Roughness index	n2	0 008		Union elbow 0 008

PRESSURE READING Po (kg/cm²)	LOSS PRESSURE Plo=P1+P2+P3 (kg/cm²)	EFECTIVE PRESSURE Pe =Po +Lh-Plo (kg/cm²)	INJECTED TIME t (min)	WATER VOLUME Qt (l)	FLOOD Q=Qt/t (l/min)	FLOOD Q1=Q/60000 (m³/s)	FLOOD Q2=Q*100/6 (cm³/s)	SPECIFIC ABSOPTION Ae = Q / L (l/min/m)	LUGEON UNIT UL = 10*Ae/Pe UL	PERMEABILITY COEFICIENT K = 0 2/(2 x Pe L) * ln 2L/D (cm/s)
1 00	0 06521	5 99	10	739.00	73.90	1.23E-03	1231 67	14 78	24 7	3 04E-04
5 00	0 19603	9.86	10	1283 00	128 30	2 14E-03	2138 33	25.66	26 0	3 21E-04
7 00	0 22477	11 84	10	1374 00	137 40	2 29E-03	2290 00	27 48	23 2	2.86E-04
5 00	0 18668	9 87	10	1252 00	125 20	2 09E-03	2086 67	25.04	25 4	3 13E-04
1 00	0 08499	5 98	10	844 00	84 40	1 41E-03	1406 67	16 88	28 3	1 16E-01

TOTAL LOSS LOAD

$$Pc = Pc_1 + Pc_2 + Pc_3$$

$$P_1 = \frac{10.34 * (n_1)^2 * (Q_1^2) * lt}{(\phi_1^{5.33})}$$

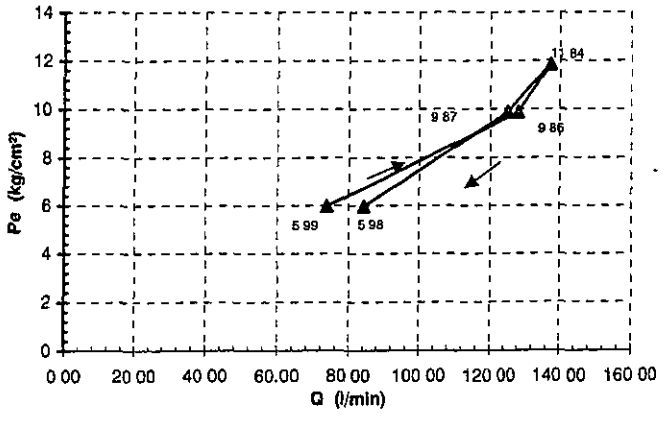
P1= loss load on steel pipe

$$P_2 = \frac{10.34 * (n_2)^2 * (Q_2^2) * lm}{(\phi_2^{5.33})}$$

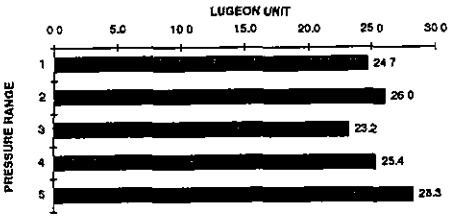
P2= loss load on plastic pipe

$$P_3 = \sum \alpha * (Q_1)$$

P3= loss load on couplings, valvles and packer



VALUES OF LUGEON UNIT



PERMEABILITY (LU) = 23.2

Po = Pressure Reading, Lh = Hydrostatic Load, Plo = Loss Pressure

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PERMEABILITY TEST

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Swissboring Overseas Corporation Ltd.

CLIENT: ELECTRIC POWER DEVELOPMENT Co.	DATE: 12-febrero-2003	LUGEON TEST Nº: 9
PROJECT.TOROLA HYDROELECTRIC COMPLEX	SITE: DAM SITE (left margin)	TESTED BY JOSE VALLECILLOS
HOLE No.. CDB-5A	ELEVATION: 217.25 m.s.l	CHECKED BY LUIS ZAVALA

Packer type	Neumatic	Length (m) =	0 80	Water pump	Bean Royal 535	Flood (l/min) =	
				Test depth (m) from	55 00	to	60 00
Test length (cm).		L * Cos X º =	500 00	Depth of hole (m)	60 00	Dip X (º)=	0
Swivel H1 (m)		H1 =	1 70	Hole diameter D (cm)	9 60	W L Before of test (m)=	58 25
Water level Ha (m)	58 25	Ha * Cos X º =	58 25	Hydrostatic load (kg/cm2)	Lh= (H1+Ha)/10 =		5 995

Steel pipe.	Length (m) =	lt	=	55 90	Plastic Pipe..	Length (m)	lm = 6 00	Reducers.	Valv cuoplings 0 2
	Diameter ϕ_1	(m)	=	0 0778		Diameter ϕ_2	(m) = 0 0254	α	Packer 0 12
	Roughness index	n1	=	0 01		Roughness index	n2 0 008		Union elbow 0 008

PRESSURE READING Po (kg/cm²)	LOSS PRESSURE Plo=P1+P2+P3 (kg/cm²)	EFECTIVE PRESSURE Pe =Po +Lh-Plo (kg/cm²)	INJECTED TIME t (min)	WATER VOLUME Qt (l)	FLOOD Q=Qt/t (l/min)	FLOOD Q1=Q/60000 (m³/s)	FLOOD Q2=Q*100/6 (cm³/s)	SPECIFIC ABSOPTION Ae = Q / L (l/min/m)	LUGEON UNIT $UL = \frac{10 * Ae}{Pe}$ UL	PERMEABILITY COEFICIENT $K = \frac{Q2}{2\pi Pe\ L} * \ln\frac{2L}{D}$ (cm/s)
1 00	0 08188	6.91	10	789 00	78 90	1 32E-03	1315 00	15 78	22.8	2 81E-04
5 00	0.13401	10.86	10	1010.00	101 00	1 68E-03	1683 33	20 20	18 6	2 29E-04
7 00	0.22903	12 77	10	1321.00	132 10	2 20E-03	2201 67	26 42	20 7	2.55E-04
5 00	0.13909	10 86	10	1029.00	102 90	1 72E-03	1715 00	20.58	19.0	2.34E-04
1 00	0 10412	6 89	10	890.00	89 00	1.48E-03	1483 33	17 80	25 8	9 36E-02

TOTAL LOSS LOAD

$$Pc = Pc_1 + Pc_2 + Pc_3$$

$$P_1 = \frac{10.34 * (n_1)^2 * (Q_1^2) * lt}{(\phi_1^{5.33})}$$

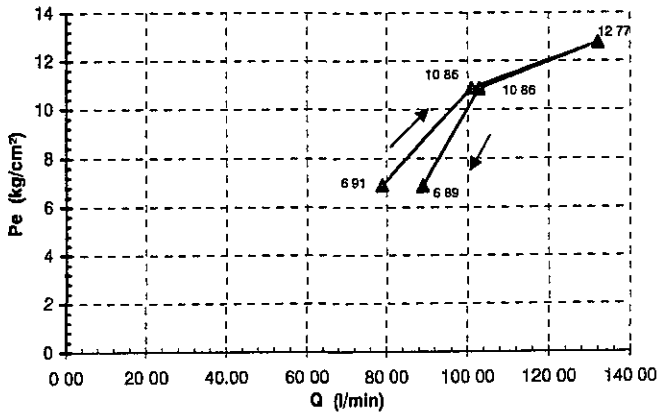
P1= loss load on steel pipe

$$P_2 = \frac{10.34 * (n_2)^2 * (Q_2^2) * lm}{(\phi_2^{5.33})}$$

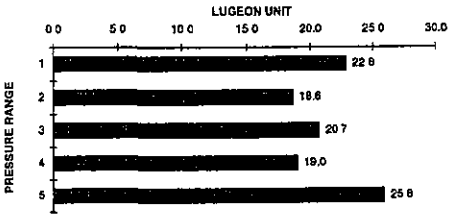
P2= loss load on plastic pipe

$$P_3 = \sum \alpha * (Q_1)$$

P3= loss load on couplings, valvies and packer



VALUES OF LUGEON UNIT



PERMEABILITY (LU) = 20.7

Po = Pressure Reading, Lh = Hydrostatic Load, Plo = Loss Pressure

PERMEABILITY TEST

swissboring
Swissboring Overseas Corporation Ltd.

CLIENT. ELECTRIC POWER DEVELOPMENT Co.	DATE: 12-febrero-2003	LUGEON TEST N°: 10
PROJECT.TOROLA HYDROELECTRIC COMPLEX	SITE. DAM SITE (left margin)	TESTED BY JOSE VALLECILLOS
HOLE No. CDB-5A	ELEVATION: 217.25 m.s.l	CHECKED BY: LUIS ZAVALA

Packer type	Neumatic	Length (m) =	0 80	Water pump	Bean Royal 535	Flood (l/min) =	
				Test depth (m) from	60 00	to	65 00
Test length (cm).		L * Cos X° =	500 00	Depth of hole (m)	65 00	Dip X (°)=	0
Swivel H1 (m)		H1 =	2 15	Hole diameter D (cm)	9 60	W L Before of test (m)=	58 25
Water level Ha (m)	58 25	Ha * Cos X° =	58 25	Hydrostatic load (kg/cm2)	Lh= (H1+Ha)/10 =		6 040

Steel pipe.	Length (m) =	lt =	61 35	Plastic Pipe.	Length (m)	lm =	6 00	Reducers.	Valv cuoplings 0 2
	Diameter ϕ_1	(m) =	0 0778		Diameter ϕ_2	(m) =	0 0254	α	Packer 0 12
	Roughness index	n1 =	0 01		Roughness index	n2	0 008		Union elbow 0 008

PRESSURE READING	LOSS PRESSURE	EFECTIVE PRESSURE	INJECTED TIME	WATER VOLUME	FLOOD			SPECIFIC ABSOPTION	LUGEON UNIT	PERMEABILITY COEFICIENT
Po (kg/cm²)	Plo=P1+P2+P3 (kg/cm²)	Pe =Po +Lh-Plo (kg/cm²)	t (min)	Qt (l)	Q=Qt/t (l/min)	Q1=Q/60000 (m³/s)	Q2=Q*100/6 (cm³/s)	Ae = Q / L (l/min/m)	$UL = \frac{10 * Ae}{Pe}$ UL	$K = \frac{Q2}{2 \pi Pe L} * \ln \frac{2L}{D}$ (cm/s)
1.00	0 06874	6 97	10	690 00	69.00	1 15E-03	1150 00	13.80	19 8	2 44E-04
5 00	0 12416	10 92	10	928 00	92 80	1 55E-03	1546 67	18.56	17 0	2 10E-04
7 00	0 24712	12.79	10	1310 00	131 00	2 18E-03	2183 33	26 20	20 5	2 52E-04
5 00	0 14819	10.89	10	1014 00	101.40	1 69E-03	1690 00	20 28	18 6	2.29E-04
1 00	0 14042	6.90	10	987 00	98 70	1 65E-03	1645 00	19.74	28 6	8.20E-02

TOTAL LOSS LOAD

$$Pc = Pc_1 + Pc_2 + Pc_3$$

$$P_1 = \frac{10.34 * (n_1)^2 * (Q_1^2) * lt}{(\phi_1^{5.33})}$$

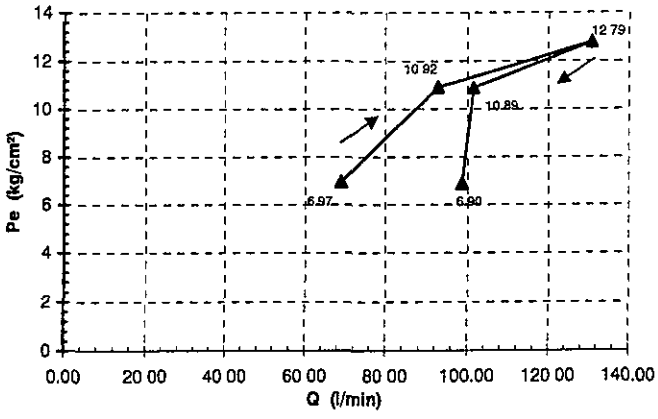
P1= loss load on steel pipe

$$P_2 = \frac{10.34 * (n_2)^2 * (Q_2^2) * lm}{(\phi_2^{5.33})}$$

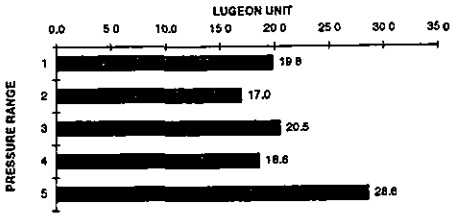
P2= loss load on plastic pipe

$$P_3 = \sum \alpha * (Q_1)$$

P3= loss load on couplings, valvles and packer



VALUES OF LUGEON UNIT



PERMEABILITY (LU) = 20.5

Po = Pressure Reading, Lh = Hydrostatic Load, Plo = Loss Pressure

315

PERMEABILITY TEST

swissboring
Swissboring Overseas Corporation Ltd.

CLIENT: ELECTRIC POWER DEVELOPMENT Co.	DATE. 13-febrero-2003	LUGEON TEST Nº: 11
PROJECT TOROLA HYDROELECTRIC COMPLEX	SITE: DAM SITE (left margin)	TESTED BY JOSE VALLECILLOS
HOLE No.. CDB-5A	ELEVATION. 217.25 m.s.l	CHECKED BY: LUIS ZAVALA

Packer type	Neumatic	Length (m) =	0 80	Water pump	Bean Royal 535	Flood (l/min) =	
				Test depth (m) from	65 00	to	70 00
Test length (cm)		L * Cos X ° =	500 00	Depth of hole (m)	70 00	Dip X (°)=	0
Swivel H1 (m)		H1 =	2 15	Hole diameter D (cm)	9 60	W L Before of test (m)=	60 65
Water level Ha (m)	60 65	Ha * Cos X ° =	60 65	Hydrostatic load (kg/cm2)	Lh= (H1+Ha)/10 =		6 280

Steel pipe.	Length (m) =	lt =	66 35	Plastic Pipe.	Length (m)	lm =	6 00	Reducers.	Valv cuoplings 0 2
	Diameter ϕ_1	(m) =	0 0778		Diameter ϕ_2	(m)	= 0 0254	α	Packer 0 12
	Roughness index	n1 =	0 01		Roughness index	n2	0 008		Union elbow 0 008

PRESSURE READING	LOSS PRESSURE	EFECTIVE PRESSURE	INJECTED TIME	WATER VOLUME	FLOOD			SPECIFIC ABSOPTION	LUGEON UNIT	PERMEABILITY COEFICIENT
Po (kg/cm²)	Plo=P1+P2+P3 (kg/cm²)	Pe =Po +Lh-Plo (kg/cm²)	t (min)	Qt (l)	Q=Qt/t (l/min)	Q1=Q/60000 (m³/s)	Q2=Q*100/6 (cm³/s)	Ae = Q / L (l/min/m)	$UL = \frac{10 * Ae}{Pe}$ UL	$K = \frac{Q2}{2\pi Pe\ L} * \ln\frac{2L}{D}$ (cm/s)
1.00	0 07735	7.20	10	704 00	70 40	1 17E-03	1173.33	14 08	19 5	2 41E-04
5 00	0 29907	10 98	10	1386 00	138 60	2.31E-03	2310.00	27 72	25 2	3 11E-04
5.00	0 29907	10 98	10	1386 00	138 60	2 31E-03	2310.00	27 72	25 2	3 11E-04
1 00	0 12966	7.15	10	912 00	91.20	1 52E-03	1520 00	18 24	25 5	3 14E-04

TOTAL LOSS LOAD

$$Pc = Pc_1 + Pc_2 + Pc_3$$

$$P_1 = \frac{10.34 * (n_1)^2 * (Q_1^2) * lt}{(\phi_1^{5.33})}$$

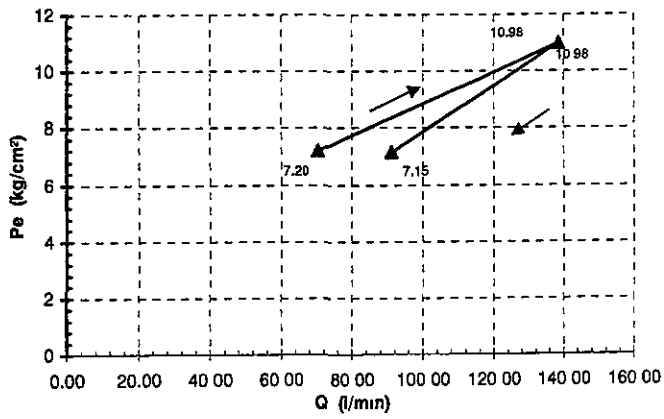
P1= loss load on steel pipe

$$P_2 = \frac{10.34 * (n_2)^2 * (Q_2^2) * lm}{(\phi_2^{5.33})}$$

P2= loss load on plastic pipe

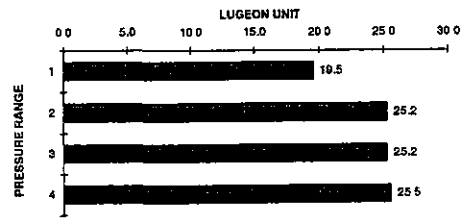
$$P_3 = \sum \alpha * (Q_1)$$

P3= loss load on couplings, valvles and packer



Po = Pressure Reading; Lh = Hydrostatic Load, Plo = Loss Pressure

VALUES OF LUGEON UNIT



PERMEABILITY (LU) = 25.2

316

PERMEABILITY TEST

swissboring
Swissboring Overseas Corporation Ltd.

CLIENT: ELECTRIC POWER DEVELOPMENT Co.	DATE: 30-enero-2003	LUGEON TEST Nº. 1
PROJECT:TOROLA HYDROELECTRIC COMPLEX	SITE: DAM SITE (left margin)	TESTED BY J. VALLECILLOS Y M. PAZ
HOLE No.: CDB-6A	ELEVATION: 228.54 m.s.l	CHECKED BY: LUIS ZAVALA

Packer type:	Neumatic	Length (m) =	0.80	Water pump:	Bean Royal 535	Flood (l/min) =	
				Test depth (m) from.	32 00	to	36 00
Test length (cm):		*L * Cos X ° =*	*400 00*	*Depth of hole (m):*	*36 00*	Dip X (°)=	0
Swivel H1 (m)		H1 =	1.70	Hole diameter D (cm)	9 60	W L Before of test (m)=	13 7
Water level Ha (m)	13 7	Ha * Cos X ° =	13 70	Hydrostatic load (kg/cm2):	Lh= (H1+Ha)/10 =		1.540

Steel pipe.	Length (m) =	lt	= 32 90	Plastic Pipe.	Length (m)	lm	= 6.00	Reducers:	Valv cuopling: 0 2
	Diameter ϕ_1	(m)	= 0 0778		Diameter ϕ_2	(m)	= 0.0254	α	Packer 0.12
	Roughness index	n1	= 0 01		Roughness index	n2:	0.008		Union elbow: 0 008

PRESSURE READING Po (kg/cm²)	LOSS PRESSURE Plo=P1+P2+P3 (kg/cm²)	EFECTIVE PRESSURE Pe = Po + Lh - Plo (kg/cm²)	INJECTED TIME t (min)	WATER VOLUME Qt (l)	FLOOD Q=Qt/t (l/min)	FLOOD Q1=Q/60000 (m³/s)	FLOOD Q2=Q*100/6 (cm³/s)	SPECIFIC ABSOPTION Ae = Q / L (l/min/m)	LUGEON UNIT UL = 10* Ae / Pe UL	PERMEABILITY COEFICIENT $K = \frac{Q2}{2\pi Pc\ L} * ln\frac{2L}{D}$ (cm/s)
1.00	0 00030	2 54	10	9.00	0 90	1 50E-05	15 00	0.23	0.9	1.04E-05
5 00	0 00081	6 54	10	15 00	1 50	2.50E-05	25 00	0.38	0.6	6 73E-06
7.00	3 58333	4 96	10	1000 00	100 00	1 67E-03	1666 67	25.00	50 4	5.92E-04
5.00	1.68151	4.86	10	685 00	68.50	1.14E-03	1141.67	17 13	35 2	4 14E-04
1.00	0 23129	2.31	10	254.00	25 40	4 23E-04	423.33	6.35	27.5	3.23E-04
Al subir la presión a 10 kg/cm2 se produce la ruptura de la roca Se continúa haciendo la prueba.										

TOTAL LOSS LOAD

$$Pc = Pc_1 + Pc_2 + Pc_3$$

$$P_1 = \frac{10.34 * (n_1)^2 * (Q_1^2) * lt}{(\phi_1^{5.33})}$$

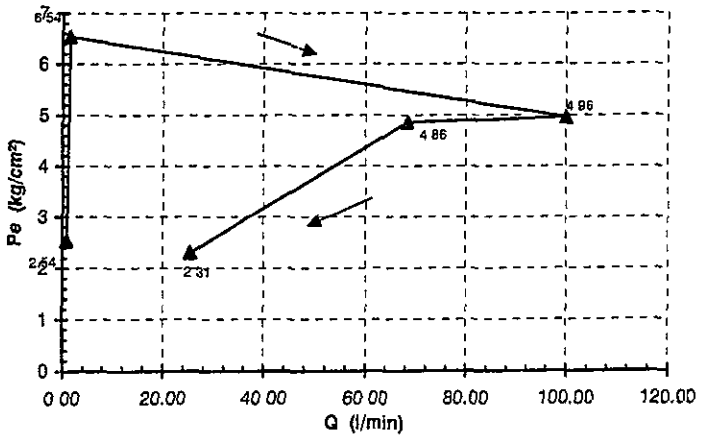
P1= loss load on steel pipe

$$P_2 = \frac{10.34 * (n_2)^2 * (Q_2^2) * lm}{(\phi_2^{5.33})}$$

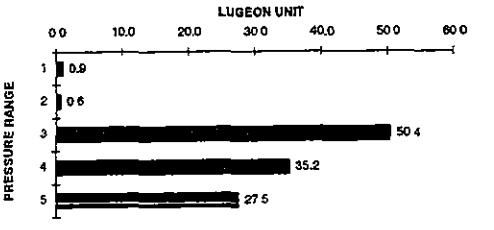
P2= loss load on plastic pipe

$$P_3 = \sum \alpha * (Q_1)$$

P3= loss load on reducciones, valvulas y uniones



VALUES OF LUGEON UNIT



PERMEABILITY (LU) = 50.4

Po = Pressure Reading, Lh = Hydrostatic Load; Plo = Loss Pressure.

317

PERMEABILITY TEST

swissboring
Swissboring Overseas Corporation Ltd.

CLIENT: ELECTRIC POWER DEVELOPMENT Co.	DATE: 31-enero-2003	LUGEON TEST Nº: 2
PROJECT:TOROLA HYDROELECTRIC COMPLEX	SITE DAM SITE (left margin)	TESTED BY J. VALLECILLOS Y M. PAZ
HOLE No.: CDB-6A	ELEVATION: 228.54 m.s.l	CHECKED BY: LUIS ZAVALA

Packer type	Neumatic	Length (m) =	0 80	Water pump	Bean Royal 535	Flood (l/min) =	
				Test depth (m) from:	36 00	to:	41 00
Test length (cm).		L * Cos X º =	500 00	Depth of hole (m):	41 00	Dip X (º)=	0
Swivel H1 (m):		H1 =	2 25	Hole diameter D (cm)	9 60	W L. Before of test (m)=	33
Water level Ha (m)	33	Ha * Cos X º =	33.00	Hydrostatic load (kg/cm2)	Lh= (H1+Ha)/10 =		3.525

Steel pipe:	Length (m) =	lt	= 37 45	Plastic Pipe.	Length (m)	lm	= 6 00	Reducers.	Valv cuopling: 0.2
	Diameter ϕ_1	(m)	= 0 0778		Diameter ϕ_2	(m)	= 0.0254	α	Packer. 0 12
	Roughness index	n1	= 0 01		Roughness index	n2:	0 008		Union elbow. 0 008

PRESSURE READING Po (kg/cm²)	LOSS PRESSURE Plo=P1+P2+P3 (kg/cm²)	EFECTIVE PRESSURE Pe =Po -Lh - Plo (kg/cm²)	INJECTED TIME t (min)	WATER VOLUME Qt (l)	FLOOD Q=Qt/t (l/min)	FLOOD Q1=Q/60000 (m³/s)	FLOOD Q2=Q*100/6 (cm³/s)	SPECIFIC ABSOPTION Ae = Q / L (l/min/m)	LUGEON UNIT $UL = \frac{10 * Ae}{Pe}$ UL	PERMEABILITY COEFICIENT $K = \frac{Q2}{2\pi Pe L} * ln\frac{2L}{D}$ (cm/s)
1.00	0 00003	4 52	10	3.00	0 30	5 00E-06	5.00	0.06	0.1	1 63E-06
5 00	0.00023	8.52	10	8.00	0.80	1 33E-05	13.33	0.16	0 2	2 31E-06
10 00	0.00036	13.52	10	10.00	1 00	1 67E-05	16.67	0 20	0.1	1.82E-06
5.00	0 00018	8 52	10	7 00	0.70	1.17E-05	11 67	0 14	0 2	2.02E-06
1 00	0 00000	4 52	10	1.00	0 10	1.67E-06	1.67	0 02	0 0	5.45E-07

TOTAL LOSS LOAD

$$Pc = Pc_1 + Pc_2 + Pc_3$$

$$P_1 = \frac{10.34 * (n_1)^2 * (Q_1^2) * lt}{(\phi_1^{5.33})}$$

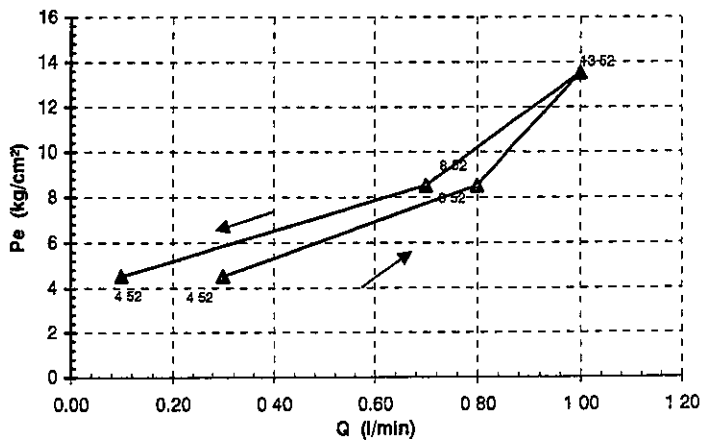
P1= loss load on steel pipe

$$P_2 = \frac{10.34 * (n_2)^2 * (Q_2^2) * lm}{(\phi_2^{5.33})}$$

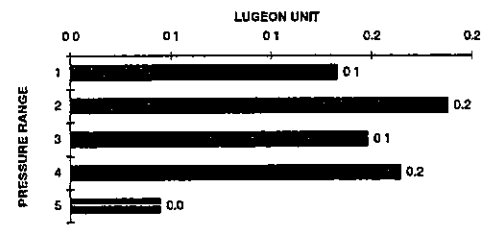
P2= loss load on plastic pipe

$$P_3 = \sum \alpha * (Q_1)$$

P3= loss load on reducciones, valvulas y uniones



VALUES OF LUGEON UNIT



PERMEABILITY (LU) = 0.1

Po = Pressure Reading; Lh = Hydrostatic Load; Plo = Loss Pressure.

PERMEABILITY TEST

swissboring
Swissboring Overseas Corporation Ltd.

CLIENT: ELECTRIC POWER DEVELOPMENT Co.	DATE: 31-enero-2003	LUGEON TEST Nº: 3
PROJECT:TOROLA HYDROELECTRIC COMPLEX	SITE: DAM SITE (left margin)	TESTED BY J. VALLECILLOS Y M. PAZ
HOLE No.: CDB-6A	ELEVATION: 228.54 m.s.l	CHECKED BY. LUIS ZAVALA

Packer type.	Neumatic	Length (m) =	0 80	Water pump	Bean Royal 535	Flood (l/min) =	
				Test depth (m) from.	41 00	to	46 00
Test length (cm)		L * Cos X º =	500 00	Depth of hole (m)	46.00	Dip X (º)=	0
Swivel H1 (m):		H1 =	1.25	Hole diameter D (cm):	9.60	W L Before of test (m)=	11 26
Water level Ha (m)	11.26	Ha * Cos X º =	11 26	Hydrostatic load (kg/cm2)	Lh= (H1+Ha)/10 =		1.251

Steel pipe.	Length (m) =	lt	=	41 45	Plastic Pipe.	Length (m)	lm	= 6.00	Reducers.	Valv cuopling:	0.2
	Diameter ϕ_1	(m)	=	0 0778		Diameter ϕ_2	(m)	= 0 0254	α	Packer.	0 12
	Roughness index	n1	=	0 01		Roughness index	n2:	0.008		Union elbow:	0 008

PRESSURE READING Po (kg/cm²)	LOSS PRESSURE Plo=P1+P2+P3 (kg/cm²)	EFECTIVE PRESSURE Pe = Po + Lh - Plo (kg/cm²)	INJECTED TIME t (min)	WATER VOLUME Qt (l)	FLOOD Q=Qt/t (l/min)	FLOOD Q1=Q/60000 (m³/s)	FLOOD Q2=Q*100/6 (cm²/s)	SPECIFIC ABSOPTION Ae = Q / L (l/min/m)	LUGEON UNIT $UL = \frac{10 * Ae}{Pe}$ UL	PERMEABILITY COEFICIENT $K = \frac{Q2}{2\pi Pe\ L} * \ln\frac{2L}{D}$ (cm/s)
1.00	0 02368	2 23	10	81.00	8 10	1.35E-04	135 00	1 62	7 3	8.96E-05
5.00	0 69774	5 55	10	440.00	44 00	7 33E-04	733.33	8 80	15.8	1.95E-04
10.00	4.76533	6.49	10	1150 00	115.00	1.92E-03	1916.67	23.00	35.5	4.37E-04
5.00	1 90982	4 34	10	728.00	72 80	1 21E-03	1213.33	14.56	33.5	4.13E-04
1.00	0.27261	1.98	10	275 00	27.50	4 58E-04	458 33	5 50	27 8	3 43E-04

TOTAL LOSS LOAD

$$Pc = Pc_1 + Pc_2 + Pc_3$$

$$P_1 = \frac{10.34 * (n_1)^2 * (Q_1^2) * lt}{(\phi_1^{5.33})}$$

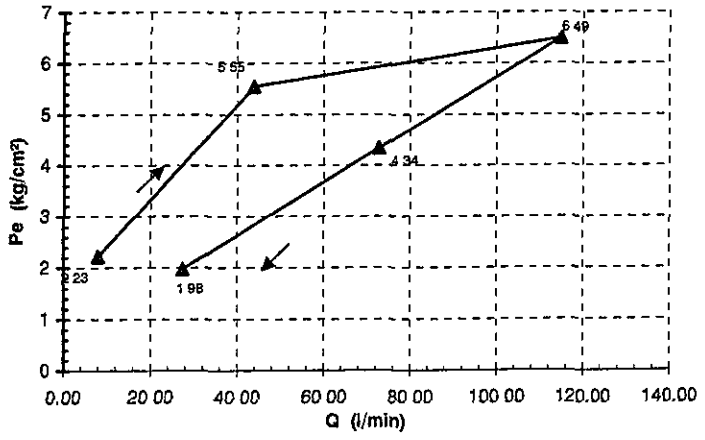
P1= loss load on steel pipe

$$P_2 = \frac{10.34 * (n_2)^2 * (Q_2^2) * lm}{(\phi_2^{5.33})}$$

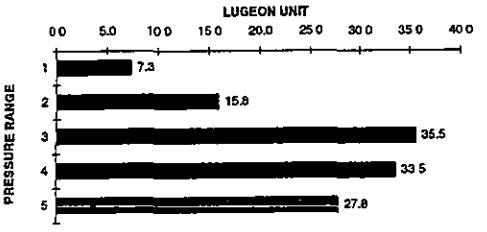
P2= loss load on plastic pipe

$$P_3 = \sum \alpha * (Q_1)$$

P3= loss load on reducciones, valvulas y uniones



VALUES OF LUGEON UNIT



PERMEABILITY (LU) = 35.5

Po = Pressure Reading; Lh = Hydrostatic Load; Plo = Loss Pressure.

PERMEABILITY TEST

swissboring
Swissboring Overseas Corporation Ltd.

CLIENT: ELECTRIC POWER DEVELOPMENT Co.	DATE: 1-febrero-2003	LUGEON TEST Nº: 4
PROJECT: TOROLA HYDROELECTRIC COMPLEX	SITE: DAM SITE (left margin)	TESTED BY J. VALLECILLOS Y M. PAZ
HOLE No.. CDB-6A	ELEVATION: 228.54 m.s.l	CHECKED BY. LUIS ZAVALA

Packer type: Neumatic — Length (m) = 0.80 — Water pump: Bean Royal 535 — Flood (l/min) =

Test depth (m) from. 46 00 *to* 50 00

Test length (cm): L * Cos X° = 400 00 — Depth of hole (m). 50 00 — Dip X (°)= 0

Swivel H1 (m): H1 = 0 80 — Hole diameter D (cm) 9 60 — W L Before of test (m)= 37 35

Water level Ha (m): 37 35 — Ha * Cos X° = 37 35 — Hydrostatic load (kg/cm2) Lh= (H1+Ha)/10 = 3 815

Steel pipe:	Length (m) =	lt = 46.00	Plastic Pipe.	Length (m)	lm = 6.00	Reducers:	Valv cuopling:	0 2
	Diameter ϕ_1	(m) = 0 0778		Diameter ϕ_2	(m) = 0 0254	α	Packer	0 12
	Roughness index	n1 = 0 01		Roughness index	n2 0 008		Union elbow	0.008

PRESSURE READING Po (kg/cm²)	LOSS PRESSURE Plo=P1+P2+P3 (kg/cm²)	EFECTIVE PRESSURE Pe =Po +Lh - Plo (kg/cm²)	INJECTED TIME t (min)	WATER VOLUME Qt (l)	FLOOD Q=Qt/t (l/min)	FLOOD Q1=Q/60000 (m³/s)	FLOOD Q2=Q*100/6 (cm³/s)	SPECIFIC ABSOPTION Ae = Q / L (l/min/m)	LUGEON UNIT UL = 10* Ae / Pe UL	PERMEABILITY COEFICIENT $K = \frac{Q2}{2\pi Pc\ L} * \ln\frac{2L}{D}$ (cm/s)
1.00	0.00870	4 81	10	49.00	4.90	8.17E-05	81 67	1 23	2.5	2.99E-05
5 00	0 15197	8 66	10	205.00	20.50	3.42E-04	341 67	5 13	5.9	6.94E-05
10.00	1.34931	12.47	10	611.00	61 10	1.02E-03	1018.33	15 28	12 3	1.44E-04
5.00	0 13751	8 68	10	195 00	19.50	3.25E-04	325.00	4.88	5.6	6 59E-05
1 00	0 00580	4 81	10	40.00	4.00	6 67E-05	66.67	1.00	2.1	2 44E-05

TOTAL LOSS LOAD

$$Pc = Pc_1 + Pc_2 + Pc_3$$

$$P_1 = \frac{10.34 * (n_1)^2 * (Q_1^2) * lt}{(\phi_1^{5.33})}$$

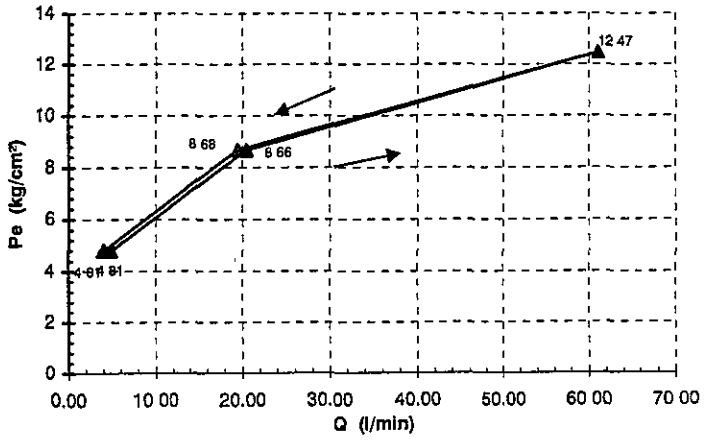
P1= loss load on steel pipe

$$P_2 = \frac{10.34 * (n_2)^2 * (Q_2^2) * lm}{(\phi_2^{5.33})}$$

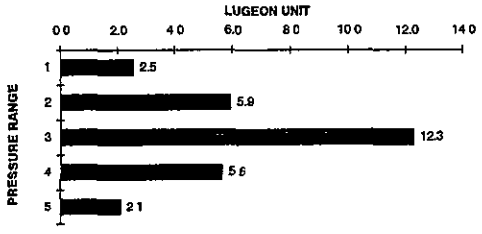
P2= loss load on plastic pipe

$$P_3 = \sum \alpha * (Q_1)$$

P3= loss load on reducciones, valvulas y uniones



VALUES OF LUGEON UNIT



PERMEABILITY (LU) = 12.3

Po = Pressure Reading; Lh = Hydrostatic Load, Plo = Loss Pressure

PERMEABILITY TEST

swissboring
Swissboring Overseas Corporation Ltd.

CLIENT. ELECTRIC POWER DEVELOPMENT Co.	DATE: 1-febrero-2003	LUGEON TEST N°: 5
PROJECT:TOROLA HYDROELECTRIC COMPLEX	SITE: DAM SITE (left margin)	TESTED BY J. VALLECILLOS Y M. PAZ
HOLE No.: CDB-6A	ELEVATION. 228.54 m.s.l	CHECKED BY: LUIS ZAVALA

Packer type. Neumatic Length (m) = 0 80 Water pump. Bean Royal 535 Flood (l/min) =

Test depth (m) from 50 00 to: 55 00

Test length (cm): L * Cos X° = 500 00 Depth of hole (m) 55 00 Dip X (°)= 0

Swivel H1 (m): H1 = 1 55 Hole diameter D (cm) 9 60 W.L Before of test (m)= 15.56

Water level Ha (m): 15.56 Ha * Cos X° = 15 56 Hydrostatic load (kg/cm2): Lh= (H1+Ha)/10 = 1 711

Steel pipe:	Length (m) =	lt	=	50.75	Plastic Pipe.	Length (m)	lm	= 6 00	Reducers.	Valv cuopling: 0 2
	Diameter ϕ_1	(m)	=	0 0778		Diameter ϕ_2	(m)	= 0 0254	α	Packer 0 12
	Roughness index	n1	=	0 01		Roughness index	n2:	0 008		Union elbow 0 008

PRESSURE READING Po (kg/cm²)	LOSS PRESSURE Plo=P1+P2+P3 (kg/cm²)	EFECTIVE PRESSURE Pe = Po + Lh - Plo (kg/cm²)	INJECTED TIME t (min)	WATER VOLUME Qt (l)	FLOOD Q=Qt/t (l/min)	FLOOD Q1=Q/60000 (m³/s)	FLOOD Q2=Q*100/6 (cm³/s)	SPECIFIC ABSOPTION Ae = Q / L (l/min/m)	LUGEON UNIT UL = 10* Ae / Pe UL	PERMEABILITY COEFICIENT K = Q 2 / 2 π Pe L * ln 2L / D (cm/s)
1.00	0.01308	2 70	10	60.00	6.00	1.00E-04	100 00	1.20	4.4	5 48E-05
5.00	0 28027	6 43	10	278.00	27 80	4 63E-04	463 33	5.56	8.6	1.07E-04
10 00	4 89468	6 82	10	1162 00	116.20	1 94E-03	1936.67	23 24	34.1	4.20E-04
5.00	1 86374	4 85	10	717.00	71.70	1.20E-03	1195.00	14.34	29.6	3 65E-04
1.00	0 75393	1.96	10	456 00	45 60	7 60E-04	760 00	9.12	46.6	5.74E-04

TOTAL LOSS LOAD

$$Pc = Pc_1 + Pc_2 + Pc_3$$

$$P_1 = \frac{10.34 * (n_1)^2 * (Q_1^2) * lt}{(\phi_1^{5.33})}$$

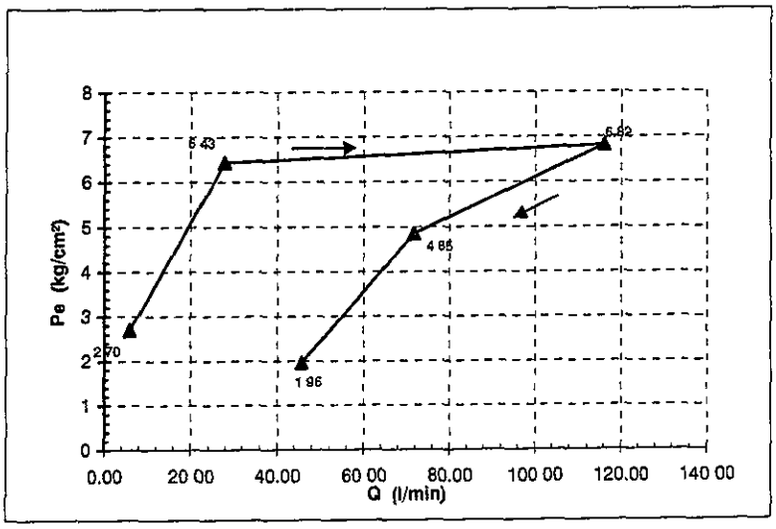
$$P_2 = \frac{10.34 * (n_2)^2 * (Q_2^2) * lm}{(\phi_2^{5.33})}$$

$$P_3 = \sum \alpha * (Q_1)$$

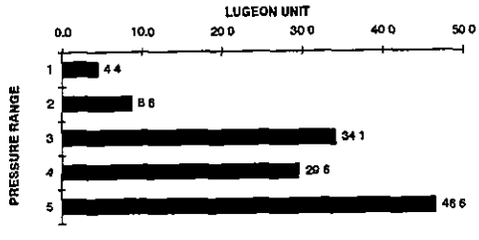
P1= loss load on steel pipe

P2= loss load on plastic pipe

P3= loss load on reducciones, valvulas y uniones



VALUES OF LUGEON UNIT



PERMEABILITY (LU) = 34.1

Po = Pressure Reading; Lh = Hydrostatic Load, Plo = Loss Pressure

PERMEABILITY TEST

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Swissboring Overseas Corporation Ltd.

CLIENT: ELECTRIC POWER DEVELOPMENT Co.	DATE: 2-febrero-2003	LUGEON TEST Nº 6
PROJECT TOROLA HYDROELECTRIC COMPLEX	SITE. DAM SITE (left margin)	TESTED BY J. VALLECILLOS Y M. PAZ
HOLE No.: CDB-6A	ELEVATION: 228.54 m.s.l	CHECKED BY: LUIS ZAVALA

Packer type	Neumatic	Length (m) =	0 80	Water pump:	Bean Royal 535	Flood (l/min) =	
				Test depth (m) from	55.00	to.	60 00
Test length (cm):		L * Cos X ° =	500 00	Depth of hole (m).	60 00	Dip X (°)=	0
Swivel H1 (m)		H1 =	2 15	Hole diameter D (cm):	9 60	W L Before of test (m)=	11.31
Water level Ha (m).	11.31	Ha * Cos X ° =	11.31	Hydrostatic load (kg/cm2):	Lh= (H1+Ha)/10 =		1 346

Steel pipe.	Length (m) =	lt	=	56 35	Plastic Pipe.: Length (m)	lm	= 6 00	Reducers.	Valv cuopling: 0 2
	Diameter ϕ_1	(m)	=	0 0778	Diameter ϕ_2	(m)	= 0 0254	α	Packer 0 12
	Roughness index	n1	=	0 01	Roughness index	n2.	0 008		Union elbow 0 008

PRESSURE READING	LOSS PRESSURE	EFECTIVE PRESSURE	INJECTED TIME	WATER VOLUME	FLOOD			SPECIFIC ABSOPTION	LUGEON UNIT	PERMEABILITY COEFICIENT
Po	Plo=P1+P2+P3	Pe =Po +Lh - Plo	t	Qt	Q=Qt/t	Q1=Q/60000	Q2=Q*100/6	Ae = Q / L	$UL = \frac{10^* Ae}{Pe}$	$K = \frac{Q2}{2\pi Pe L} * \ln \frac{2L}{D}$
(kg/cm²)	(kg/cm²)	(kg/cm²)	(min)	(l)	(l/min)	(m³/s)	(cm³/s)	(l/min/m)	U L	(cm/s)
1 00	0 01786	2 33	10	70 00	7.00	1 17E-04	116 67	1 40	6.0	7 41E-05
5.00	0 09913	6 25	10	165.00	16.50	2.75E-04	275 00	3.30	5.3	6.51E-05
10.00	1 46715	9 88	10	635 00	63.50	1 06E-03	1058.33	12.70	12.9	1 58E-04
5 00	0 62371	5 72	10	414.00	41.40	6.90E-04	690.00	8.28	14.5	1.78E-04
1.00	0 23298	2.11	10	253.00	25 30	4.22E-04	421.67	5 06	23 9	2 95E-04

TOTAL LOSS LOAD

$$Pc = Pc_1 + Pc_2 + Pc_3$$

$$P_1 = \frac{10.34 * (n_1)^2 * (Q_1^2) * lt}{(\phi_1^{5.33})}$$

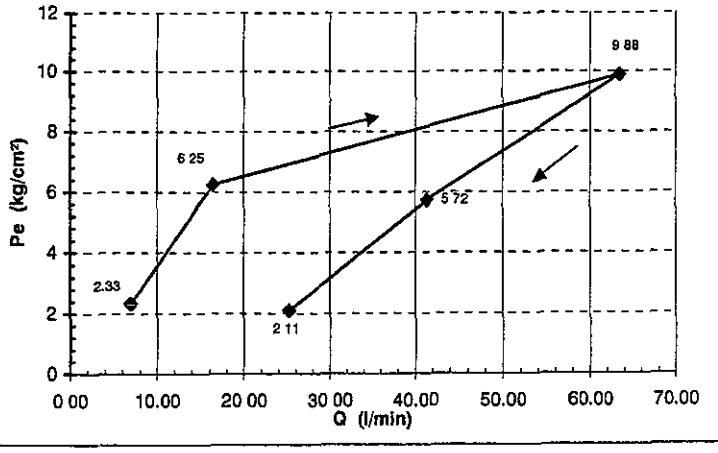
P1= loss load on steel pipe

$$P_2 = \frac{10.34 * (n_2)^2 * (Q_2^2) * lm}{(\phi_2^{5.33})}$$

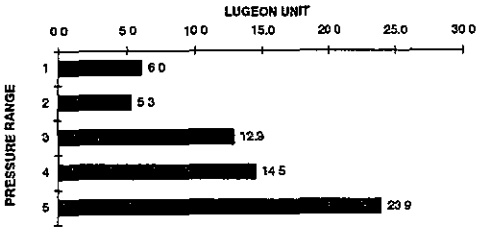
P2= loss load on plastic pipe

$$P_3 = \sum \alpha * (Q_1)$$

P3= loss load on reducciones, valvulas y uniones



VALUES OF LUGEON UNIT



PERMEABILITY (LU) = 12 9

Po = Pressure Reading, Lh = Hydrostatic Load, Plo = Loss Pressure

PERMEABILITY TEST

swissboring
Swissboring Overseas Corporation Ltd.

CLIENT: ELECTRIC POWER DEVELOPMENT Co.	DATE: 3-febrero-2003	LUGEON TEST Nº: 7
PROJECT:TOROLA HYDROELECTRIC COMPLEX	SITE: DAM SITE (left margin)	TESTED BY J. VALLECILLOS Y M. PAZ
HOLE No.: CDB-6A	ELEVATION: 228.54 m.s.l	CHECKED BY: LUIS ZAVALA

Packer type.	Neumatic	Length (m) =	0 80	Water pump:	Bean Royal 535	Flood (l/min) =	
				Test depth (m) from	60.00	to	65 00
Test length (cm).		L * Cos X ° =	500 00	Depth of hole (m)	65.00	Dip X (°)=	0
Swivel H1 (m):		H1 =	0.70	Hole diameter D (cm)	9 60	W L Before of test (m)=	13.15
Water level Ha (m)	13 15	Ha * Cos X ° =	13.15	Hydrostatic load (kg/cm2):	Lh= (H1+Ha)/10 =		1 385

Steel pipe.	Length (m) =	lt	=	59 90	Plastic Pipe.	Length (m)	lm	= 6 00	Reducers.	Valv. cuopling:	0 2
	Diameter ϕ_1	(m)	=	0.0778		Diameter ϕ_2	(m)	= 0 0254	α	Packer:	0 12
	Roughness index	n1	=	0 01		Roughness index	n2:	0 008		Union elbow.	0 008

PRESSURE READING	LOSS PRESSURE	EFECTIVE PRESSURE	INJECTED TIME	WATER VOLUME	FLOOD			SPECIFIC ABSOPTION	LUGEON UNIT	PERMEABILITY COEFICIENT
Po	Plo=P1+P2+P3	Pe = Po + Lh - Plo	t	Qt	Q=Qt/t	Q1=Q/60000	Q2=Q*100/6	Ae = Q / L	UL = 10* Ae / Pe	K = Q 2 / 2 π Pe L * ln 2L / D
(kg/cm²)	(kg/cm²)	(kg/cm²)	(min)	(l)	(l/min)	(m³/s)	(cm³/s)	(l/min/m)	U L	(cm/s)
1.00	0 00133	2 38	10	19.00	1 90	3.17E-05	31 67	0 38	1 6	1.96E-05
5 00	0.22619	6.16	10	249.00	24 90	4 15E-04	415.00	4.98	8.1	9.97E-05
10.00	3 90623	7 48	10	1035 00	103 50	1.73E-03	1725 00	20.70	27.7	3 41E-04
5.00	1.54078	4 84	10	650.00	65.00	1 08E-03	1083.33	13.00	26.8	3.31E-04
1 00	0.62816	1.76	10	415.00	41 50	6.92E-04	691 67	8 30	47 2	5 82E-04

TOTAL LOSS LOAD

$$Pc = Pc_1 + Pc_2 + Pc_3$$

$$P_1 = \frac{10.34 * (n_1)^2 * (Q_1^2) * lt}{(\phi_1^{5.33})}$$

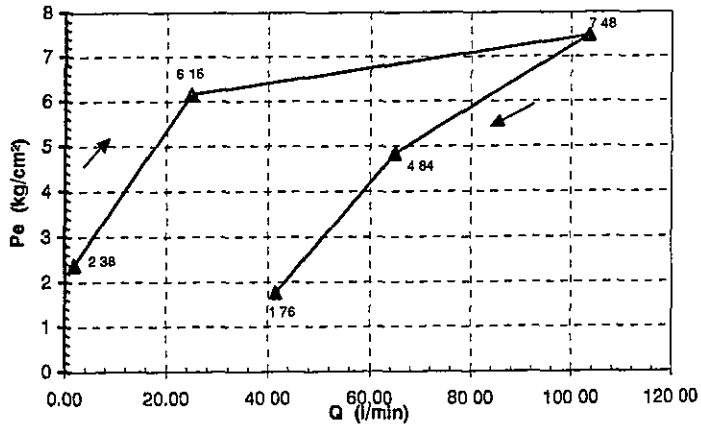
P1= loss load on steel pipe

$$P_2 = \frac{10.34 * (n_2)^2 * (Q_2^2) * lm}{(\phi_2^{5.33})}$$

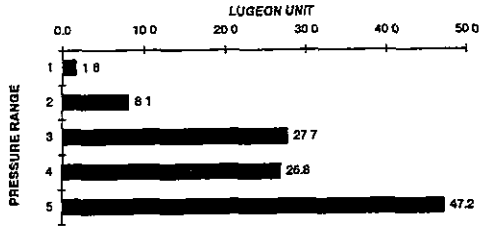
P2= loss load on plastic pipe

$$P_3 = \sum \alpha * (Q_1)$$

P3= loss load on reducciones, valvulas y uniones



VALUES OF LUGEON UNIT



PERMEABILITY (LU) = 27.7

Po = Pressure Reading; Lh = Hydrostatic Load, Plo = Loss Pressure.

323

PERMEABILITY TEST

swissboring
Swissboring Overseas Corporation Ltd.

CLIENT: ELECTRIC POWER DEVELOPMENT Co.	DATE: 3-febrero-2003	LUGEON TEST Nº: 8
PROJECT: TOROLA HYDROELECTRIC COMPLEX	SITE: DAM SITE (left margin)	TESTED BY J. VALLECILLOS Y M. PAZ
HOLE No.: CDB-6A	ELEVATION: 228.54 m.s.l	CHECKED BY: LUIS ZAVALA

Packer type:	Neumatic	Length (m) =	0 80	Water pump:	Bean Royal 535	Flood (l/min) =	
				Test depth (m) from	65 00	to	70 00
Test length (cm)		L * Cos X ° =	500 00	Depth of hole (m):	70 00	Dip X (°)=	0
Swivel H1 (m):		H1 =	1 15	Hole diameter D (cm):	9 60	W L Before of test (m)=	13 59
Water level Ha (m)	13.59	Ha * Cos X ° =	13 59	Hydrostatic load (kg/cm2):	Lh= (H1+Ha)/10 =		1 474

Steel pipe:	Length (m) =	lt	=	65 35	Plastic Pipe :	Length (m)	lm =	6 00	Reducers:	Valv cuopings	0 2
	Diameter ϕ_1	(m)	=	0 0778		Diameter ϕ_2	(m)	= 0 0254	α	Packer:	0 12
	Roughness Index	n1	=	0 01		Roughness index	n2	0 008		Union elbow	0.008

PRESSURE READING	LOSS PRESSURE	EFECTIVE PRESSURE	INJECTED TIME	WATER VOLUME	FLOOD			SPECIFIC ABSOPTION	LUGEON UNIT	PERMEABILITY COEFICIENT
Po	Plo=P1+P2+P3	Pe = Po + Lh - Plo	t	Qt	Q=Qt/t	Q1=Q/60000	Q2=Q*100/6	Ae = Q / L	$UL = \frac{10 * Ae}{Pe}$	$K = \frac{Q2}{2 \pi Pe L} * \ln \frac{2L}{D}$
(kg/cm²)	(kg/cm²)	(kg/cm²)	(min)	(l)	(l/min)	(m³/s)	(cm³/s)	(l/min/m)	U L	(cm/s)
1.00	0.00917	2 46	10	50 00	5 00	8 33E-05	83.33	1.00	4 1	5.00E-05
5.00	0.04761	6 43	10	114 00	11 40	1 90E-04	190 00	2.28	3 5	4.37E-05
10.00	3.57923	7 89	10	989 00	98 90	1 65E-03	1648 33	19.78	25 1	3 09E-04
5.00	1.33510	5 14	10	604 00	60 40	1 01E-03	1006 67	12.08	23 5	2 90E-04
1.00	0.29734	2 18	10	285 00	28 50	4.75E-04	475 00	5 70	26 2	3 23E-04

TOTAL LOSS LOAD

$$Pc = Pc_1 + Pc_2 + Pc_3$$

$$P_1 = \frac{10.34 * (n_1)^2 * (Q_1^2) * lt}{(\phi_1^{5.33})}$$

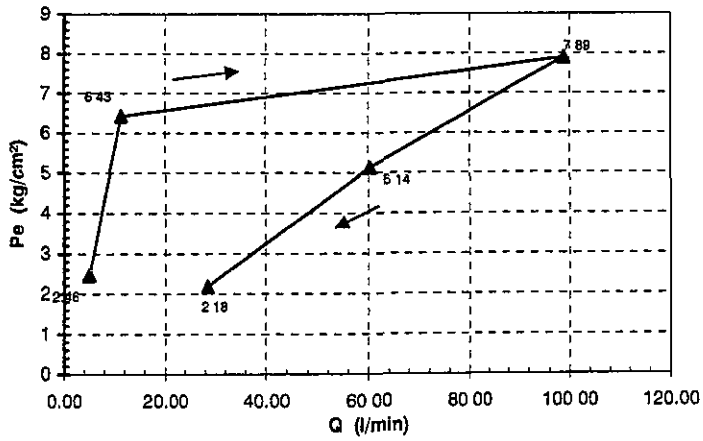
P1= loss load on steel pipe

$$P_2 = \frac{10.34 * (n_2)^2 * (Q_2^2) * lm}{(\phi_2^{5.33})}$$

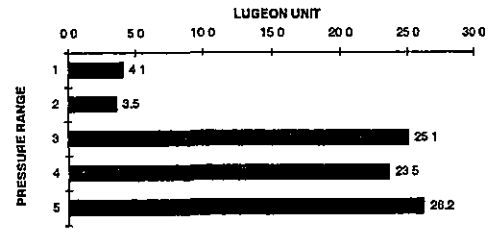
P2= loss load on plastic pipe

$$P_3 = \sum \alpha * (Q_1)$$

P3= loss load on reducciones, valvulas y uniones



VALUES OF LUGEON UNIT



PERMEABILITY (LU) = 25.1

Po = Pressure Reading; Lh = Hydrostatic Load, Plo = Loss Pressure.

PERMEABILITY TEST

swissboring
Swissboring Overseas Corporation Ltd.

CLIENT: ELECTRIC POWER DEVELOPMENT Co.	DATE 12-diciembre-2001	LUGEON TEST N° 1
PROJECT TOROLA HYDROELECTRIC COMPLEX	SITE DAM SITE (left margin)	TESTED BY Geols. L.Peréz- R. Alvarado
HOLE No. CDB-7	ELEVATION 184.06 m.s.l	CHECKED BY· Geol.W. Hernández

Packer type	Neumatic	Length (m) =	0 80	Water pump	Bean Royal 535	Flood (l/min) =	
				Test depth (m) from	10 00	to	15 00
Test length (cm)		L * Cos X ° =	500 00	Depth of hole (m)	15 00	Dip X (°)=	0
Swivel H1 (m)		H1 =	1 60	Diameter of hole D (cm)	7 57	W L Before of test (m)=	9 5
Water level Ha (m)	9 5	Ha * Cos X ° =	9 50	Hydrostatic load (kg/cm2)	Lh= (H1+Ha)/10 =		1 110
Steel pipe.	Length (m) =	lt =	5 00	Plastic Pipe. Length (m)	1 m = 5 00	Reducciones.	Valv uniones: 0 2
	Diameter ϕ_1	(m) =	0 0603	Diameter ϕ_2	(m) = 0 0254	α	Packer 0 12
	Coef rugosidad	n1 =	0 01	Coef rugosidad	n2 = 0 008		Codo 0 008

PRESSURE READING Po (kg/cm²)	LOSS PRESSURE Plo=P1+P2+P3 (kg/cm²)	EFECTIVE PRESSURE Pe =Po +Lh - Plo (kg/cm²)	INJECTED TIME t (min)	WATER VOLUME Qt (l)	FLOOD Qo=Qt/t (l/min)	FLOOD Q1=Q/60000 (m³/s)	FLOOD Q2=Q*100/6 (cm³/s)	SPECIFIC ABSOPTION Ae = Q / L (l/min/m)	LUGEON UNIT $UL = \frac{10 * Ae}{Pe}$ UL	PERMEABILITY COEFICIENT $K = \frac{Q2}{2\pi Pe L} * ln\frac{2L}{D}$ (cm/s)
1.00	0 28899	1.82	10	312 00	31 20	5.20E-04	520 00	6 24	34.3	4 44E-04
5 00	1 46253	4.65	10	702 00	70 20	1 17E-03	1170 00	14 04	30 2	3 91E-04
10 00	2 93204	8 18	10	994 00	99 40	1 66E-03	1656 67	19.88	24 3	3.15E-04
5 00	1 62513	4 48	10	740 00	74 00	1 23E-03	1233 33	14.80	33.0	4.27E-04
1 00	0 38901	1 72	10	362 00	36 20	6.03E-04	603 33	7 24	42 1	5 45E-04

TOTAL LOSS LOAD

$$Pc = Pc_1 + Pc_2 + Pc_3$$

$$P_1 = \frac{10.34 * (n_1)^2 * (Q_1^2) * lt}{(\phi_1^{5.33})}$$

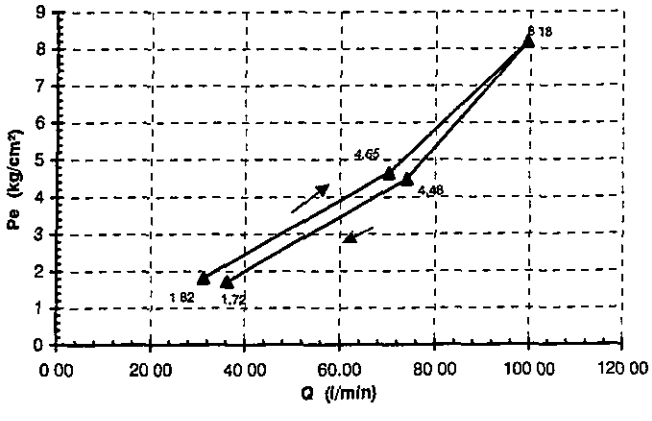
P1= loss load on steel pipe

$$P_2 = \frac{10.34 * (n_2)^2 * (Q_2^2) * lm}{(\phi_2^{5.33})}$$

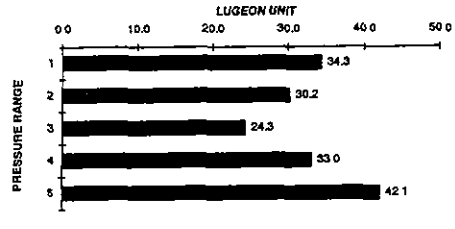
P2= loss load on plastic pipe

$$P_3 = \sum \alpha * (Q_1)$$

P3= loss load on reducciones, valvulas y uniones



VALUES OF LUGEON UNIT



PERMEABILITY (LU) = 24.3

Po = Pressure Reading; Lh = Hydrostatic Load, Plo = Loss Pressure

325

PERMEABILITY TEST

swissboring
Swissboring Overseas Corporation Ltd.

CLIENT. ELECTRIC POWER DEVELOPMENT Co.	DATE 12-diciembre-2001	LUGEON TEST N°. 2
PROJECT TOROLA HYDROELECTRIC COMPLEX	SITE· DAM SITE (left margin)	TESTED BY Geols. L.Peréz- R. Alvarado
HOLE No CDB-7	ELEVATION 184.06 m.s.l	CHECKED BY. Geol.W. Hernández

Packer type	Neumatic	Length (m) =	0 80	Water pump	Bean Royal 535	Flood (l/min) =	
				Test depth (m) from	15 00	to	20 00
Test length (cm)		L * Cos X ° =	500 00	Depth of hole (m)	20 00	Dip X (°)=	0
Swivel H1 (m)		H1 =	2 70	Diameter of hole D (cm)	7 57	W L Before of test (m)=	10 25
Water level Hs (m)	10 25	Ha * Cos X ° =	10 25	Hydrostatic load (kg/cm2)	Lh= (H1+Ha)/10 =		1 295

Steel pipe.	Length (m) =	lt	= 5 00	Plastic Pipe.	Length (m)	1 m = 5 00	Reducciones.	Valv. uniones	0 2
	Diameter ϕ_1	(m)	= 0 0603		Diameter ϕ_2	(m) = 0 0254	α	Packer	0 12
	Coef rugosidad	n1	= 0 01		Coef rugosidad	n2 = 0 008		Codo	0 008

PRESSURE READING Po (kg/cm²)	LOSS PRESSURE Plo=P1+P2+P3 (kg/cm²)	EFECTIVE PRESSURE Pc =Po +Lh -Plo (kg/cm²)	INJECTED TIME t (min)	WATER VOLUME Qt (l)	FLOOD Qo=Qt/t (l/min)	FLOOD Q1=Q/60000 (m³/s)	FLOOD Q2=Q*100/6 (cm³/s)	SPECIFIC ABSOPTION Ae = Q / L (l/min/m)	LUGEON UNIT $UL = \frac{10 * Ae}{Pe}$ UL	PERMEABILITY COERCIENT $K = \frac{Q2}{2\pi Pe L} * \ln \frac{2L}{D}$ (cm/s)
1 00	0 00526	2 29	10	42 00	4 20	7 00E-05	70 00	0 84	3 7	4 75E-05
5 00	0.13346	6 16	10	212 00	21 20	3.53E-04	353 33	4 24	6 9	8 91E-05
10 00	1 29279	10 00	10	660 00	66 00	1 10E-03	1100.00	13 20	13 2	1 71E-04
5.00	0.55652	5 74	10	433 00	43 30	7 22E-04	721 67	8 66	15 1	1 95E-04
1 00	0 04868	2 25	10	128 00	12 80	2 13E-04	213 33	2 56	11 4	1 48E-04

TOTAL LOSS LOAD

$$Pc = Pc_1 + Pc_2 + Pc_3$$

$$P_1 = \frac{10.34 * (n_1)^2 * (Q_1^2) * lt}{(\phi_1^{5.33})}$$

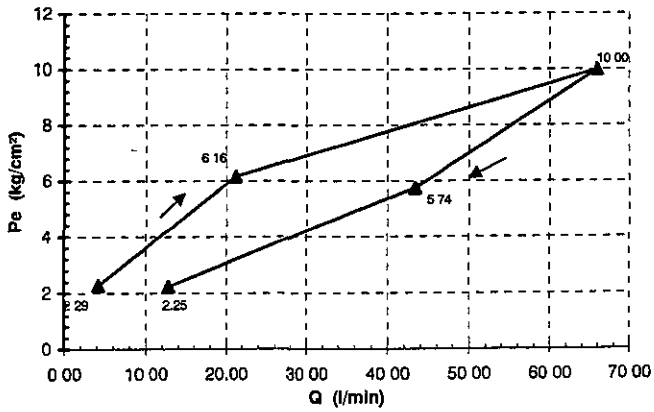
P1= loss load on steel pipe

$$P_2 = \frac{10.34 * (n_2)^2 * (Q_2^2) * lm}{(\phi_2^{5.33})}$$

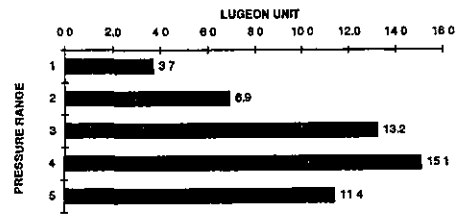
P2= loss load on plastic pipe

$$P_3 = \sum \alpha * (Q_1)$$

P3= loss load on reducciones, valvulas y uniones



VALUES OF LUGEON UNIT



PERMEABILITY (LU) = 13 2

Po = Pressure Reading, Lh = Hydrostatic Load, Plo = Loss Pressure

PERMEABILITY TEST

swissboring
Swissboring Overseas Corporation Ltd.

CLIENT ELECTRIC POWER DEVELOPMENT Co.	DATE 12-diciembre-2001	LUGEON TEST N° 3
PROJECT TOROLA HYDROELECTRIC COMPLEX	SITE DAM SITE (left margin)	TESTED BY Geols. L.Peréz- R. Alvarado
HOLE No CDB-7	ELEVATION. 184.06 m.s.l	CHECKED BY· Geol.W. Hernández

Packer type	Neumatic	Length (m) =	0 80	Water pump	Bean Royal 535	Flood (l/min) =	
				Test depth (m) from	20 00	to	25 00
Test length (cm)		L * Cos X ° =	500 00	Depth of hole (m)	25 00	Dip X (°)=	0
Swivel H1 (m)		H1 =	0 95	Diameter of hole D (cm)	7 57	W L Before of test (m)=	10 25
Water level Ha (m)	*10 25*	*Ha * Cos X ° =*	*10 25*	*Hydrostatic load (kg/cm2)*	*Lh= (H1+Ha)/10*	=	1 120

Steel pipe.	Length (m) =	1t	= 5 00	Plastic Pipe.	Length (m)	1 m	= 5 00	Reducciones.	Valv uniones 0 2
	Diameter ϕ_1	(m)	= 0 0603		Diameter ϕ_2	(m)	= 0 0254	α	Packer 0 12
	Coef rugosidad	n1	= 0 01		Coef rugosidad	n2	= 0 008		Codo 0 008

PRESSURE READING Po (kg/cm²)	LOSS PRESSURE Plo=P1+P2+P3 (kg/cm²)	EFECTIVE PRESSURE Pe = Po +Lh -Plo (kg/cm²)	INJECTED TIME t (min)	WATER VOLUME Qt (l)	FLOOD Qo=Qt/t (l/min)	FLOOD Q1=Q/60000 (m³/s)	FLOOD Q2=Q*100/6 (cm³/s)	SPECIFIC ABSOPTION Ae = Q / L (l/min/m)	LUGEON UNIT $UL = \frac{10 * Ae}{Pe}$ UL	PERMEABILITY COERCIENT $K = \frac{Q2}{2\pi Pe L} * \ln\frac{2L}{D}$ (cm/s)
1 00	0 00000	2 12	10	0.00	0 00	0 00E+00	0 00	0 00	0 0	0 00E+00
5 00	0 00251	6 12	10	29 00	2 90	4 83E-05	48 33	0 58	0 9	1 23E-05
10 00	0 03340	11 09	10	106 00	10 60	1 77E-04	176 67	2.12	1 9	2 48E-05
5 00	0 00715	6 11	10	*49 00*	*4 90*	*8 17E-05*	*81 67*	*0 98*	*1 6*	2 08E-05
1 00	0 00000	2 12	10	0 00	0.00	0 00E+00	0 00	0 00	0 0	0 00E+00

TOTAL LOSS LOAD

$$Pc = Pc_1 + Pc_2 + Pc_3$$

$$P_1 = \frac{10.34 * (n_1)^2 * (Q_1^2) * lt}{(\phi_1^{5.33})}$$

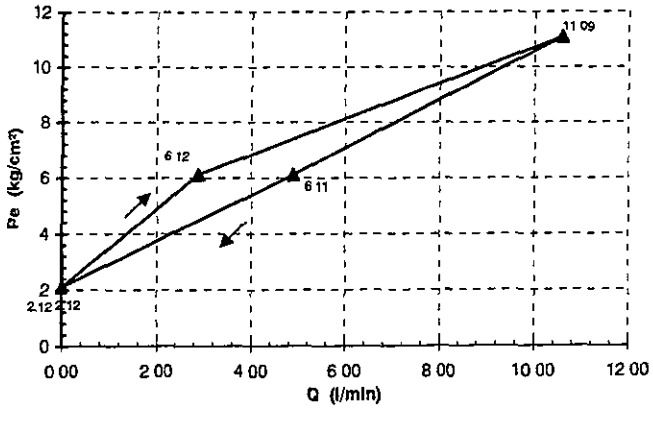
P1= loss load on steel pipe

$$P_2 = \frac{10.34 * (n_2)^2 * (Q_2^2) * lm}{(\phi_2^{5.33})}$$

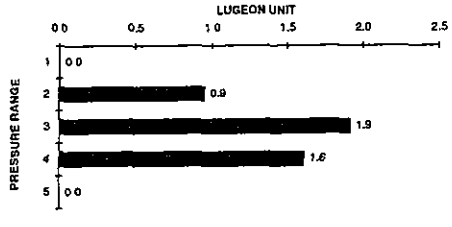
P2= loss load on plastic pipe

$$P_3 = \sum \alpha * (Q_1)$$

P3= loss load on reducciones, valvulas y uniones



VALUES OF LUGEON UNIT



PERMEABILITY (LU) = 1 9

Po = Pressure Reading, Lh = Hydrostatic Load, Plo = Loss Pressure

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PERMEABILITY TEST

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Swissboring Overseas Corporation Ltd.

CLIENT ELECTRIC POWER DEVELOPMENT Co.	DATE: 12-diciembre-2001	LUGEON TEST Nº: 4
PROJECT TOROLA HYDROELECTRIC COMPLEX	SITE: DAM SITE (left margin)	TESTED BY Geols. L.Peréz- R. Alvarado
HOLE No CDB-7	ELEVATION: 184.06 m.s.l	CHECKED BY. Geol.W. Hernández

Packer type	Neumatic	Length (m) =	0 80	Water pump	Bean Royal 535	Flood (l/min) =	
				Test depth (m) from	25 00	to	30 00
Test length (cm)		L * Cos X º =	500 00	Depth of hole (m)	30 00	Dip X (º)=	0
Swivel H1 (m)		H1 =	1 10	Diameter of hole D (cm)	7 57	W L Before of test (m)=	11 05
Water level Ha (m)	11 05	Ha * Cos X º =	11 05	Hydrostatic load (kg/cm2)	Lh= (H1+Ha)/10 =		1 215
Steel pipe	Length (m) =	lt =	5 00	Plastic Pipe	Length (m)	1 m = 5 00	
	Diameter ϕ_1	(m) =	0 0603		Diameter ϕ_2	(m) = 0 0254	
	Coef rugosidad	n1 =	0 01		Coef rugosidad	n2 = 0 008	

Reducciones.		
α	Valv uniones	0 2
	Packer	0 12
	Codo	0 008

PRESSURE READING Po (kg/cm²)	LOSS PRESSURE Plo=P1+P2+P3 (kg/cm²)	EFECTIVE PRESSURE Pe =Po +Lh - Plo (kg/cm²)	INJECTED TIME t (min)	WATER VOLUME Qt (l)	FLOOD Qo=Qt/t (l/min)	FLOOD Q1=Q/60000 (m³/s)	FLOOD Q2=Q*100/6 (cm³/s)	SPECIFIC ABSOPTION Ae = Q / L (l/min/m)	LUGEON UNIT UL = 10* Ae / Pe UL	PERMEABILITY COEFICIENT K = Q 2 / 2 π Pe L * ln 2L / D (cm/s)
1 00	0 00172	2 21	10	24 00	2 40	4 00E-05	40 00	0 48	2 2	2 81E-05
5 00	0 36991	5 85	10	353 00	35 30	5 88E-04	588 33	7 06	12 1	1 56E-04
10 00	1 28496	9 93	10	658 00	65 80	1 10E-03	1096 67	13 16	13 3	1 72E-04
5 00	0 49655	5 72	10	409 00	40 90	6.82E-04	681 67	8 18	14 3	1 85E-04
1 00	0 11760	2 10	10	199 00	19.90	3 32E-04	331 67	3 98	19 0	2 46E-04

TOTAL LOSS LOAD

$$Pc = Pc_1 + Pc_2 + Pc_3$$

$$P_1 = \frac{10.34 * (n_1)^2 * (Q_1^2) * lt}{(\phi_1^{5.33})}$$

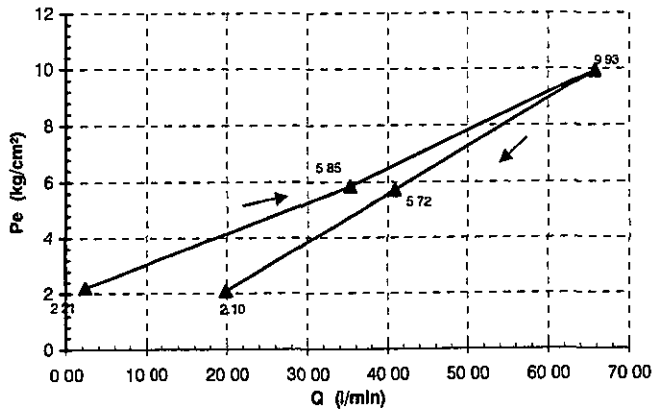
P1= loss load on steel pipe

$$P_2 = \frac{10.34 * (n_2)^2 * (Q_2^2) * lm}{(\phi_2^{5.33})}$$

P2= loss load on plastic pipe

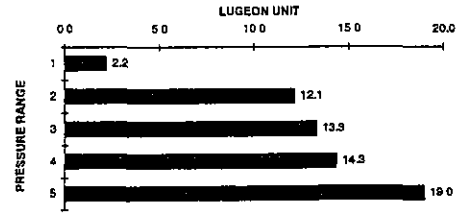
$$P_3 = \sum \alpha * (Q_1)$$

P3= loss load on reducciones, valvulas y uniones



Po = Pressure Reading, Lh = Hydrostatic Load, Plo = Loss Pressure.

VALUES OF LUGEON UNIT



PERMEABILITY (LU) = 13 3

PERMEABILITY TEST

swissboring
Swissboring Overseas Corporation Ltd.

CLIENT: ELECTRIC POWER DEVELOPMENT Co.	DATE 13-diciembre-2001	LUGEON TEST Nº 5
PROJECT:TOROLA HYDROELECTRIC COMPLEX	SITE: DAM SITE (left margin)	TESTED BY Geols. L.Peréz- R. Alvarado
HOLE No : CDB-7	ELEVATION. 184.06 m.s.l	CHECKED BY: Geol.W. Hernández

Packer type	Neumatic	Length (m) =	0 80	Water pump	Bean Royal 535	Flood (l/min) =	
				Test depth (m) from	30 00	to	35 00
Test length (cm)		L * Cos X ° =	500 00	Depth of hole (m)	35 00	Dip X (°)=	0
Swivel H1 (m)		H1 =	2 90	Diameter of hole D (cm)	7 57	W L Before of test (m)=	31 25
Water level Ha (m)	31 25	Ha * Cos X ° =	31 25	Hydrostatic load (kg/cm2)	Lh= (H1+Ha)/10 =		3 415

Steel pipe.	Length (m) =	1t	= 5 00	Plastic Pipe.	Length (m)	1 m = 5 00	Reducciones.	Valv uniones	0 2
	Diameter ϕ_1	(m)	= 0 0603		Diameter ϕ_2	(m) = 0 0254	α	Packer	0 12
	Coef rugosidad	n1	= 0 01		Coef rugosidad	n2 = 0 008		Codo	0 008

PRESSURE READING Po (kg/cm²)	LOSS PRESSURE Plo=P1+P2+P3 (kg/cm²)	EFECTIVE PRESSURE Pe =Po +Lh - Plo (kg/cm²)	INJECTED TIME t (min)	WATER VOLUME Qt (l)	FLOOD Qb=Qt/t (l/min)	FLOOD Q1=Q/60000 (m³/s)	FLOOD Q2=Q*100/6 (cm³/s)	SPECIFIC ABSOPTION Ae = Q / L (l/min/m)	LUGEON UNIT UL = 10* Ae / Pe U L	PERMEABILITY COEFICIENT $K = \frac{Q2}{2\pi Pe\ L} * \ln\frac{2L}{D}$ (cm/s)
1 00	0.31744	4 10	10	327 00	32 70	5 45E-04	545 00	6 54	16.0	2.07E-04
5 00	0.80256	7 61	10	520 00	52 00	8 67E-04	866 67	10 40	13 7	1 77E-04
10.00	2 50086	10 91	10	918 00	91 80	1.53E-03	1530 00	18 36	16 8	2 18E-04
5.00	1.40887	7 01	10	689 00	68 90	1.15E-03	1148 33	13 78	19.7	2 55E-04
1 00	0 49412	3 92	10	408 00	40 80	6 80E-04	680 00	8 16	20 8	2 70E-04

TOTAL LOSS LOAD

$$Pc = Pc_1 + Pc_2 + Pc_3$$

$$P_1 = \frac{10.34 * (n_1)^2 * (Q_1^2) * lt}{(\phi_1^{5.33})}$$

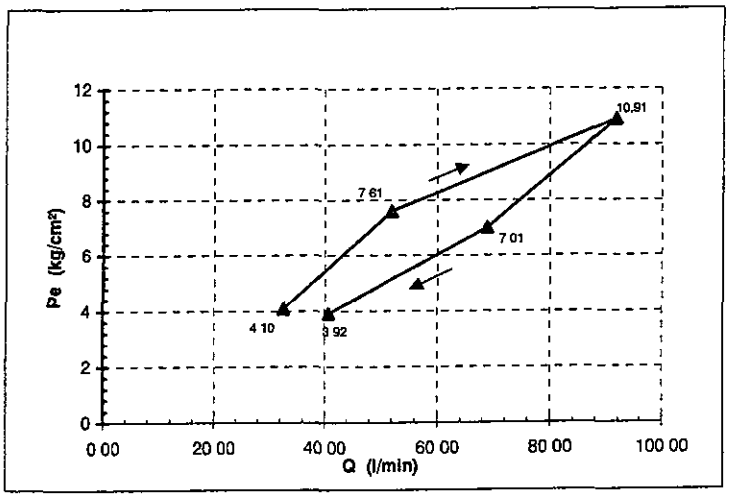
P1= loss load on steel pipe

$$P_2 = \frac{10.34 * (n_2)^2 * (Q_2^2) * lm}{(\phi_2^{5.33})}$$

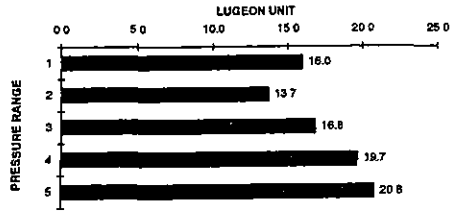
P2= loss load on plastic pipe

$$P_3 = \sum \alpha * (Q_1)$$

P3= loss load on reducciones, valvulas y uniones



VALUES OF LUGEON UNIT



PERMEABILITY (LU) = 16.8

Po = Pressure Reading, Lh = Hydrostatic Load, Plo = Loss Pressure

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PERMEABILITY TEST

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Swissboring Overseas Corporation Ltd.

CLIENT ELECTRIC POWER DEVELOPMENT Co.	DATE 13-diciembre-2001	LUGEON TEST Nº. 6
PROJECT TOROLA HYDROELECTRIC COMPLEX	SITE DAM SITE (left margin)	TESTED BY Geols. L.Peréz- R. Alvarado
HOLE No.: CDB-7	ELEVATION 184.06 m.s.l	CHECKED BY Geol.W. Hernández

Packer type	Neumatic	Length (m) =	0 80	Water pump	Bean Royal 535	Flood (l/min) =	
				Test depth (m) from	35 00	to	40 00
Test length (cm)		L * Cos X ° =	500 00	Depth of hole (m)	40 00	Dip X (°)=	0
Swivel H1 (m)		H1 =	1 00	Diameter of hole D (cm)	7 57	W L Before of test (m)=	28 45
Water level Ha (m)	28 45	Ha * Cos X ° =	28 45	Hydrostatic load (kg/cm2)	Lh= (H1+Ha)/10 =		2 945

Steel pipe.	Length (m) =	1t	= 5 00	Plastic Pipe.	Length (m)	1 m = 5 00	Reducciones.	Valv uniones	0 2
	Diameter ϕ_1	(m)	= 0 0603		Diameter ϕ_2	(m) = 0 0254	α	Packer	0 12
	Coef rugosidad	n1	= 0 01		Coef rugosidad	n2 = 0 008		Codo	0 008

PRESSURE READING Po (kg/cm²)	LOSS PRESSURE Plo=P1+P2+P3 (kg/cm²)	EFECTIVE PRESSURE Pe =Po +Lh - Plo (kg/cm²)	INJECTED TIME t (min)	WATER VOLUME Qt (l)	FLOOD Qo=Qt/t (l/min)	FLOOD Q1=Q/60000 (m³/s)	FLOOD Q2=Q*100/6 (cm³/s)	SPECIFIC ABSOPTION Ae = Q / L (l/min/m)	LUGEON UNIT $UL = \frac{10 * Ae}{Pe}$ UL	PERMEABILITY COEFICIENT $K = \frac{Q2}{2\pi Pe L} * \ln \frac{2L}{D}$ (cm/s)
1.00	0.17389	3 77	10	242 00	24 20	4 03E-04	403 33	4 84	12 8	1 66E-04
5 00	0 75993	7 19	10	506 00	50 60	8 43E-04	843 33	10.12	14 1	1 82E-04
10 00	2 18467	10 76	10	858 00	85 80	1 43E-03	1430 00	17.16	15 9	2 07E-04
5 00	0 98812	6 96	10	577 00	57 70	9 62E-04	961 67	11.54	16 6	2 15E-04
1 00	0 23277	3.71	10	280 00	28 00	4 67E-04	466 67	5 60	15 1	1 95E-04

TOTAL LOSS LOAD

$$Pc = Pc_1 + Pc_2 + Pc_3$$

$$P_1 = \frac{10.34 * (n_1)^2 * (Q_1^2) * lt}{(\phi_1^{5.33})}$$

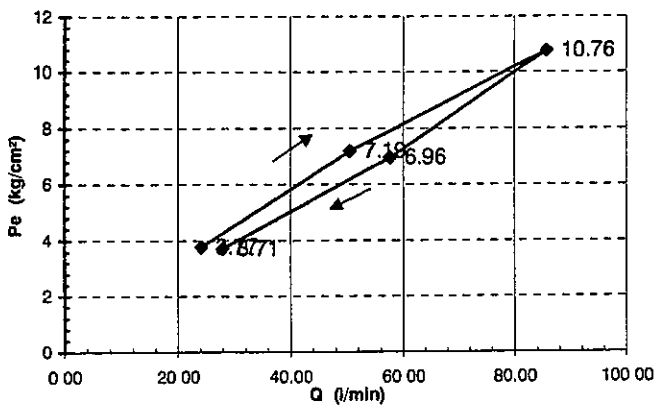
P1= loss load on steel pipe

$$P_2 = \frac{10.34 * (n_2)^2 * (Q_2^2) * lm}{(\phi_2^{5.33})}$$

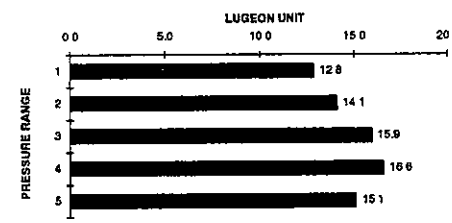
P2= loss load on plastic pipe

$$P_3 = \sum \alpha * (Q_1)$$

P3= loss load on reducciones, valvulas y uniones



VALUES OF LUGEON UNIT



PERMEABILITY (LU) = 15.9

Po = Pressure Reading, Lh = Hydrostatic Load, Plo = Loss Pressure

PERMEABILITY TEST

swissboring
Swissboring Overseas Corporation Ltd.

CLIENT: ELECTRIC POWER DEVELOPMENT Co.	DATE 13-diciembre-2001	LUGEON TEST Nº 7
PROJECT: TOROLA HYDROELECTRIC COMPLEX	SITE DAM SITE (left margin)	TESTED BY Geols. L.Peréz- R. Alvarado
HOLE No.: CDB-7	ELEVATION: 184.06 m.s.l	CHECKED BY Geol.W. Hernández

Packer type	Neumatic	Length (m) =	0 80	Water pump	Bean Royal 535	Flood (l/min) =	
				Test depth (m) from	40 00	to	45 00
Test length (cm)		L * Cos X º =	500 00	Depth of hole (m)	45 00	Dip X (º)=	0
Swivel H1 (m)		H1 =	2 20	Diameter of hole D (cm)	7 57	W L Before of test (m)=	24 15
Water level Ha (m)	24 15	Ha * Cos X º =	24 15	Hydrostatic load (kg/cm2)	Lh= (H1+Ha)/10 =		2 635

Steel pipe	Length (m) =	1t	= 5 00	Plastic Pipe	Length (m)	1 m = 5 00	Reducciones	Valv uniones	0 2
	Diameter ϕ_1	(m)	= 0 0603		Diameter ϕ_2	(m) = 0 0254	α	Packer	0 12
	Coef rugosidad	n1	= 0 01		Coef rugosidad	n2 = 0 008		Codo	0.008

PRESSURE READING	LOSS PRESSURE	EFECTIVE PRESSURE	INJECTED TIME	WATER VOLUME	FLOOD			SPECIFIC ABSOPTION	LUGEON UNIT	PERMEABILITY COEFICIENT
Po	Plo=P1+P2+P3	Pe =Po +Lh - Plo	t	Qt	Qo=Qt/t	Q1=Q/60000	Q2=Q*100/6	Ae = Q / L	UL = 10* Ae / Pe	$K = \frac{Q2}{2\pi Pe\ L} * \ln\frac{2L}{D}$
(kg/cm²)	(kg/cm²)	(kg/cm²)	(min)	(l)	(l/min)	(m³/s)	(cm³/s)	(l/min/m)	U L	(cm/s)
1 00	0 00000	3 64	10	0 00	0 00	0 00E+00	0 00	0 00	0 0	0.00E+00
5 00	0 00234	7 63	10	28 00	2 80	4 67E-05	46 67	0.56	0 7	9 50E-06
10 00	*0.00805*	*12 63*	*10*	*52 00*	*5 20*	*8 67E-05*	*86 67*	1 04	0 8	1.07E-05
5 00	0 00269	7 63	10	30 00	3 00	5 00E-05	50 00	0 60	0 8	1 02E-05
1 00	0 00001	3 63	10	2 00	0 20	3 33E-06	3 33	0 04	0 1	1 43E-06

TOTAL LOSS LOAD

$$Pc = Pc_1 + Pc_2 + Pc_3$$

$$P_1 = \frac{10.34 * (n_1)^2 * (Q_1^2) * lt}{(\phi_1^{5.33})}$$

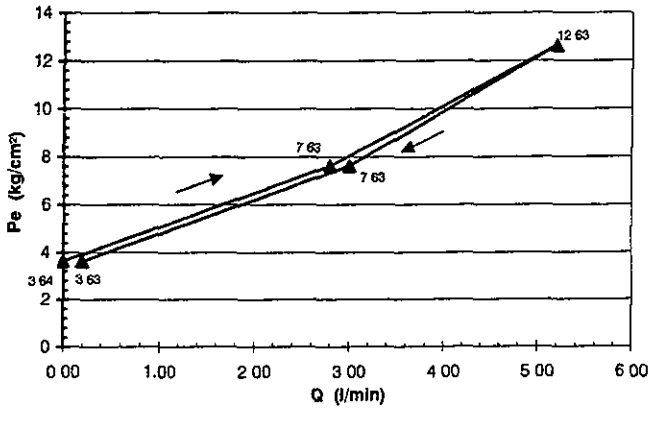
P1= loss load on steel pipe

$$P_2 = \frac{10.34 * (n_2)^2 * (Q_2^2) * lm}{(\phi_2^{5.33})}$$

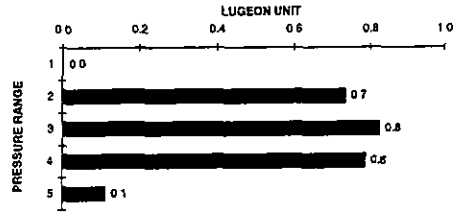
P2= loss load on plastic pipe

$$P_3 = \sum \alpha * (Q_1)$$

P3= loss load on reducciones, valvulas y uniones



VALUES OF LUGEON UNIT



PERMEABILITY (LU) = 0 8

Po = Pressure Reading, Lh = Hydrostatic Load, Plo = Loss Pressure

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PERMEABILITY TEST

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Swissboring Overseas Corporation Ltd.

CLIENT: ELECTRIC POWER DEVELOPMENT Co.	DATE 13-diciembre-2001	LUGEON TEST Nº 8
PROJECT TOROLA HYDROELECTRIC COMPLEX	SITE DAM SITE (left margin)	TESTED BY Geols. L.Peréz- R. Alvarado
HOLE No.: CDB-7	ELEVATION 184.06 m.s.l	CHECKED BY Geol.W. Hernández

Packer type	Neumatic	Length (m) =	0 60	Water pump	Bean Royal 535	Flood (l/min) =	
				Test depth (m) from	45 00	to	50 00
Test length (cm)		L * Cos X ° =	500 00	Depth of hole (m)	50 00	Dip X (°)=	0
Swivel H1 (m)		H1 =	1 05	Diameter of hole D (cm)	7 57	W L Before of test (m)=	26 35
Water level Ha (m)	26 35	Ha * Cos X ° =	26 35	Hydrostatic load (kg/cm2)	Lh= (H1+Ha)/10 =		2 740

Steel pipe.	Length (m) =	lt	= 5 00	Plastic Pipe.	Length (m)	1 m = 5 00	Reducciones.	Valv uniones	0 2
	Diameter ϕ_1	(m)	= 0 0603		Diameter ϕ_2	(m) = 0 0254	α	Packer	0 12
	Coef rugosidad	n1	= 0 01		Coef rugosidad	n2 = 0 008		Codo	0 008

PRESSURE READING Po (kg/cm²)	LOSS PRESSURE Plo=P1+P2+P3 (kg/cm²)	EFECTIVE PRESSURE Pe =Po +Lh - Plo (kg/cm²)	INJECTED TIME t (min)	WATER VOLUME Qt (l)	FLOOD Qc=Qt/t (l/min)	FLOOD Q1=Q/60000 (m³/s)	FLOOD Q2=Q*100/6 (cm³/s)	SPECIFIC ABSOPTION Ae = Q / L (l/min/m)	LUGEON UNIT UL = 10* Ae / Pe UL	PERMEABILITY COEFICIENT K = Q 2 / 2 π Pe L * ln 2 L / D (cm/s)
1.00	0 00202	3 74	10	26 00	2 60	4 33E-05	43 33	0 52	1 4	1 80E-05
5 00	0 02250	7 72	10	87 00	8 70	1 45E-04	145 00	1 74	2 3	2 92E-05
10 00	0 12118	12 62	10	202 00	20 20	3 37E-04	336 67	4 04	3 2	4 15E-05
5 00	0 03999	7 70	10	116 00	11 60	1 93E-04	193.33	2 32	3 0	3 90E-05
1 00	0 00234	3 74	10	28 00	2.80	4 67E-05	46 67	0.56	1 5	1 94E-05

TOTAL LOSS LOAD

$$Pc = Pc_1 + Pc_2 + Pc_3$$

$$P_1 = \frac{10.34 * (n_1)^2 * (Q_1^2) * lt}{(\phi_1^{5.33})}$$

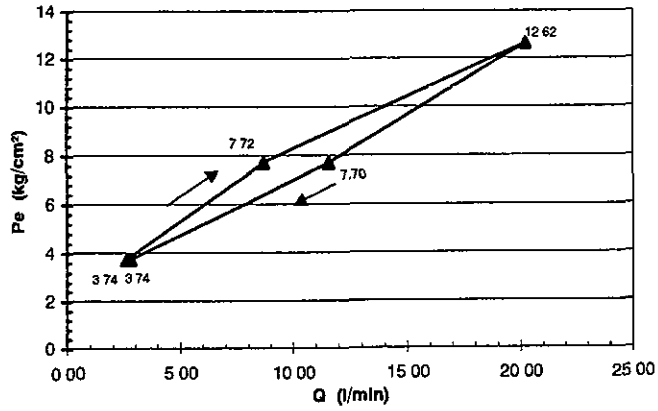
P1= loss load on steel pipe

$$P_2 = \frac{10.34 * (n_2)^2 * (Q_2^2) * lm}{(\phi_2^{5.33})}$$

P2= loss load on plastic pipe

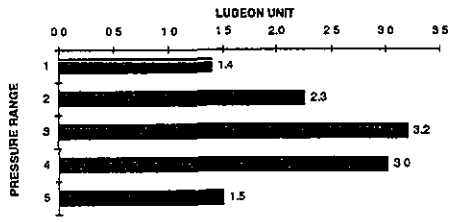
$$P_3 = \sum \alpha * (Q_1)$$

P3= loss load on reducciones, valvulas y uniones



Po = Pressure Reading, Lh = Hydrostatic Load, Plo = Loss Pressure

VALUES OF LUGEON UNIT



PERMEABILITY (LU) = 3 2

PERMEABILITY TEST

swissboring
Swissboring Overseas Corporation Ltd.

CLIENT. ELECTRIC POWER DEVELOPMENT Co.	DATE. 5-noviembre-2002	LUGEON TEST Nº: 1
PROJECT:TOROLA HYDROELECTRIC COMPLEX	SITE: DAM SITE (right margin)	TESTED BY: ERNESTO HERRERA
HOLE No.: CDB-8	ELEVATION: 196.43 m.s.l	CHECKED BY: Geol.W. Hernández

Packer type: Neumatic — Length (m) = 0.80 — Water pump: Bean Royal 535 — Flood (l/min) =

Test depth (m) from: 15.00 to 21 00

Test length (cm): — L * Cos X º = 600.00 — Depth of hole (m) 21.00 — Dip X (º)= 0

Swivel H1 (m): — H1 = 0 75 — Hole Diameter D (cm) 7 57 — W L Before of test (m)= 18

Water level Ha (m) 18 — Ha * Cos X º = 18 00 — Hydrostatic load (kg/cm2): Lh= (H1+Ha)/10 = 1 875

Steel pipe: Length (m) = lt = 14 95 — Diameter ϕ_1 (m) = 0 0603 — Roughness index n1 = 0.01

Plastic Pipe : Length (m) lm = 5 00 — Diameter ϕ_2 (m) = 0 0254 — Roughness index n2, 0 008

Reducers: — α — Valv cuopling: 0 2 — Packer 0 12 — Union elbow 0 008

PRESSURE READING Po (kg/cm²)	LOSS PRESSURE Plo=P1+P2+P3 (kg/cm²)	EFECTIVE PRESSURE Pe = Po +Lh-Plo (kg/cm²)	INJECTED TIME t (min)	WATER VOLUME Qt (l)	FLOOD Q=Qt/t (l/min)	FLOOD Q1=Q/60000 (m³/s)	FLOOD Q2=Q*100/6 (cm³/s)	SPECIFIC ABSOPTION Ae = Q / L (l/min/m)	LUGEON UNIT UL = 10* Ae / Pe UL	PERMEABILITY COEFICIENT $K = \frac{Q2}{2\pi Pe\ L} * \ln\frac{2L}{D}$ (cm/s)
1.00	0 40309	2.47	10	363 00	36 30	6 05E-04	605 00	6.05	24.5	3.29E-04
5.00	1 13060	5 74	10	608.00	60.80	1.01E-03	1013.33	10 13	17 6	2.37E-04
10.00	2 71945	9.16	10	943 00	94.30	1 57E-03	1571 67	15.72	17.2	2.31E-04
5 00	1.43506	5 44	10	685.00	68 50	1 14E-03	1141.67	11 42	21 0	2.82E-04
1.00	0 45342	2 42	10	385 00	38.50	6 42E-04	641 67	6.42	26.5	3 56E-04

TOTAL LOSS LOAD

$$Pc = Pc_1 + Pc_2 + Pc_3$$

$$P_1 = \frac{10.34 * (n_1)^2 * (Q_1^2) * lt}{(\phi_1^{5.33})}$$

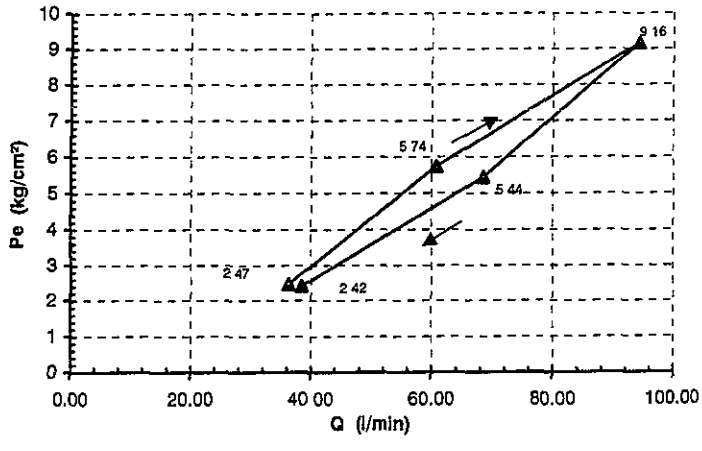
P1= loss load on steel pipe

$$P_2 = \frac{10.34 * (n_2)^2 * (Q_2^2) * lm}{(\phi_2^{5.33})}$$

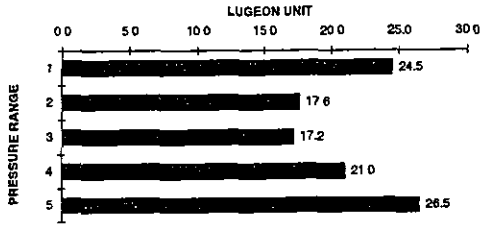
P2= loss load on plastic pipe

$$P_3 = \sum \alpha * (Q_1)$$

P3= loss load on couplings, valvles and packer



VALUES OF LUGEON UNIT



PERMEABILITY (LU) = 17.2

Po = Pressure Reading; Lh = Hydrostatic Load, Plo = Loss Pressure

333

PERMEABILITY TEST

swissboring
Swissboring Overseas Corporation Ltd.

CLIENT: ELECTRIC POWER DEVELOPMENT Co.	DATE: 5-diciembre-2002	LUGEON TEST Nº: 2
PROJECT:TOROLA HYDROELECTRIC COMPLEX	SITE: DAM SITE (right margin)	TESTED BY: JULIO RIVERA
HOLE No.: CDB-8	ELEVATION: 196.43 m.s.l	CHECKED BY: Geol.W. Hernández

Packer type	Neumatic	Length (m) =	0 80	Water pump	Bean Royal 535	Flood (l/min) =	
				Test depth (m) from	20 00	to.	25 00
Test length (cm)		L * Cos X º =	500 00	Depth of hole (m)	25.00	Dip X (º)=	0
Swivel H1 (m)		H1 =	1 00	Hole Diameter D (cm).	7 57	W L Before of test (m)=	22 15
Water level Ha (m)	22.15	Ha * Cos X º =	22 15	Hydrostatic load (kg/cm2).	Lh= (H1+Ha)/10 =		2.315

Steel pipe:	Length (m) =	lt =	25.20	Plastic Pipe :	Length (m)	lm = 5 00	Reducers:	Valv cuopling:	0 2
	Diameter ϕ_1	(m) =	0 0603		Diameter ϕ_2	(m) = 0 0254	α	Packer:	0 12
	Roughness index	n1 =	0 01		Roughness index	n2 0 008		Union elbow	0 008

PRESSURE READING Po (kg/cm²)	LOSS PRESSURE Plo=P1+P2+P3 (kg/cm²)	EFECTIVE PRESSURE Pe = Po +Lh-Plo (kg/cm²)	INJECTED TIME t (min)	WATER VOLUME Qt (l)	FLOOD Q=Qt/t (l/min)	FLOOD Q1=Q/60000 (m³/s)	FLOOD Q2=Q*100/6 (cm³/s)	SPECIFIC ABSOPTION Ae = Q / L (l/min/m)	LUGEON UNIT $UL = \frac{10 * Ae}{Pe}$ UL	PERMEABILITY COEFICIENT $K = \frac{Q2}{2 \times Pe \times L} * \ln \frac{2L}{D}$ (cm/s)
1.00	1.29094	2.02	10	640 00	64 00	1.07E-03	1066.67	12 80	63 2	8 19E-04
5 00	1 99185	5.32	10	795.00	79 50	1.33E-03	1325.00	15.90	29 9	3 87E-04
10 00	3 77165	8 54	10	1094 00	109 40	1.82E-03	1823 33	21 88	25.6	3 32E-04
5.00	2 44050	4.87	10	880.00	88 00	1.47E-03	1466 67	17 60	36 1	4.68E-04
1.00	1.82035	1.49	10	760 00	76 00	1.27E-03	1266.67	15 20	101.7	1.32E-03

TOTAL LOSS LOAD

$$Pc = Pc_1 + Pc_2 + Pc_3$$

$$P_1 = \frac{10.34 * (n_1)^2 * (Q_1^2) * lt}{(\phi_1^{5.33})}$$

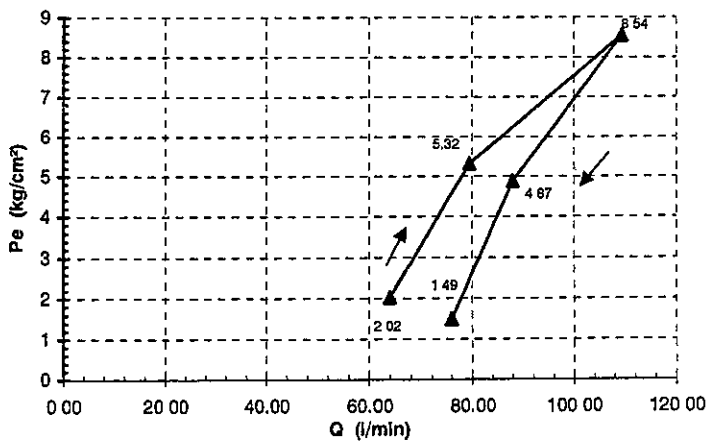
P1= loss load on steel pipe

$$P_2 = \frac{10.34 * (n_2)^2 * (Q_2^2) * lm}{(\phi_2^{5.33})}$$

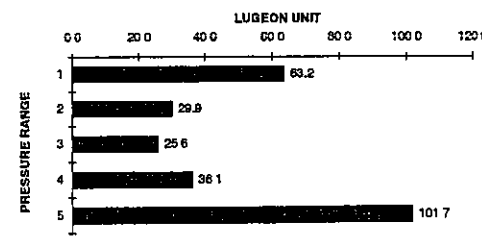
P2= loss load on plastic pipe

$$P_3 = \sum \alpha * (Q_1)$$

P3= loss load on couplings, valvles and packer



VALUES OF LUGEON UNIT



PERMEABILITY (LU) = 25.6

Po = Pressure Reading; Lh = Hydrostatic Load, Plo = Loss Pressure.

Appendix 7.6

Water Level in Drillhole after Drilling

Appendix 7.6.1: Monthly Water Level in Drillhole

Appendix 7.6.2: Water Level in Drillhole measured by CEL

Appendix 7.6.1

Monthly Water Level in Drillhole

Monthly Water level in Drillhole after Drilling

Drillhole	CDB-1		CDB-2		CDB- 3		CDB- 4		CDB-5		CDB-6		CDB-7		CDB-8	
	Depth	Elevation	Depth	Elevation	Depth	Elevation	Depth	Elevation	Depth	Elevation	Depth	Elevation	Depth	Elevation	Depth	Elevation
	70.00	208.84	60.00	183.95	50.00	136	80.00	222.45	70.00	225.45	70 00	219	50.00	184.06	50 00	204.33
Dec. 18 01	52.30	156.54	42.58	141.37									40.10	143.96		
Apr 03 02			41.26	142.69									40.84	143.22		
May 03 02			41.49	142.46									41.46	142.60		
June 08 02	46.77	162.07	40.05	143.90									32.29	151.77		
July 04 02	63.11	145.73	41.31	142.64									35.68	148.38		
Aug. 01 02	50.12	158.72	33.78	150 17									40.87	143.19		
Sept. 05 02	59.86	148.98	41.46	142.49									36.69	147.37		
Oct. 03 02	40.39	168.45	39.57	144.38									32.48	151.58		
Nov 01 02	60.50	148.34	40.15	143.80									35 00	149.06		
Dec 07 02	61.21	147.63	39.24	144.71			76.08	146.37	68.8	156.65			35.04	149.02		
Jan 09 03	62.26	146.58	39.98	143.97	1.97	134.03	76.77	145.68	69.62	155.83	46.99	172.01	35.88	148.18	49.88	154 45
Feb 06 03	62.45	146.39	40.27	143.68	2.05	133.95	77.28	145.17	69.62	155.83	47.44	171.56	35.93	148.13	49.89	154.44
Apr 11 03	63.16	145.68	41.26	142.69	3.1	132.9	78.04	144.41	70.51	154.94	49.63	169.37	37.21	146.85	50.83	153.5
May 09 03	63.29	145.55	41.53	142.42	3 06	132.94	77.8	144.65	70.49	154.96	49.43	169.57	38.32	145.74	50.81	153.52
Jun 04 03	63.02	145.82	41.03	142.92	0.36	135.64	76.1	146 35	69.66	155.79	46.51	172.49	38.68	145.38	49.85	154.48
Jul 09 03	49.64	159.20	40.33	143.62	1.25	134.75	76.09	146.36	69.7	155.75	36.86	182.14	34.41	149.65	49.13	155 2
Aug 15 03	62.64	146.20	40.89	143.06			76.46	145.99	69.69	155.76	46.79	172.21	35.62	148.44	49.84	154.49
Sep 19 03	34.81	174.03	38.48	145.47			74.18	148.27	69.67	155.78	20.37	198.63	28.83	155.23	45.14	159.19
Oct. 14 03	44.15	164.69	39.18	144.77			75.19	147 26	69.68	155.77	44.01	174.99	34.8	149 26	47.89	156.44

Appendix 7.6.2

Water Level in Drillhole measured by CEL

LECTURAS PIEZOMETRICAS
PROYECTO: El Chaparral, río Torola

POZO # CDB-1

ELEV. TUBO — h de tubo 0.42

FECHA	HORA	LECTURA	NIVEL DEL AGUA
09/Ene./03		62.68	62.26
21/Ene./03		62.72	62.30
30/Ene./03		62.82	62.40
03/Feb./ 03		68.98	68.56
06/Feb./ 03		62.87	62.45
14/Feb./ 03		62.90	62.48
25/Feb./ 03		63.02	62.60
11/Abr./03		63.58	63.16
09/May /03		63.71	63.29
04/Jun./03		63.44	63 02
09/Jul./03		50.06	49.64
15/Ago./03		63.06	62.64
19/Sep./03	11:00	35.23	34.81
14/Oct./03	11:00	44.57	44.15

7-6-4

LECTURAS PIEZOMETRICAS
PROYECTO: El Chaparral, río Torola

POZO # CDB-2

ELEV. TUBO — h de tubo 0.4

FECHA	HORA	LECTURA	NIVEL DEL AGUA
09/Ene./03		40.38	39.98
21/Ene./03		40.45	40.05
30/Ene /03		39.58	39.18
03/Feb./ 03		60.33	59.93
06/Feb./ 04		40.67	40.27
14/Feb./ 03		40.71	40.31
25/Feb./ 03		40.80	40.40
11/Abr./03		41.66	41 26
09/May./03		41.93	41.53
04/Jun./03		41.43	41 03
09/Jul./03		40.73	40.33
15/Ago./03		41.29	40.89
19/Sep./03	11:30	38.88	38.48
14/Oct./03	11·28	39.58	39.18

LECTURAS PIEZOMETRICAS
PROYECTO: El Chaparral, río Torola

POZO # CDB-3

ELEV. TUBO — h de tubo **0.95**

FECHA	HORA	LECTURA	NIVEL DEL AGUA
09/Ene./03		2.92	1.97
21/Ene./03		2.75	1.80
30/Ene./03		2.94	1.99
03/Feb./ 03		3.04	2.09
06/Feb./ 03		3.00	2.05
14/Feb./ 03		3.01	2.06
25/Feb./ 03		3.04	2.09
11/Abr./03		4.05	3.10
09/May./03		4.01	3.06
04/Jun./03		0.59	-0.36
09/Jul./03		2.20	1.25
15/Ago./03		xxx	xxx
19/Sep./03		xxx	xxx
14/Oct./03			

LECTURAS PIEZOMETRICAS
PROYECTO: El Chaparral, río Torola

POZO # CDB-4

ELEV. TUBO — h de tubo **0.74**

FECHA	HORA	LECTURA	NIVEL DEL AGUA
09/Ene./03		77 51	76.77
21/Ene./03		77.56	76.82
30/Ene./03		77.94	77.20
03/Feb./ 03		77.75	77.01
06/Feb./ 03		78.02	77.28
14/Feb./ 03		77.95	77.21
25/Feb./ 03		77.74	77.00
11/Abr./03		78.78	78.04
09/May./03		78.54	77.80
04/Jun./03		76.84	76.10
09/Jul./03		76 83	76.09
15/Ago./03		77.20	76.46
19/Sep./03	13:15	74.92	74.18
14/Oct./03	13:45	76.53	75.79

LECTURAS PIEZOMETRICAS
PROYECTO: El Chaparral, río Torola

POZO # CDB-5

0.5 Nueva h de tubo

ELEV. TUBO 0.8

FECHA	HORA	LECTURA	NIVEL DEL AGUA
09/Ene./03		70.12	69.62
21/Ene./03		70.15	69.65
30/Ene./03		70.24	69.74
03/Feb./ 03		70.40	69.90
06/Feb./ 03		70.12	69.62
14/Feb./ 03		70.05	69.55
25/Feb./ 03		70.54	69.74
11/Abr./03		71.31	70.51
09/May./03		71.29	70.49
04/Jun./03		70.46	69.66
09/Jul./03		70.50	69.70
15/Ago./03		70.49	69.69
19/Sep./03	14:10	70.47	69.67
14/Oct./03	13:15	70.48	69.68

7-6-6

LECTURAS PIEZOMETRICAS
PROYECTO: El Chaparral, río Torola

POZO # CDB-6

h de tubo

ELEV. TUBO 0.95

FECHA	HORA	LECTURA	NIVEL DEL AGUA
09/Ene./03		47.94	46.99
21/Ene./03		48.05	47.10
30/Ene./03		47.78	46.83
03/Feb./ 03		49.40	48.45
06/Feb./ 03		48.39	47.44
14/Feb./ 03		49.65	48.70
25/Feb./ 03		49.40	48.45
11/Abr./03		50.58	49.63
09/May./03		50.38	49.43
04/Jun./03		47.46	46.51
09/Jul./03		37.81	36.86
15/Ago./03		47.74	46.79
19/Sep./03	15:00	21.32	20.37
14/Oct./03	13:40	44.96	44.01

LECTURAS PIEZOMETRICAS
PROYECTO: El Chaparral, río Torola

POZO # CDB-7

h de tubo

ELEV. TUBO **0.30**

FECHA	HORA	LECTURA	NIVEL DEL AGUA
09/Ene./03		36.18	35.88
21/Ene./03		36.15	35.85
30/Ene./03		35.30	35.00
03/Feb./ 03		50.95	50.65
06/Feb./ 03		36.23	35.93
14/Feb./ 03		36.21	35.91
25/Feb./ 03		36.18	35.88
11/Abr./03		37.51	37.21
09/May./03		38.62	38.32
04/Jun./03		38.98	38.68
09/Jul./03		34.71	34.41
15/Ago./03		35.92	35.62
19/Sep./03	11:20	29.13	28.83
14/Oct./03	11:15	35.10	34.80

7-6-7

LECTURAS PIEZOMETRICAS
PROYECTO: El Chaparral, río Torola

POZO # CDB-8

h de tubo

ELEV. TUBO **0.90**

FECHA	HORA	LECTURA	NIVEL DEL AGUA
09/Ene./03		50.78	49.88
21/Ene./03		50.70	49.80
30/Ene./03		50.81	49.91
03/Feb./ 03		50.74	49.84
06/Feb./ 03		50.79	49.89
14/Feb./ 03		50.81	49.91
25/Feb./ 03		50.78	49.88
11/Abr./03		51.73	50.83
09/May./03		51.71	50.81
04/Jun./03		50.75	49.85
09/Jul./03		50.03	49.13
15/Ago./03		50.74	49.84
19/Sep./03	13:25	46.04	45.14
14/Oct./03	13:40	48.79	47.89