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TABLE 1.1 List of samples.

Sample Set.	Bentonite Content (%)	Overburden Stress (kPa)	Fracture Plane*
1	5	100, 200, 300	H/V
2	10	100, 200, 300	H/V
3	15	100, 200, 300	H/V
4	20	100, 200, 300	H/V

Remark: * H = Horizontal Plane, V = Vertical Plane

TABLE 2.1 Engineering classifications of potential buffer materials (from Dixon and Woodcock, 1984)

Property	Illitic shale	Na bentonite	Quartz sand
Clay, < 2 μm (%)	32	60	0
Silt, 2 μm—0.06 mm (%)	65	39	5
Sand, 0.06—0.2 mm (%)	2	1	19
0.2—1 mm (%)	1	0	58
1—2 mm (%)	0	0	16
> 2 mm (%)	0	0	2
Specific surface area (m^2/g)	60	620	< 1
Cation exchange capacity (meq./100 g)	16	80	< 10
Liquid limit (%)	30	250	—
Plastic limit (%)	21	49	NP
Unified classification	CL	CH	SW

TABLE 2.2 Soil-Separate Size Limits

Classification systems	Grain size (mm)
AASHTO	Gravel: 75 mm to 2 mm
	Sand: 2 mm to 0.05 mm
	Silt: 0.05 mm to 0.002 mm
Unified	Gravel: 75 mm to 4.75 mm
	Sand: 4.75 mm to 0.075 mm
	Silt: < 0.075 mm

TABLE 2.3 U.S. Standard sieve sizes.

Sieve no.	Opening (mm)
4	4.750
6	3.350
8	2.360
10	2.000
16	1.180
20	0.850
30	0.600
40	0.425
50	0.300
60	0.250
80	0.180

TABLE 2.4 Typical values of coefficient of permeability for various soils

Materials	Coefficient of permeability, cm/s
Coarse	1.0 to 10^{2}
Fine gravel, coarse and medium sand	10^{-3} to 1.0
Fine sand, loose silt	10^{-5} to 10^{-3}
Dense silt, clayey silt	10^{-6} to 10^{-5}
Silty clay, clay	10^{-9} to 10^{-6}

TABLE 3.1 Physical properties of Sing River Sand

Descriptions	Values
C_u	3.95
C_c	0.70
Fine content (finer than 75 micron), %	0.60
Specific gravity (G_s)	2.65
e_{min}	0.501
e_{max}	0.740

TABLE 3.2 Chemical Properties of MAC-GEL Bentonite.

SiO_2	55-58%	MgO	2.1-2.5%
Al_2O_3	16-18%	CaO	1.9-2.1%
Fe_2O_3	5-7%	K_2O	0.3-0.5%
Na_2O	3.6-4.0%	TiO_2	1.2-1.5%
LOl	11-12%	CEC	80 meq/100 g

TABLE 3.3 Physical Properties of MAC-GEL Bentonite.

Specification	Typical	API Standard
Fann Viscosity @ 600 rpm, cp	40-50	30 min
Fann Viscosity @ 300 rpm, cp	28-35	-
Plastic Viscosity, cp	12-15	-
Yield Point, lb/100 ft^2	16-20	3xPv max.
Filtrate Loss, ml	13.5-14.5	15.0 max.
Dry Screen (passing 75 micron), %	80-85	-
Wet Screen (retained 75 micron), %	1.5-2.0	4.0 max.
PH (6 % suspension)	9.0-11.0	-

TABLE 3.3 Physical Properties of MAC-GEL Bentonite. (Cont.)

Moisture Content, %	8-10	10.0 max.
- Swelling Index	: 25-30 ml per 2 g of clay	
- Loose bulk density	: 0.80-0.95 g/ml	
- Apparent settled density	: 1.05-1.10 g/ml	
- Specific gravity	: 2.5-2.7	
- Gel strength, 10 sec.	: 10-16 lb/100 ft^2	
- Gel strength, 10 min.	: 25-30 lb/100 ft^2	

TABLE 4.1 Summaries of standard compaction tests.

No.	Bentonite Content (%)	Optimum Water Content (%)	Maximum Dry Density (kN/m^3)
1	5	11.0	18.8
2	10	13.0	18.8
3	15	11.3	18.7
4	20	11.0	18.7
5	25	13.0	18.6

TABLE 4.2 Summaries of Undrained Shear Strength.

Bentonite Content , *%B (%)*	Undrained Shear Strength , S_u *(kPa)*
5	24.347
10	41.722
15	57.141
20	70.287
25	85.209

TABLE 4.3 Summaries Direct shear test.

Bentonite Content , *%B (%)*	Cohesion , C_{DSS} *(kPa)*	Internal friction angle , ϕ *(degree)*
5	15.506	35.777
10	16.813	33.145
15	19.602	30.293
20	20.638	29.116
25	27.641	26.349

TABLE 4.4 Summaries of hydraulic conductivity test.

Sample	No.	Description				Flow Rate	Hydraukic Conductivity
		Bentonite Content	Water Content	Over burden Pressure	Dry Density		
		$,B$	$,w$	$,\sigma_v'$	$,\gamma_d$	$,q$	$,k$
		%	%	kPa	kN/m^3	cm^3/s	cm/s
HF	01	5	18	100	14.87	8.02E-02	2.37E-04
HF	06	5	18	200	14.78	8.51E-02	2.85E-04
HF	11	5	18	300	14.80	3.62E-03	1.05E-05
HF	02	10	18	100	14.49	4.66E-05	1.62E-07
HF	07	10	18	200	14.70	6.78E-06	7.94E-08
HF	12	10	18	300	14.70	7.56E-07	8.97E-09
HF	03	15	18	100	14.31	3.13E-06	4.33E-08
HF	08	15	18	200	14.30	1.56E-06	7.22E-09
HF	13	15	18	300	14.50	1.00E-05	8.67E-09
HF	04	20	18	100	13.35	9.39E-07	1.30E-08
HF	09	20	18	200	13.50	1.25E-06	4.33E-09
HF	14	20	18	300	14.40	1.88E-06	8.67E-09
HF	05	25	18	100	13.12	1.00E-06	1.04E-09
HF	10	25	18	200	13.10	5.22E-07	1.73E-09
HF	15	25	18	300	14.10	6.26E-07	8.67E-09

TABLE 4.5 Wet sieve analysis test results.

Sample	No.	Bentonite Content ,B %	Bentonite from Wet Sieve ,B %	Design Water Content ,w %	Measure Water Content ,w %
SHF	01	5	4.86	18	18.23
SHF	06	5	4.88	18	18.90
SHF	11	5	4.90	18	19.20
SHF	02	10	9.80	18	19.40
SHF	07	10	9.87	18	19.60
SHF	12	10	9.92	18	19.00
SHF	03	15	14.65	18	18.60
SHF	08	15	14.66	18	18.50
SHF	13	15	14.70	18	18.46
SHF	04	20	19.28	18	18.66
SHF	09	20	19.65	18	19.54
SHF	14	20	19.73	18	19.55
SHF	05	25	24.80	18	18.65
SHF	10	25	24.75	18	19.20
SHF	15	25	24.63	18	18.45

TABLE 4.6 Summaries of hydraulic fracture test – Slow Rate Test.

Sample No.	Description				Breakthrough Pressure	Pressure Ratio
	Bentonite Content	Water Content	Over burden Pressure	Dry Density		
	B	w	σ_v	γ_d	P_b	P_b/σ_v
	%	%	kPa	t/m3	kPa	
Horizontal Fracture Plane						
SHF 01	5	18	100	1.48	60	0.6
SHF 06	5	18	200	1.45	160	0.8
SHF 11	5	18	300	1.53	210	0.7
SHF 02	10	18	100	1.32	100	1.0
SHF 07	10	18	200	1.45	200	1.0
SHF 12	10	18	300	1.51	240	0.8
SHF 03	15	18	100	1.34	130	1.3
SHF 08	15	18	200	1.46	230	1.2
SHF 13	15	18	300	1.57	300	1.0
SHF 04	20	18	100	1.32	180	1.8
SHF 09	20	18	200	1.35	220	1.1
SHF 14	20	18	300	1.46	340	1.1
SHF 05	25	18	100	1.33	190	1.9
SHF 10	25	18	200	1.31	290	1.5
SHF 15	25	18	300	1.30	360	1.2
Vertical Fracture Plane						
SVF 01	5	18	100	1.51	90	0.9
SVF 06	5	18	200	1.48	160	0.8
SVF 11	5	18	300	1.50	250	0.8
SVF 02	10	18	100	1.46	100	1.0
SVF 07	10	18	200	1.42	150	0.8
SVF 12	10	18	300	1.48	280	0.9
SVF 03	15	18	100	1.43	150	1.5
SVF 08	15	18	200	1.48	260	1.3
SVF 13	15	18	300	1.45	300	1.0
SVF 04	20	18	100	1.43	210	2.1
SVF 09	20	18	200	1.43	220	1.1
SVF 14	20	18	300	1.45	330	1.1

TABLE 4.7 Summary of hydraulic fracture test – Quick Rate Test.

Sample	Name	Description				Breakdown Pressure	Pressure Ratio
		Bentonite Content	Water Content	Over burden Pressure	Dry Density		
		B	w	σ_v'	γ_d	P_b	P_b/σ_v'
		%	%	kPa	t/m3	kPa	
Horizontal Fracture Plane							
QHF	01	5	18	100	1.49	80	0.80
QHF	02	10	18	100	1.45	100	1.00
QHF	03	15	18	100	1.43	130	1.30
QHF	04	20	18	100	1.33	180	1.80
QHF	05	25	18	100	1.31	190	1.90
QHF	06	5	18	200	1.48	150	0.75
QHF	07	10	18	200	1.47	180	0.90
QHF	08	15	18	200	1.43	230	1.15
QHF	09	20	18	200	1.35	270	1.35
QHF	10	25	18	200	1.31	290	1.45
QHF	11	5	18	300	1.48	210	0.70
QHF	12	10	18	300	1.47	250	0.83
QHF	13	15	18	300	1.45	320	1.07
QHF	14	20	18	300	1.44	350	1.17
QHF	15	25	18	300	1.41	360	1.20
Vertical Fracture Plane							
QVF	01	5	18	100	1.51	90	0.90
QVF	02	10	18	100	1.46	110	1.10
QVF	03	15	18	100	1.43	130	1.30
QVF	04	20	18	100	1.43	170	1.70
QVF	06	5	18	200	1.50	150	0.75
QVF	07	10	18	200	1.46	200	1.00
QVF	08	15	18	200	1.43	210	1.05
QVF	09	20	18	200	1.40	270	1.35
QVF	11	5	18	300	1.50	200	0.67
QVF	12	10	18	300	1.48	260	0.87
QVF	13	15	18	300	1.45	300	1.00
QVF	14	20	18	300	1.45	320	1.07

TABLE 4.8 Fracture form of hydraulic fracture test – Slow Rate Test.

Sample No.	Description				Breakthrough Pressure	Fracture Form
	Bentonite Content ,B %	Water Content ,w %	Over burden Pressure ,σ_v kPa	Dry Density ,γ_d t/m3	,P_b kPa	
Horizontal Fracture Plane						
SHF 01	5	18	100	1.48	60	2S-D
SHF 06	5	18	200	1.45	160	2S-D
SHF 11	5	18	300	1.53	210	2S-D
SHF 02	10	18	100	1.32	100	S-D
SHF 07	10	18	200	1.45	200	S-D
SHF 12	10	18	300	1.51	240	S-D
SHF 03	15	18	100	1.34	130	G-D
SHF 08	15	18	200	1.46	230	G
SHF 13	15	18	300	1.57	300	G-D
SHF 04	20	18	100	1.32	180	G-D
SHF 09	20	18	200	1.35	220	G-D
SHF 14	20	18	300	1.46	340	G-D
SHF 05	25	18	100	1.33	190	G-D
SHF 10	25	18	200	1.31	290	G
SHF 15	25	18	300	1.30	360	G
Vertical Fracture Plane						
SVF 01	5	18	100	1.51	90	FD
SVF 06	5	18	200	1.48	160	
SVF 11	5	18	300	1.50	250	FD
SVF 02	10	18	100	1.46	100	VG-D
SVF 07	10	18	200	1.42	150	
SVF 12	10	18	300	1.48	280	VG-D
SVF 03	15	18	100	1.43	150	VD
SVF 08	15	18	200	1.48	260	
SVF 13	15	18	300	1.45	300	VD
SVF 04	20	18	100	1.43	210	
SVF 09	20	18	200	1.43	220	VD
SVF 14	20	18	300	1.45	330	VD

TABLE 4.9 Fracture form of hydraulic fracture test – Quick Rate Test.

Sample	No.	Description				Breakthrough	Fracture
		Bentonite Content ,B %	Water Content ,w %	Over burden Pressure ,σ_v' kPa	Dry Density ,γ_d t/m3	Pressure ,P_b kPa	Form
				Horizontal Fracture Plane			
QHF	01	5	18	100	1.49	80	2S-D
QHF	06	5	18	200	1.48	150	2S-D
QHF	11	5	18	300	1.48	210	2S-D
QHF	02	10	18	100	1.45	100	S-D
QHF	07	10	18	200	1.47	180	S-D
QHF	12	10	18	300	1.47	250	S-D
QHF	03	15	18	100	1.43	130	S-D
QHF	08	15	18	200	1.43	230	S-D
QHF	13	15	18	300	1.45	320	G-D
QHF	04	20	18	100	1.33	180	G-D
QHF	09	20	18	200	1.35	270	G
QHF	14	20	18	300	1.44	350	G
QHF	05	25	18	100	1.31	190	G
QHF	10	25	18	200	1.31	290	G
QHF	15	25	18	300	1.41	360	G
				Vertical Fracture Plane			
QVF	01	5	18	100	1.51	90	FD
QVF	06	5	18	200	1.50	150	FD
QVF	11	5	18	300	1.50	200	FD
QVF	02	10	18	100	1.46	110	FD
QVF	07	10	18	200	1.46	200	FD
QVF	12	10	18	300	1.48	260	VG-D
QVF	03	15	18	100	1.43	130	VG-D
QVF	08	15	18	200	1.43	210	VD
QVF	13	15	18	300	1.45	300	VG-D
QVF	04	20	18	100	1.43	170	VD
QVF	09	20	18	200	1.40	270	VD
QVF	14	20	18	300	1.45	320	VD

TABLE 4.10 Empirical Values m and b from Normalized Pressure by C_{DSS}.

Description	m	b	R^2
Horizontal Fracture Plane			
Slow Rate Test			
5% to 10% of Bentonite Content	0.7058	1.2249	0.8748
15% to 25% of Bentonite Content	0.7911	4.3737	0.7131
Quick Rate Test			
5% to 10% of Bentonite Content	0.6791	1.5650	0.9343
15% to 25% of Bentonite Content	0.8699	3.6719	0.9495
Vertical Fracture Plane			
Slow Rate Test			
5% to 10% of Bentonite Content	0.8401	0.2137	0.9566
15% to 25% of Bentonite Content	0.6746	5.4639	0.8653
Quick Rate Test			
5% to 10% of Bentonite Content	0.6179	2.7200	0.8748
15% to 25% of Bentonite Content	0.7886	4.3737	0.7131

TABLE 4.11 Empirical Values m and b from Normalized Pressure by S_u.

Description	m	b	R^2
Horizontal Fracture Plane			
Slow Rate Test			
5% to 10% of Bentonite Content	0.8401	0.2137	0.9566
15% to 25% of Bentonite Content	0.6746	5.4639	0.8653
Quick Rate Test			
5% to 10% of Bentonite Content	0.6791	1.5650	0.9343
15% to 25% of Bentonite Content	0.8699	3.6719	0.9495
Vertical Fracture Plane			
Slow Rate Test			
5% to 10% of Bentonite Content	0.8401	0.2137	0.9566
15% to 25% of Bentonite Content	0.6746	5.4639	0.8653
Quick Rate Test			
5% to 10% of Bentonite Content	0.6179	2.7200	0.8400
15% to 25% of Bentonite Content	0.7880	3.7346	0.9099

TABLE 5.1 Conclusions of Engineering Properties of Sand – Bentonite Mixture.

Engineering Properties	Values
Maximum Dry Unit Weight, γ_d (kN/m^3)	18.6 – 18.8
Optimum Moisture Content, w (%)	11.0 – 13.0
Undrained Shear Strength, Su (kPa)	24.35 – 85.21
Cohesion, C_{DSS} (kPa)	15.51 – 27.64
Internal Friction Angle, ϕ (degree)	26.35 – 35.78
Hydraulic Conductivity, k (cm/s)	2.37×10^{-4} – 8.67×10^{-9}

TABLE 5.2 Empirical Values m and b from Normalized Pressure by C_{DSS}.

Description	m	b
Horizontal Fracture Plane		
5% to 10% of Bentonite Content	0.68 – 0.84	0.21 – 1.56
15% to 25% of Bentonite Content	0.67 – 0.87	3.67 – 5.46
Vertical Fracture Plane		
5% to 10% of Bentonite Content	0.62 – 0.84	0.21 – 2.72
15% to 25% of Bentonite Content	0.67 – 0.79	4.37 – 5.46

TABLE 5.3 Empirical Values m and b from Normalized Pressure by S_u.

Description	m	b
Horizontal Fracture Plane		
5% to 10% of Bentonite Content	0.68 – 0.84	0.21 – 1.56
15% to 25% of Bentonite Content	0.67 – 0.87	3.67 – 5.46
Vertical Fracture Plane		
5% to 10% of Bentonite Content	0.62 – 0.84	0.21 – 2.72
15% to 25% of Bentonite Content	0.67 – 0.79	3.73 – 5.46

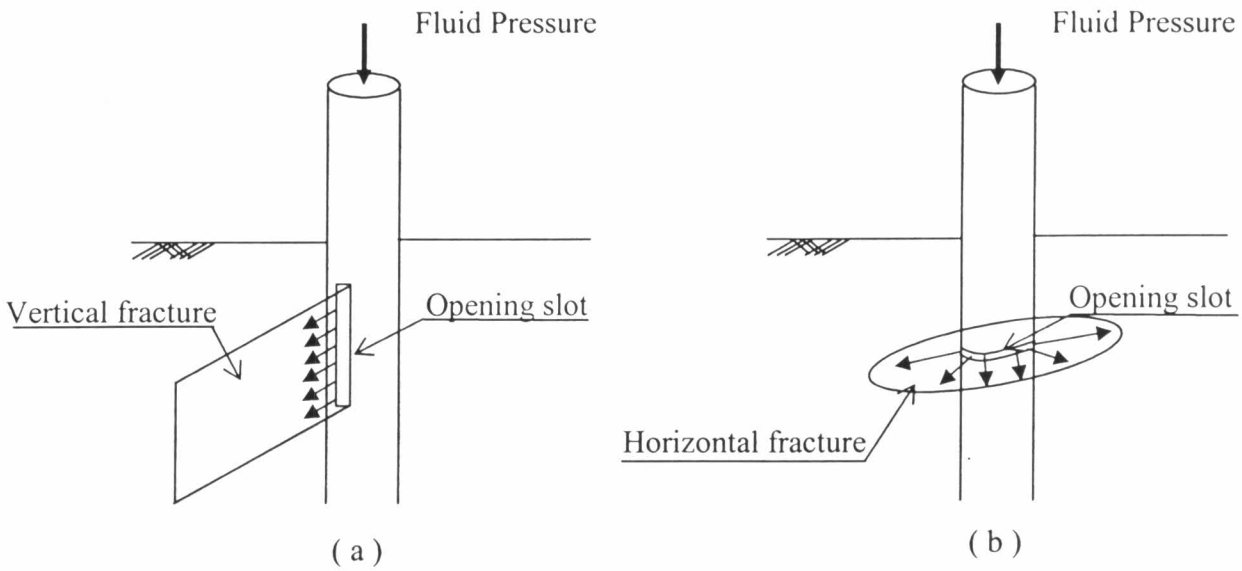


FIGURE 2.1 Two possible planes of hydraulic fracture

(a) vertical fracture and (b) horizontal fracture

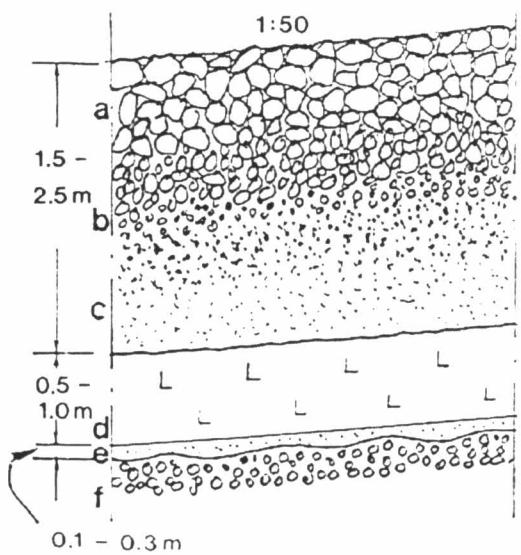


FIGURE 2.2 Example of low-pervious top cover of solid waste; a = pebbles;

b = sandy gravel; c = silty sand; d = clay-based layer; e = silty sand; f = solid waste.

(from Pusch and Alstermark, 1985)

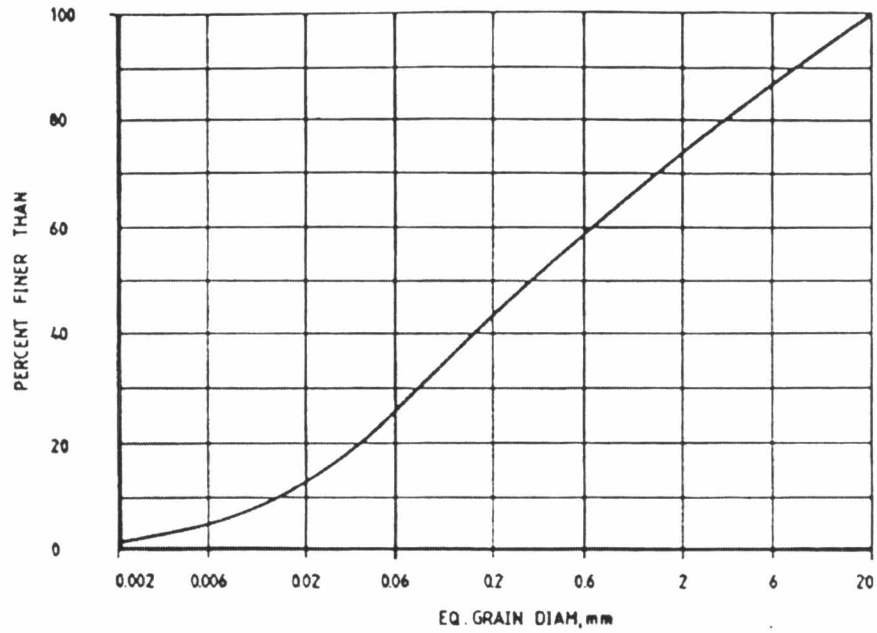


FIGURE 2.3 Granulometry of the till used as ballast in the till/bentonite mixture.

(from Pusch and Alstermark, 1985)

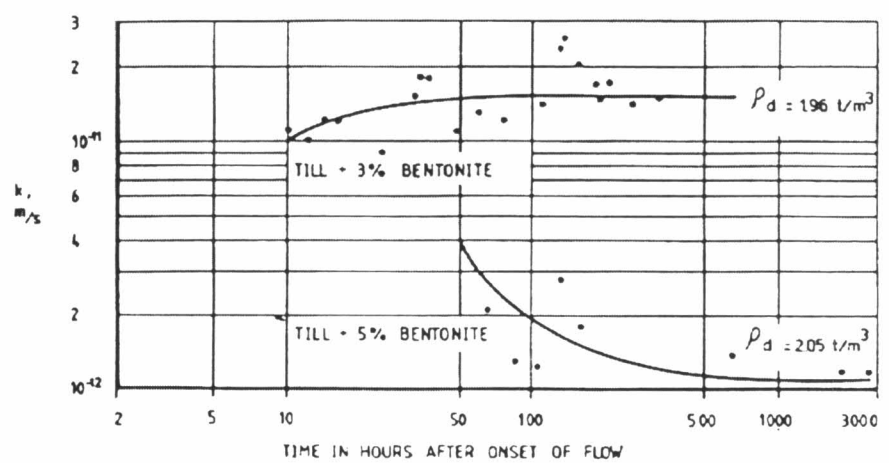


FIGURE 2.4 Hydraulic conductivity of the till/bentonite mixture.

(from Pusch and Alstermark, 1985)

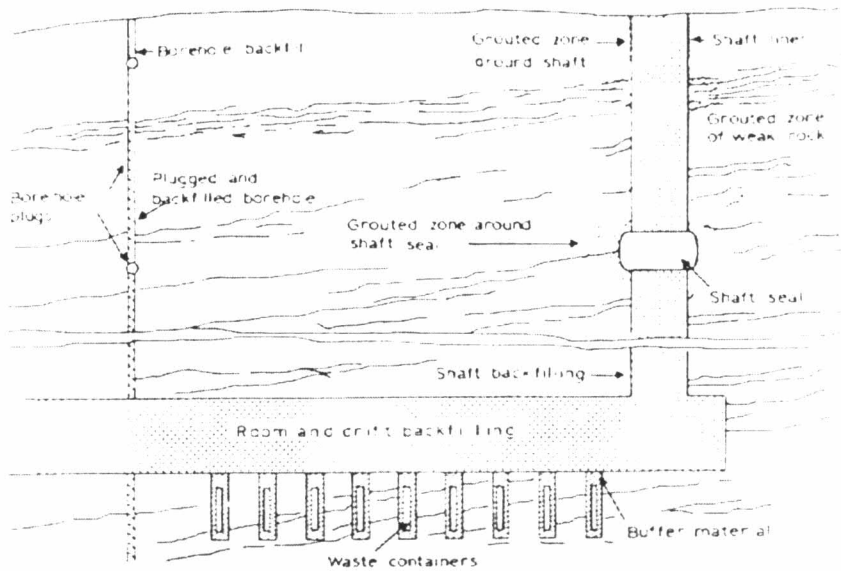
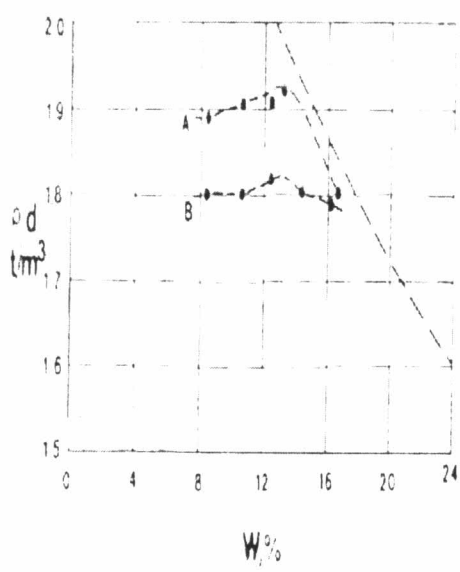
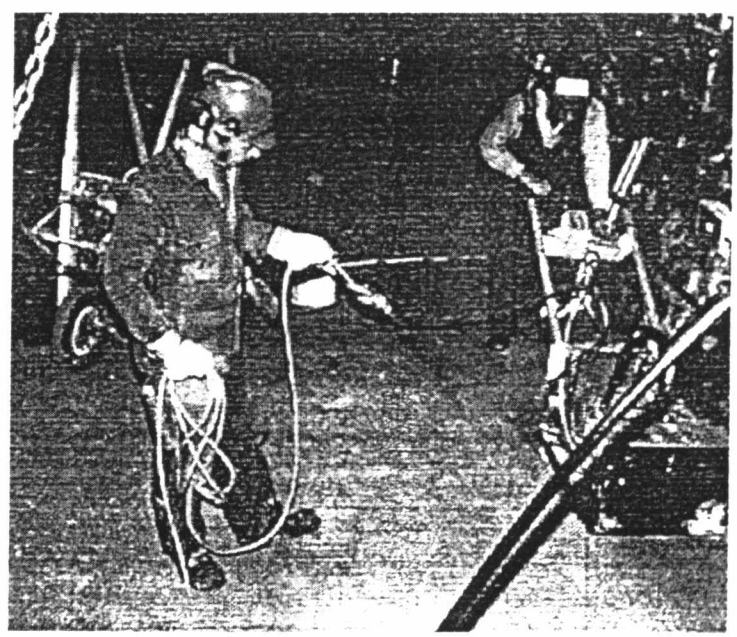


FIGURE 2.5The components of the Canadian nuclear fuel waste disposal vault concept. (from Dixon, Gray, and Thomas, 1985)





(a) (b)

FIGURE 2.6 (a) Compaction curves for the backfill (Modified Proctor test). A = 10% bentonite mixture; B = 20% bentonite mixture. (b) Compaction with the plate vibrator. (from Nilsson, 1985)

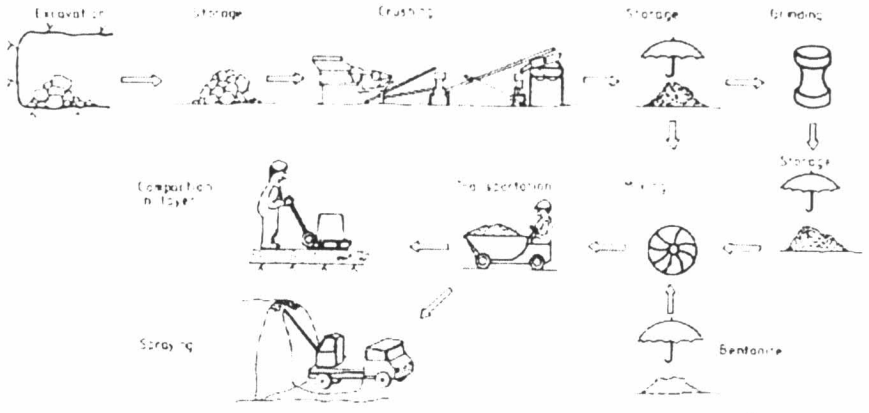


FIGURE 2.7 Schematic picture of the production of backfill material and the backfilling process. (from Holopainen, 1985)

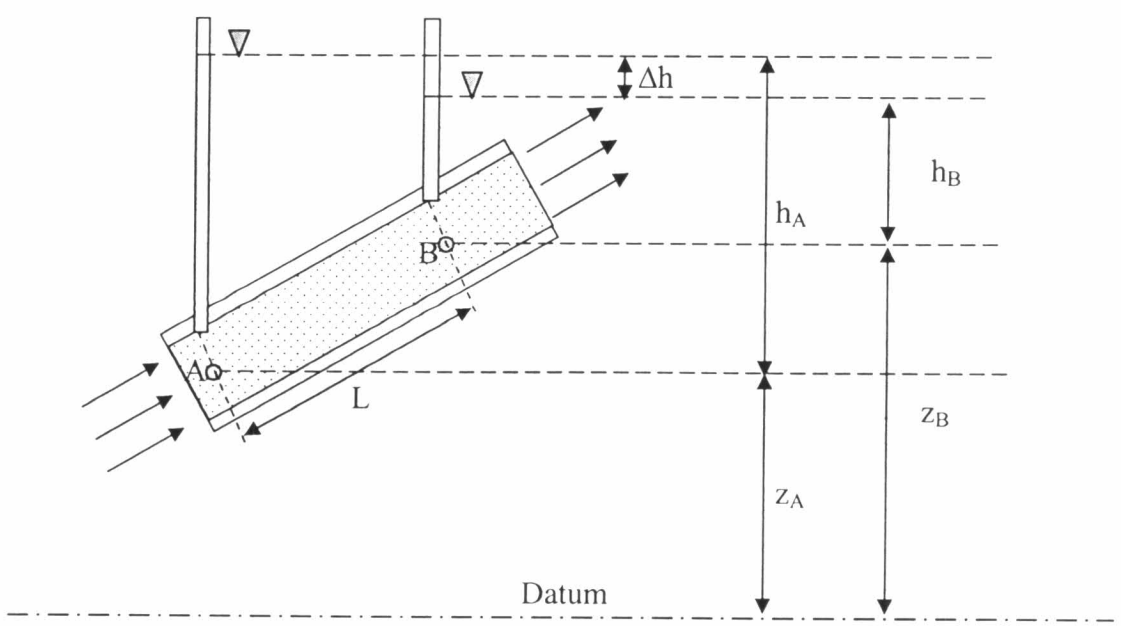


FIGURE 2.8 Development of Darcy's law.

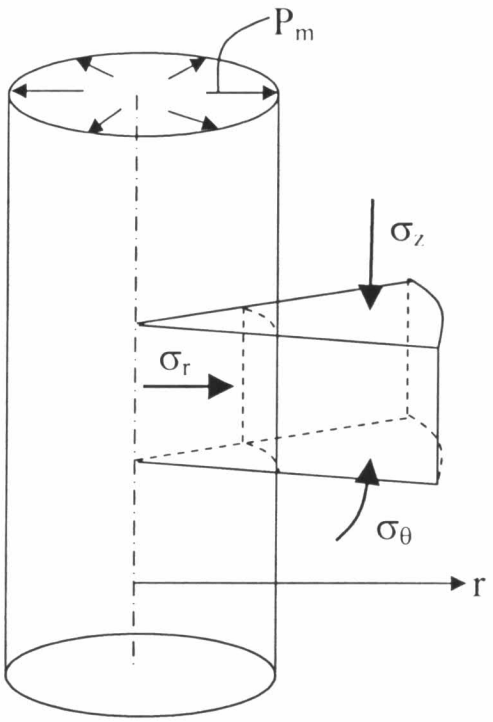


FIGURE 2.9 Stress around a borehole. P_m, borehole pressure; r, radius from center of borehole.

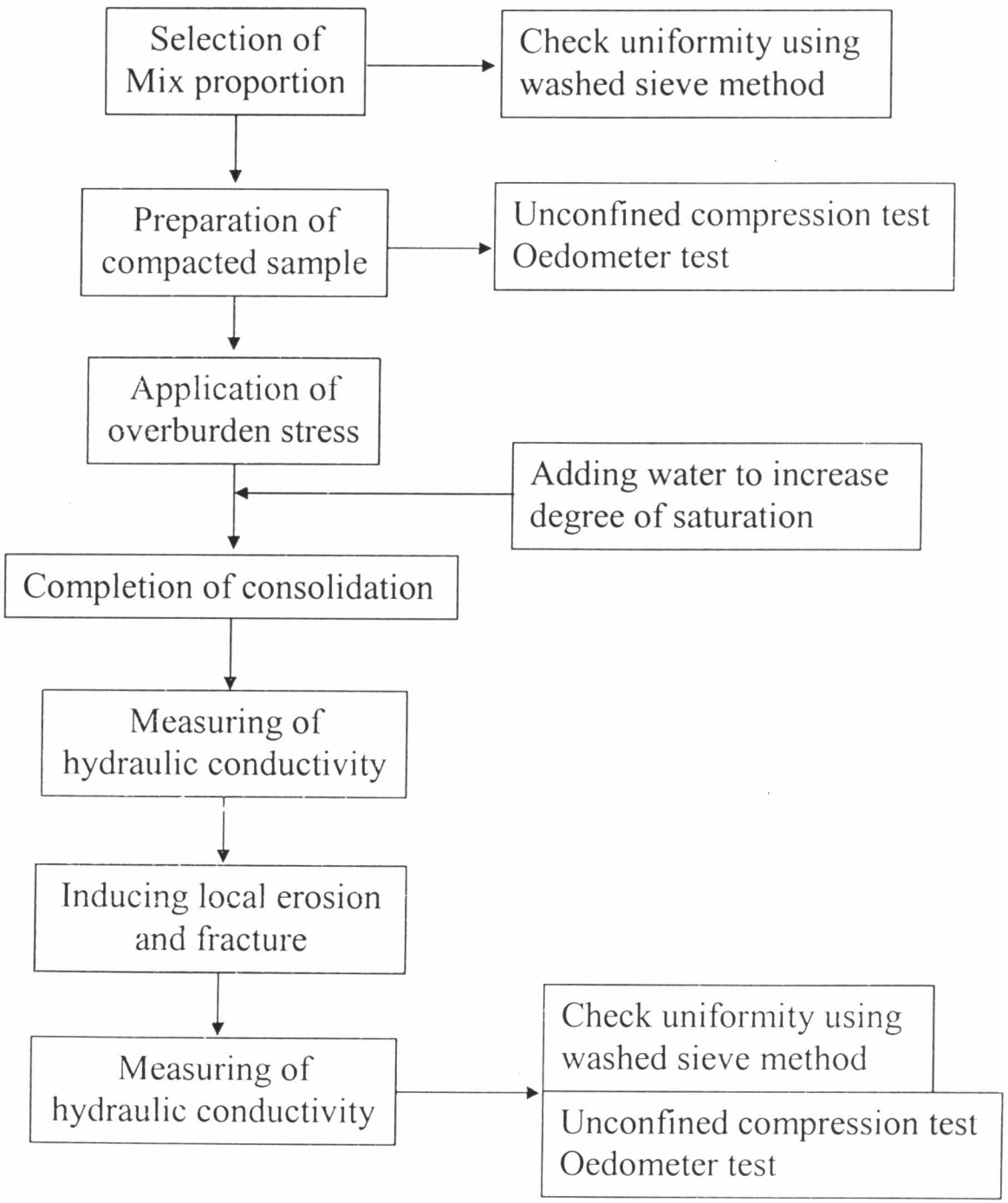


FIGURE 3.1 General testing procedures.

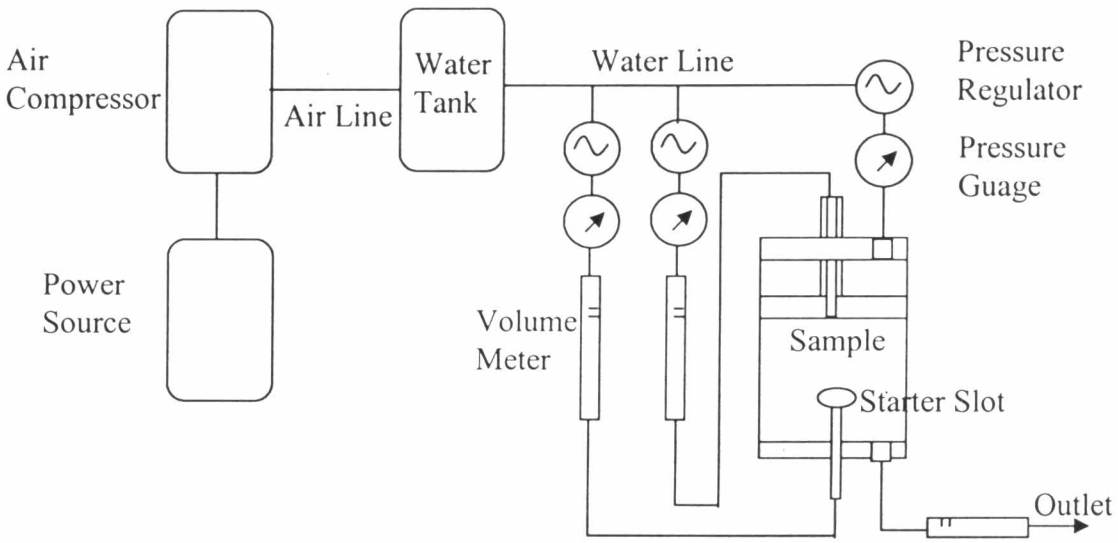


FIGURE 3.2 The main apparatus.

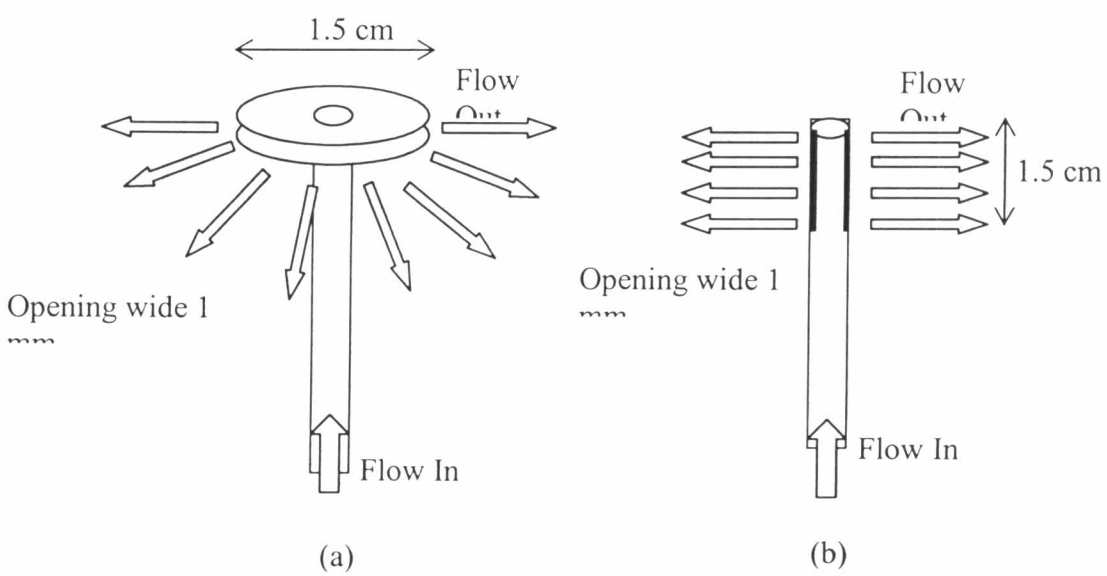


FIGURE 3.3 A schematic view of the starter slot a) horizontal plane b) vertical plane

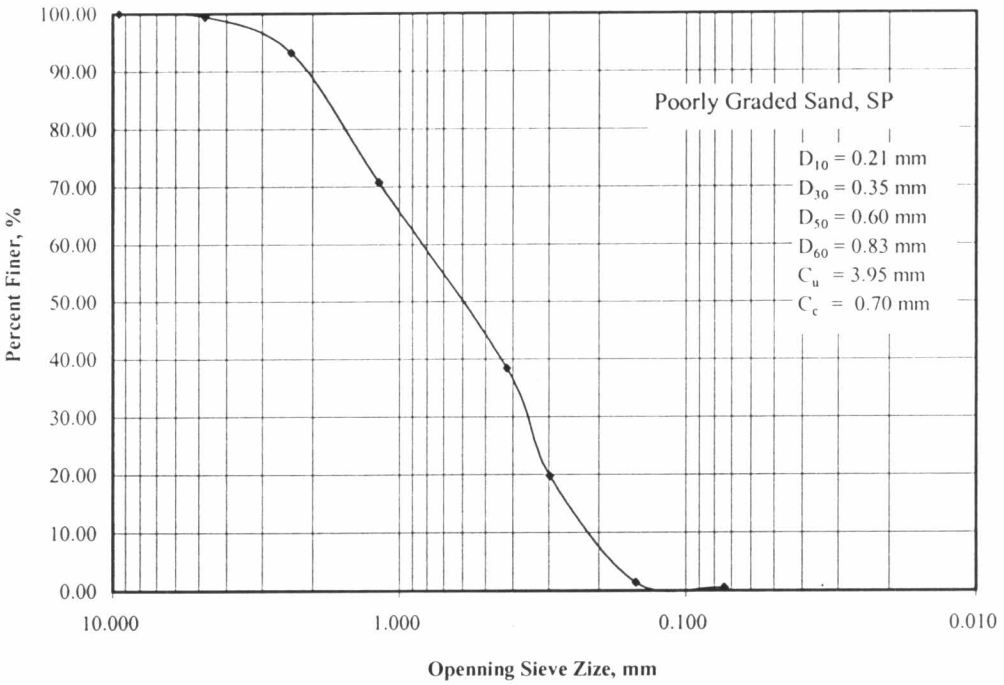


FIGURE 3.4 The grain size distribution of the Singh River sand

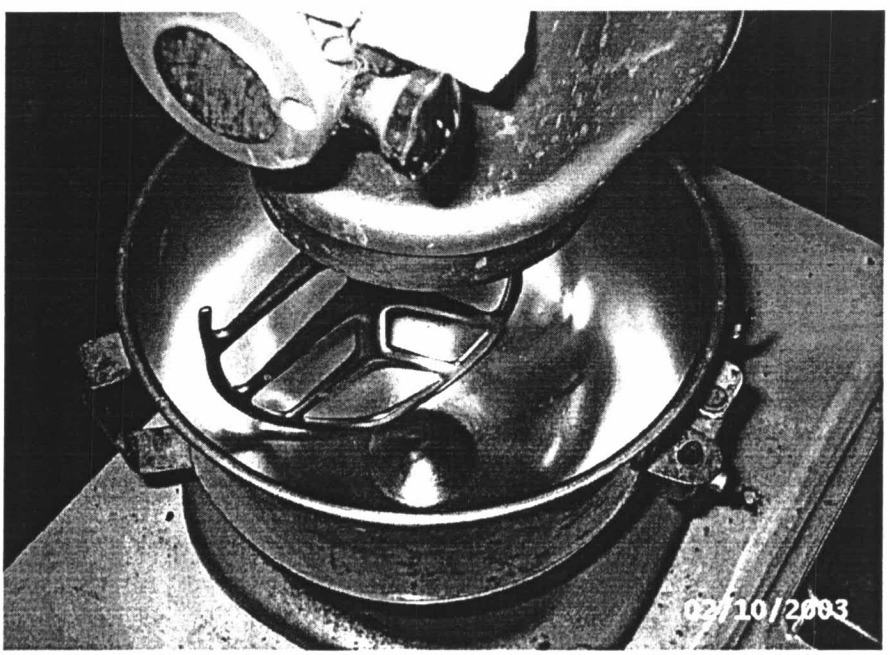


FIGURE 3.5 Electronic mixing apparatus.

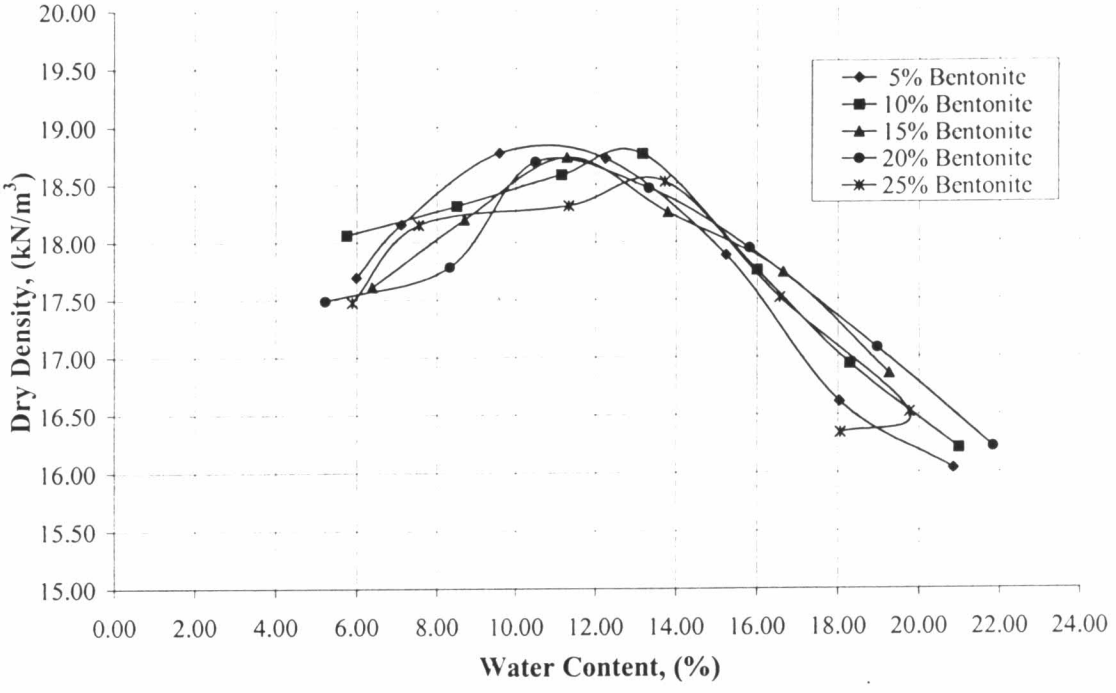


FIGURE 4.1 The compaction characteristics of sand-bentonite mixtures.

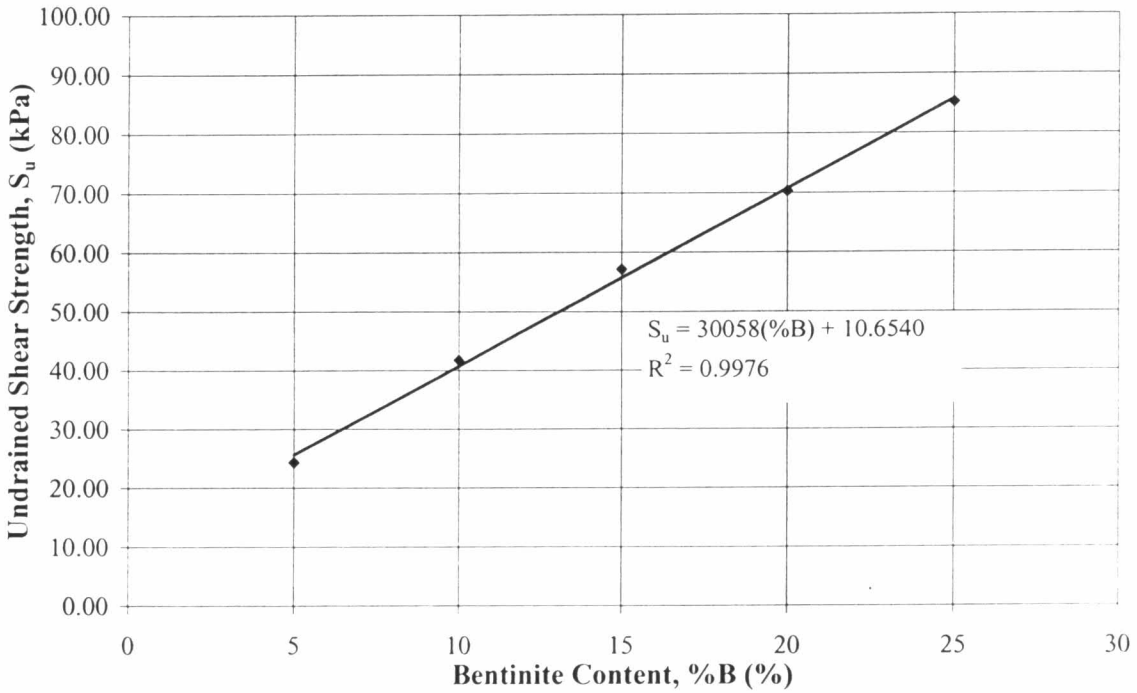
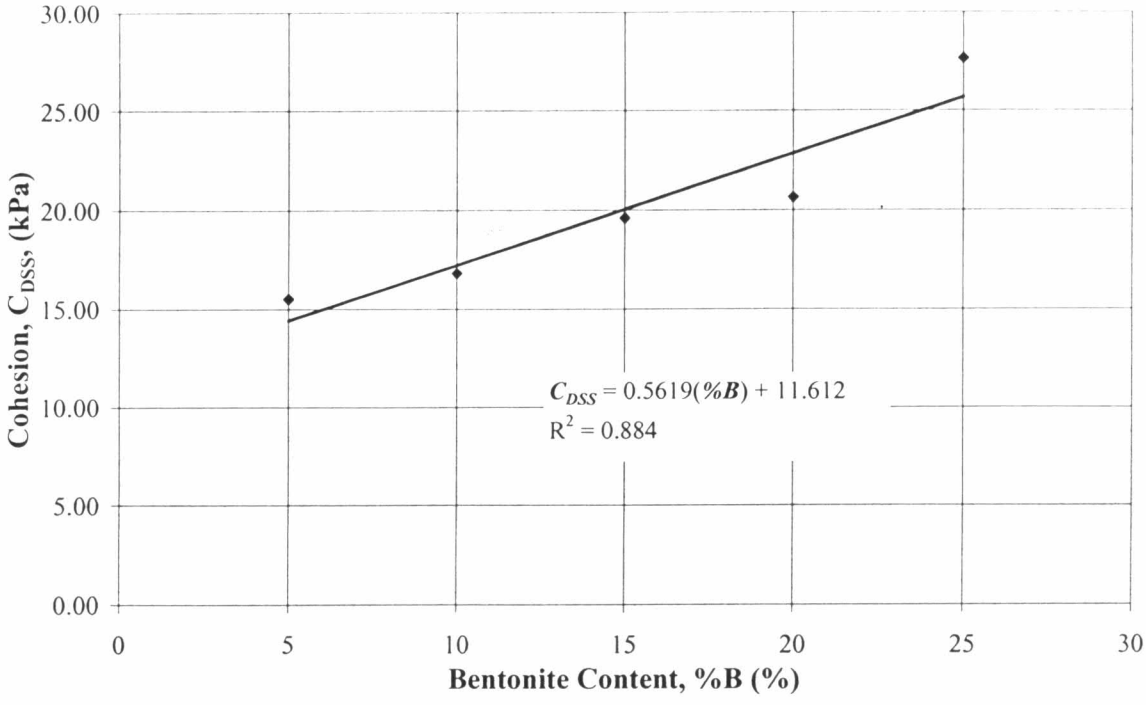
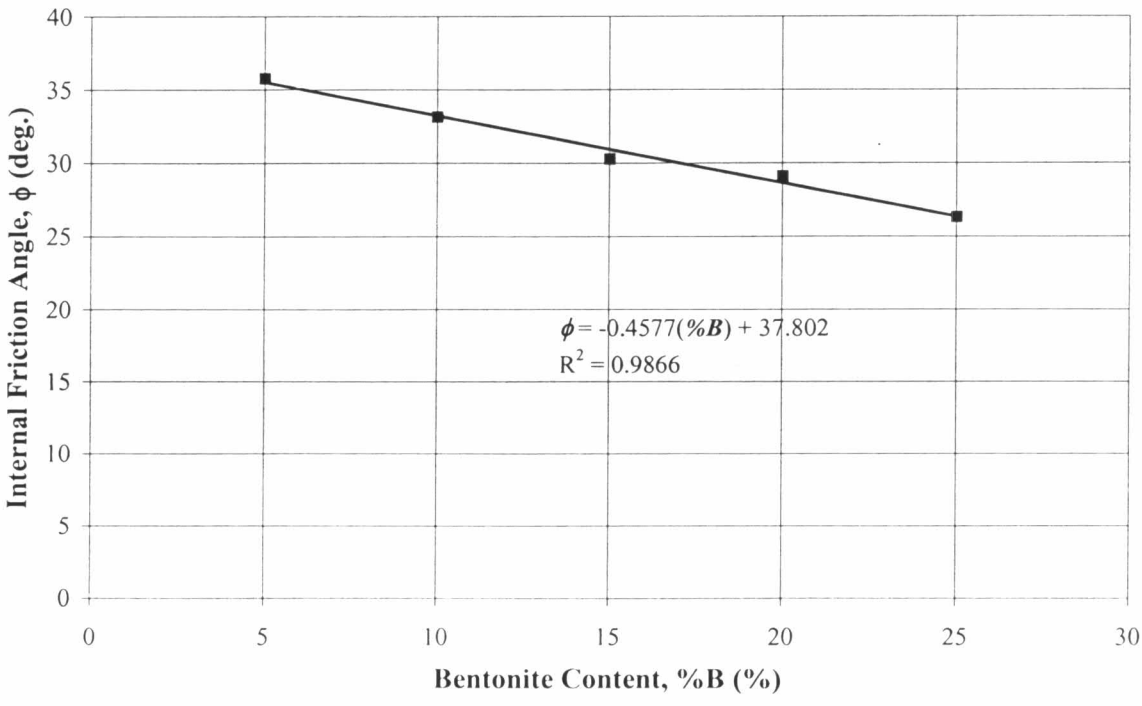


FIGURE 4.2 Summarized of Unconfined compressive strength test results.



(a)



(b)

FIGURE 4.3 Relations between Bentonite content and cohesion (a) and internal friction angle (b) from Direct Shear Test.

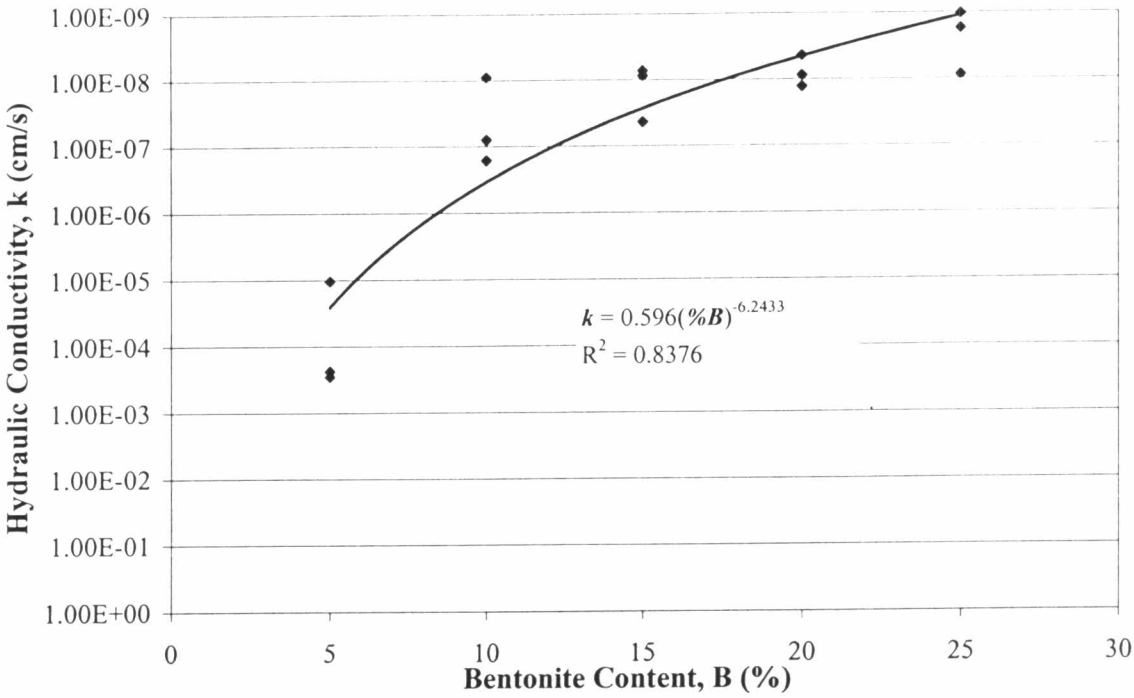


FIGURE 4.4 The plot between bentonite content and the coefficient of permeability, *k*, of the mixtures.

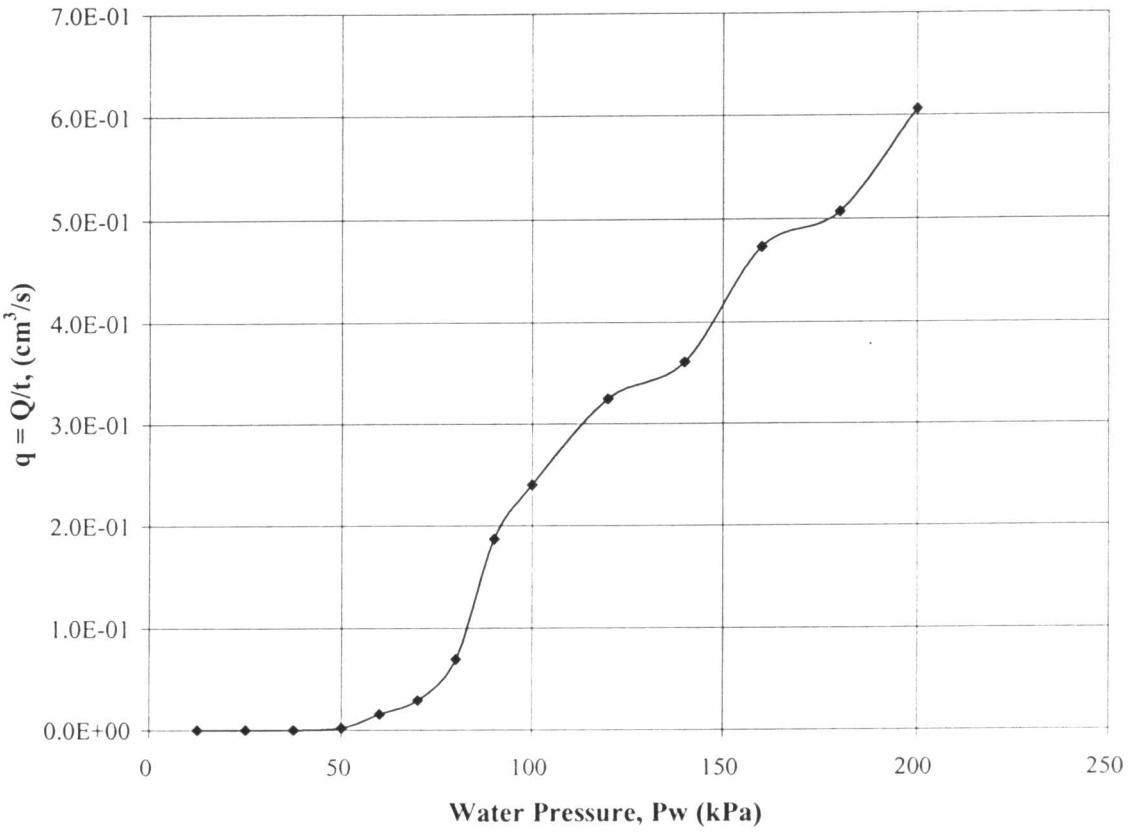


FIGURE 4.5 The measured flow rates of water in the starter slot plotted against the applied pressures obtained from sample SHF01.

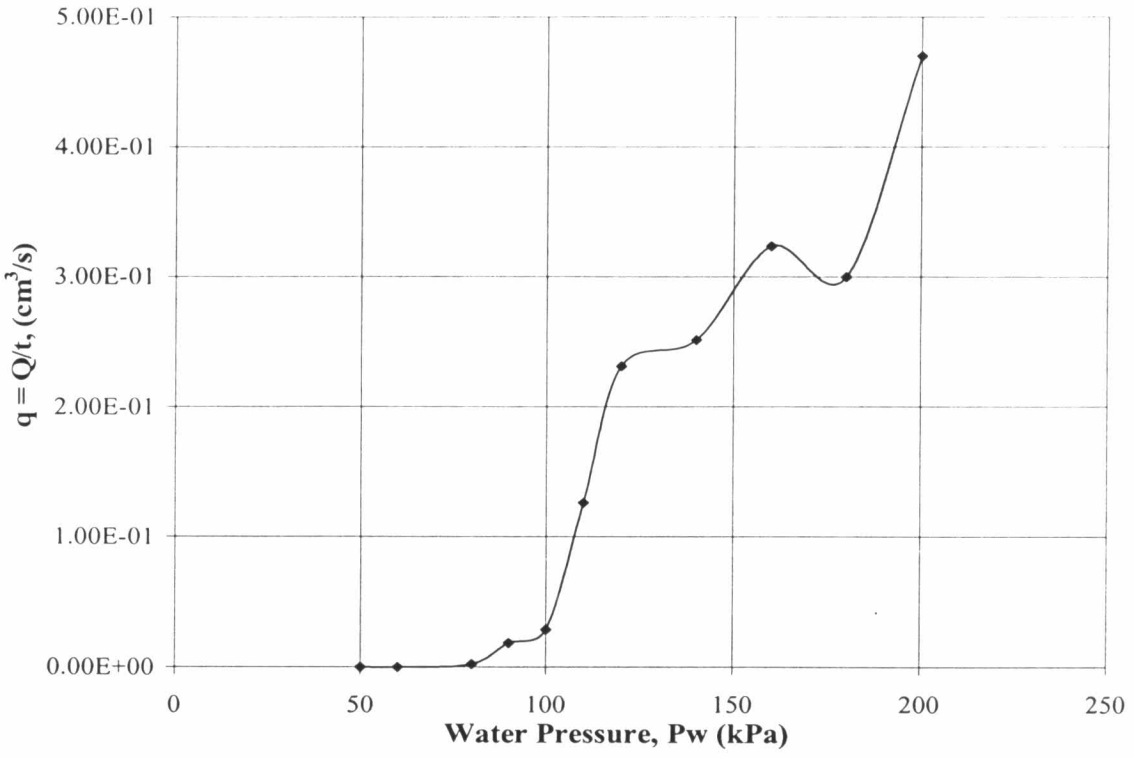


FIGURE 4.6 The measured flow rates of water in the starter slot plotted against the applied pressures obtained from samples QHF01.

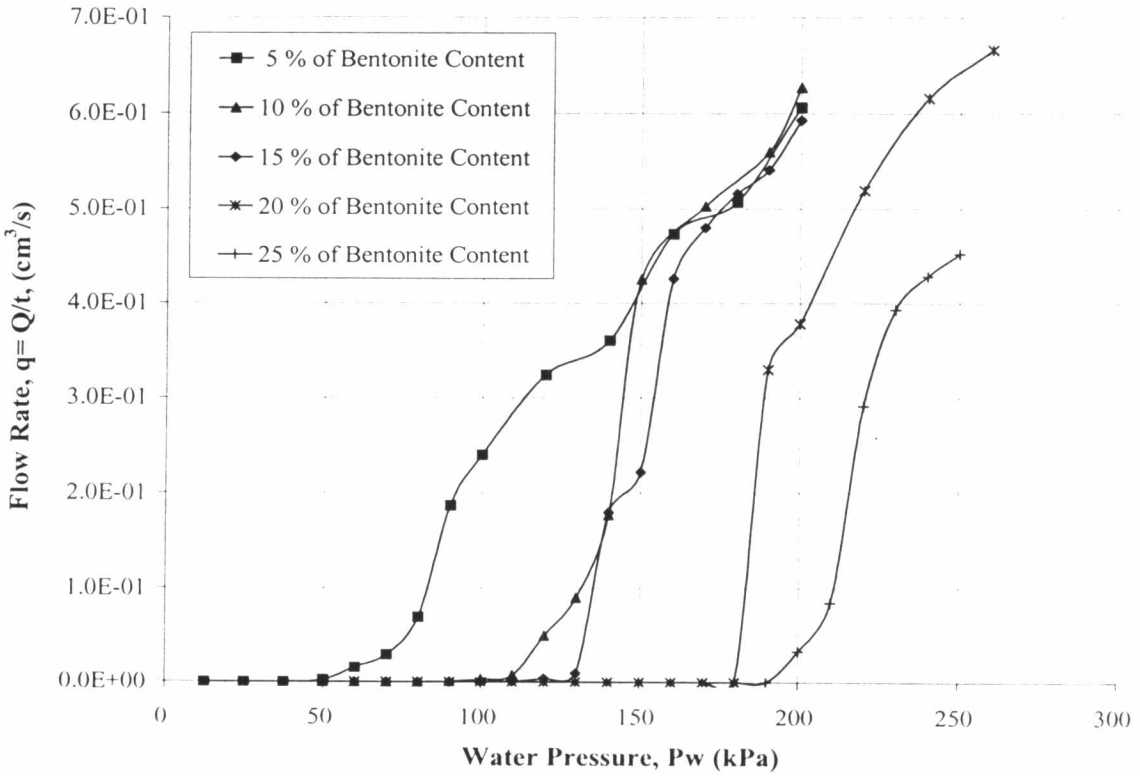


FIGURE 4.7 The Flow Rate and Water Pressure from Hydraulic Fracture Slow Rate Test on Horizontal Fracture Plane under 100 kPa of Overburden Pressure.

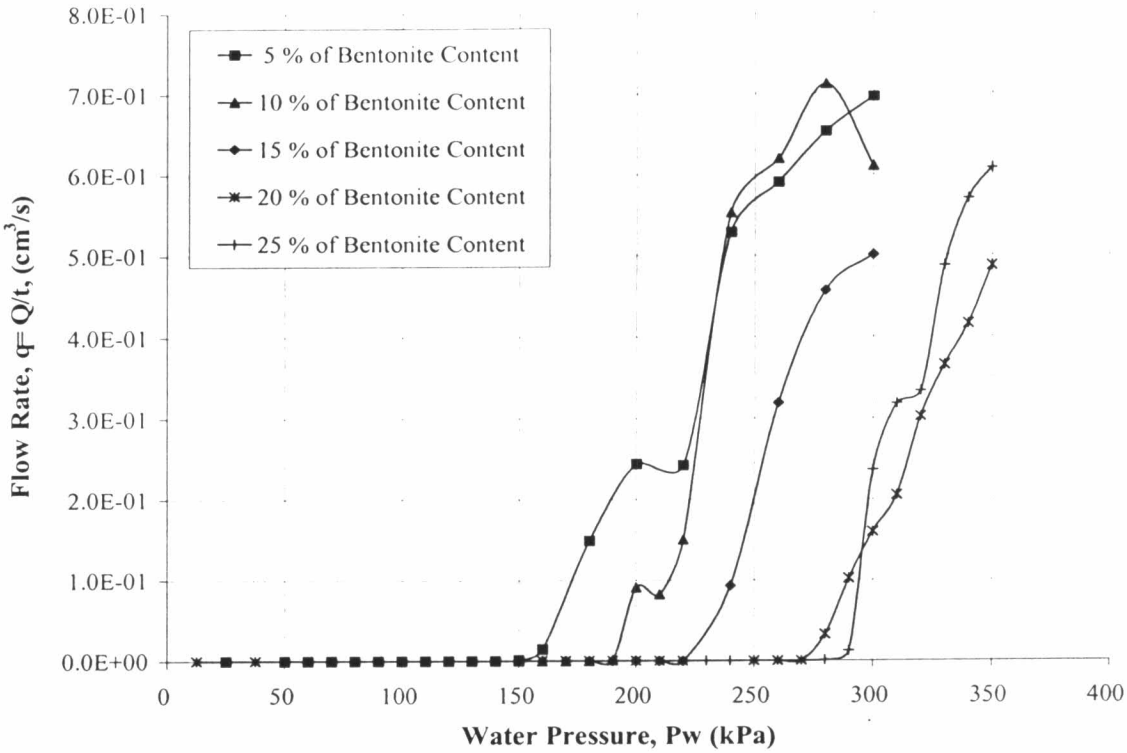


FIGURE 4.8 The Flow Rate and Water Pressure from Hydraulic Fracture Slow Rate Test on Horizontal Fracture Plane under 200 kPa of Overburden Pressure.

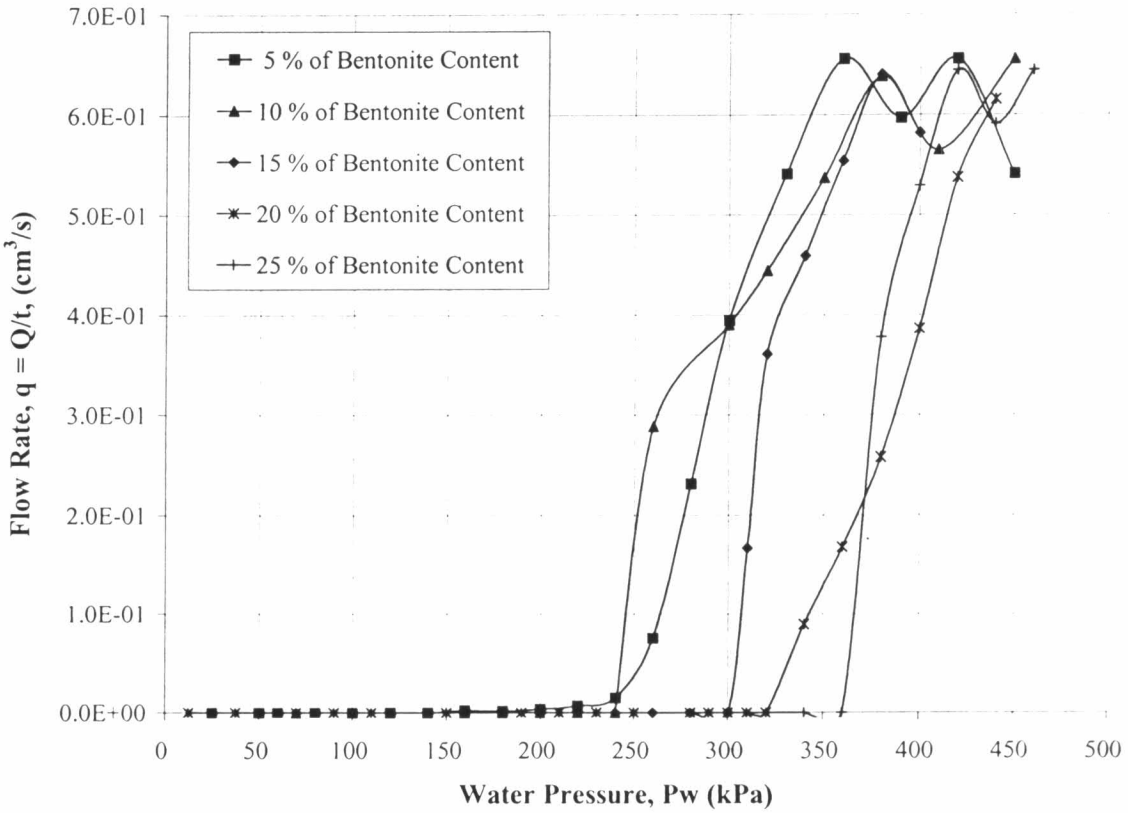


FIGURE 4.9 The Flow Rate and Water Pressure from Hydraulic Fracture Slow Rate Test on Horizontal Fracture Plane under 300 kPa of Overburden Pressure.

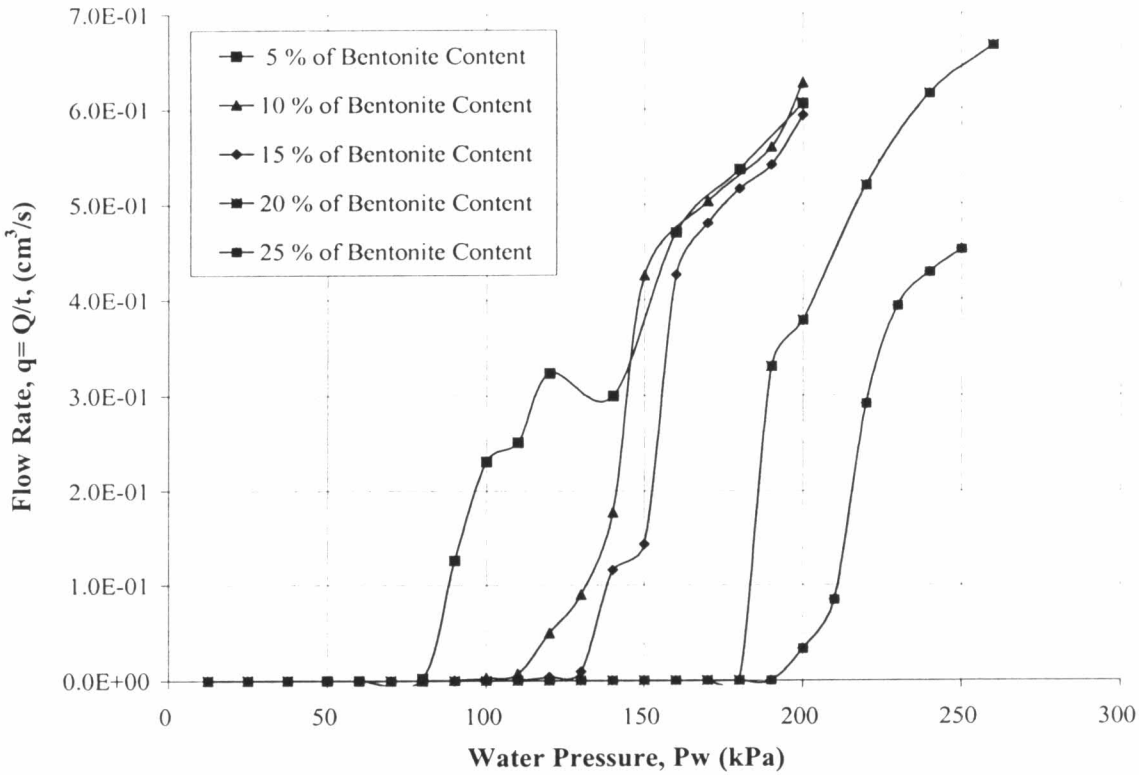


FIGURE 4.13 The Flow Rate and Water Pressure from Hydraulic Fracture Quick Rate Test on Horizontal Fracture Plane under 100 kPa of Overburden Pressure.

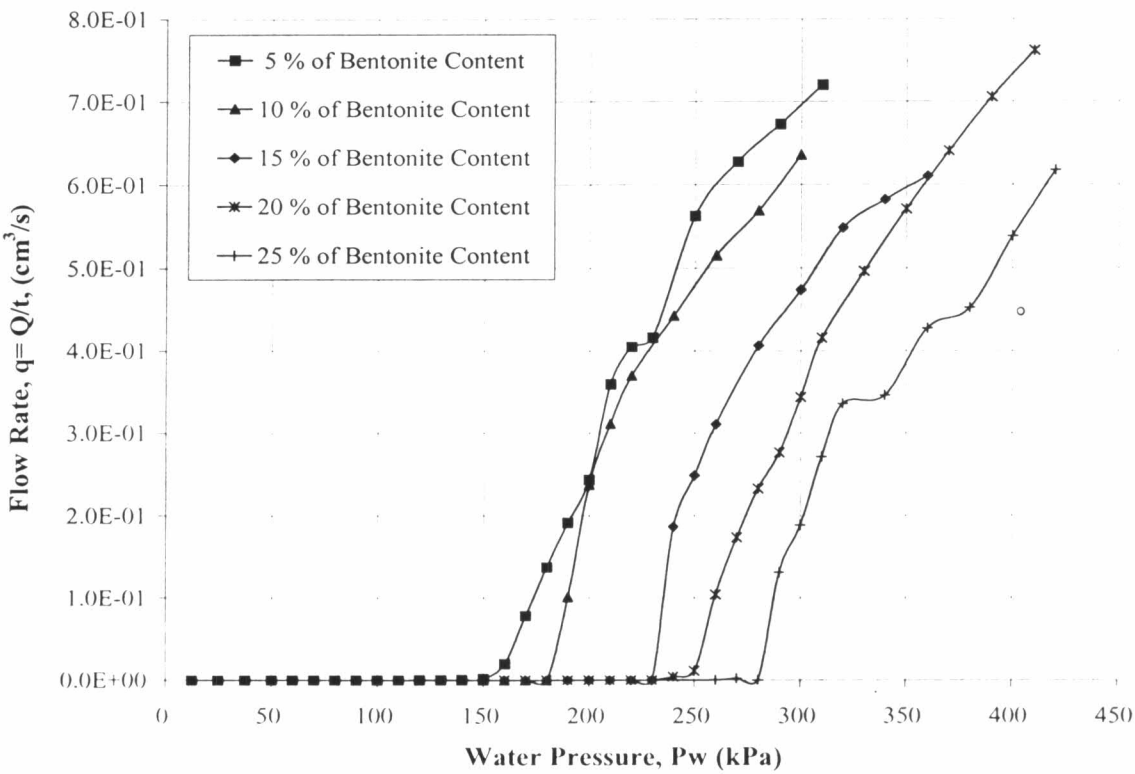


FIGURE 4.14 The Flow Rate and Water Pressure from Hydraulic Fracture Quick Rate Test on Horizontal Fracture Plane under 200 kPa of Overburden Pressure.

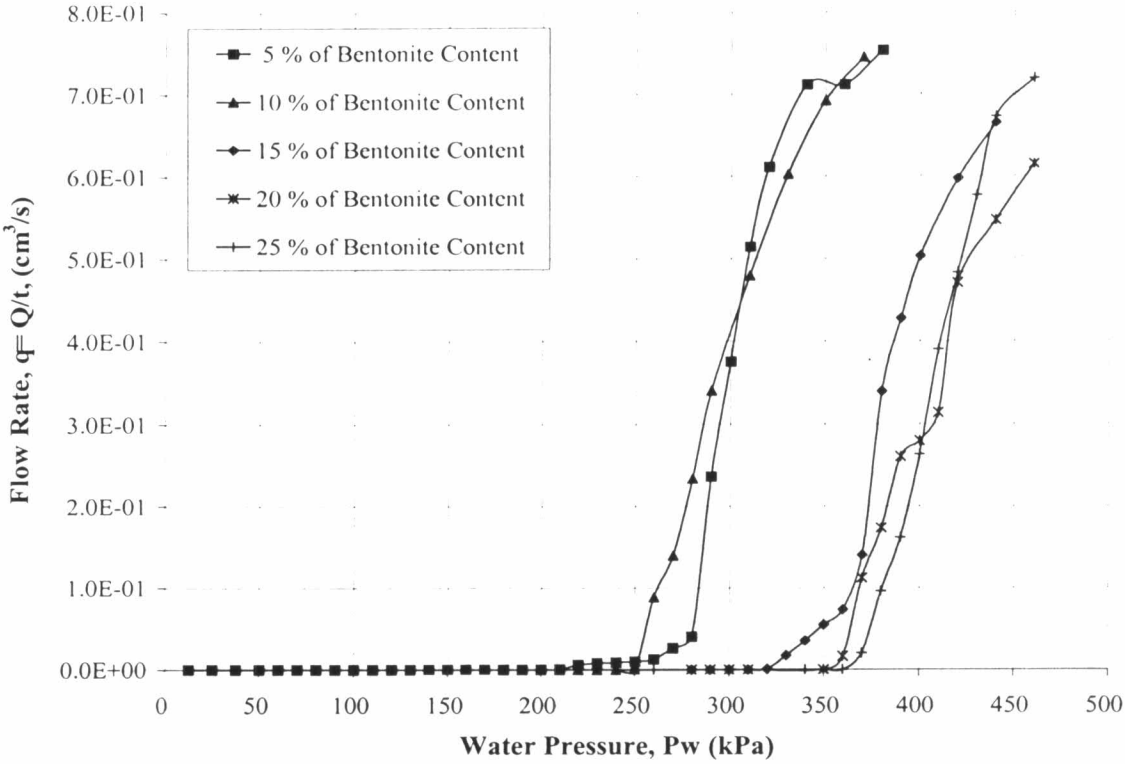


FIGURE 4.15 The Flow Rate and Water Pressure from Hydraulic Fracture Quick Rate Test on Horizontal Fracture Plane under 300 kPa of Overburden Pressure.

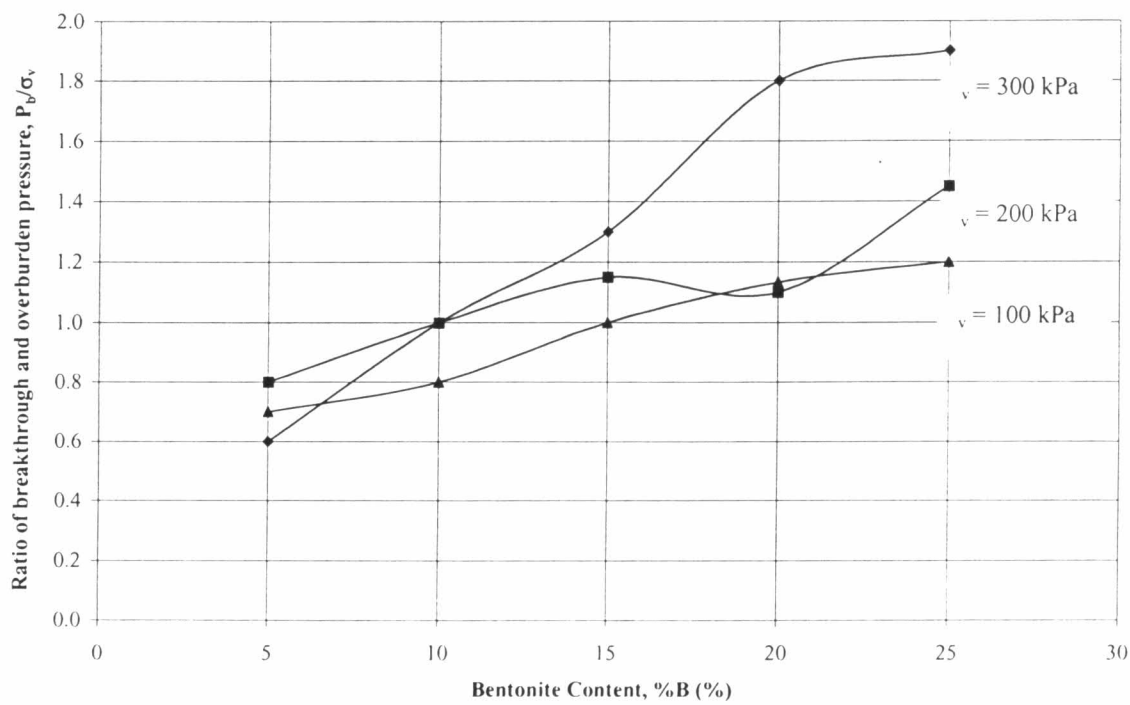


FIGURE 4.22 The Relations of Breakthrough and Overburden Pressure with Bentonite Content of Hydraulic Fracture Slow Rate Test on Horizontal Fracture Plane.

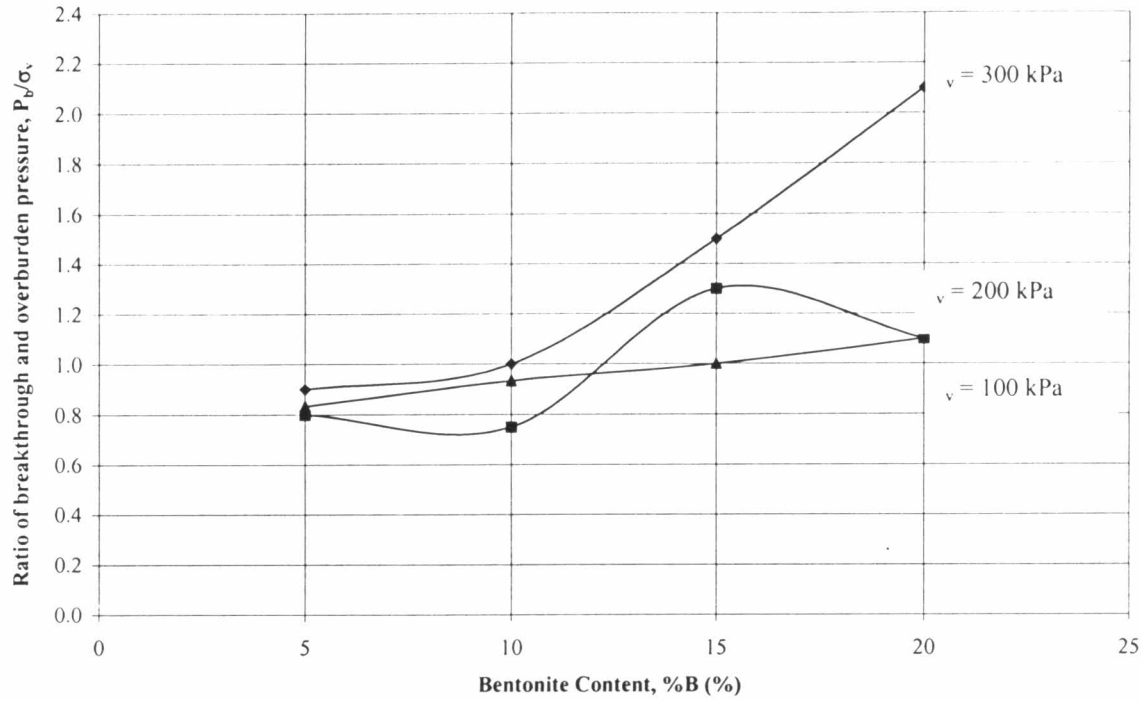


FIGURE 4.23 The Relations of Breakthrough and Overburden Pressure with Bentonite Content of Vertical Fracture Slow Rate Test on Horizontal Fracture Plane.

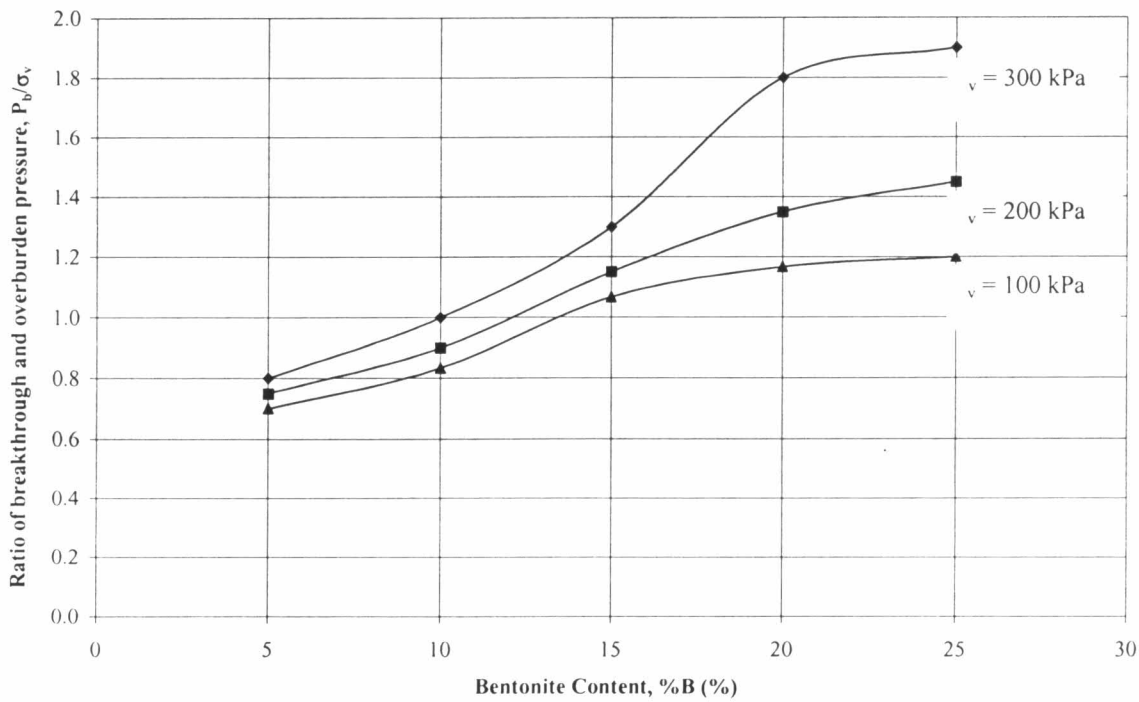


FIGURE 4.24 The Relations of Breakthrough and Overburden Pressure with Bentonite Content of Hydraulic Fracture Quick Rate Test on Horizontal Fracture Plane.

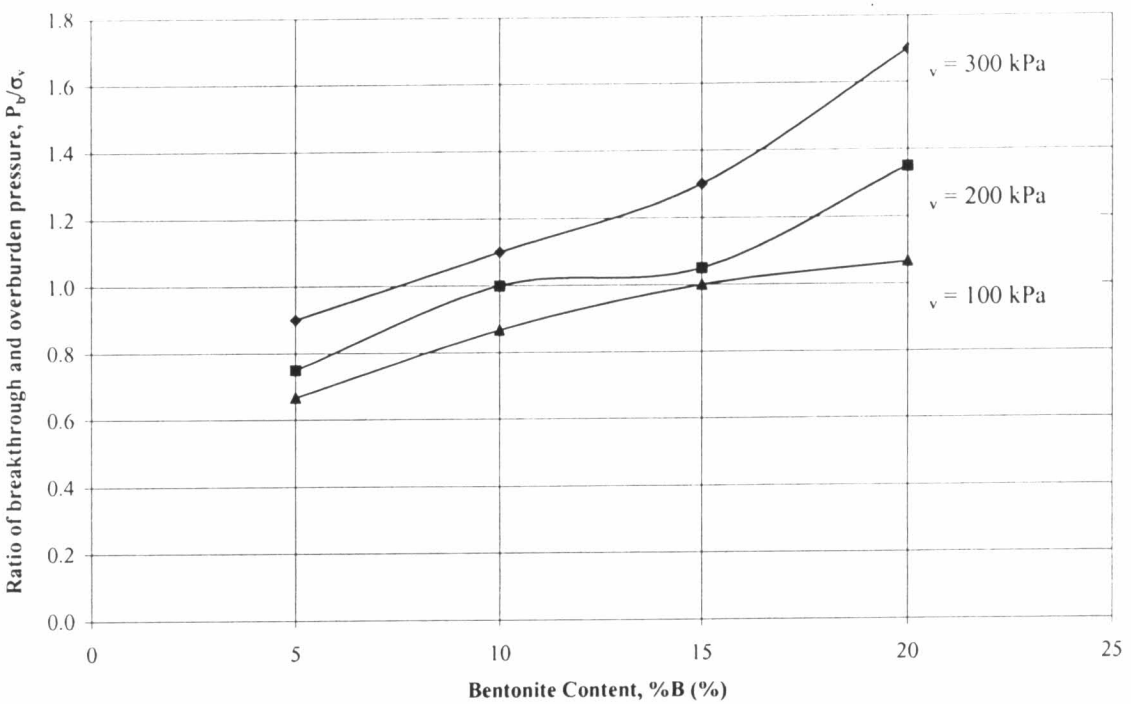


FIGURE 4.25 The Relations of Breakthrough and Overburden Pressure with Bentonite Content of Vertical Fracture Quick Rate Test on Horizontal Fracture Plane.

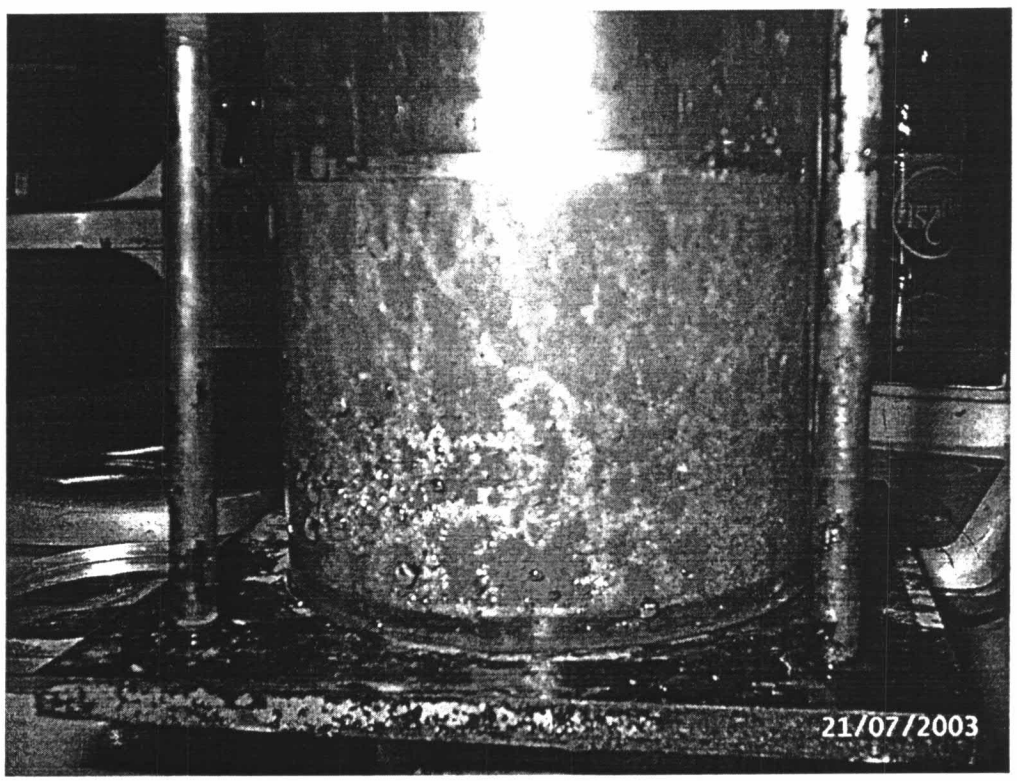


FIGURE 4.26 Show the detachment path with can observed from the outside of perpex.

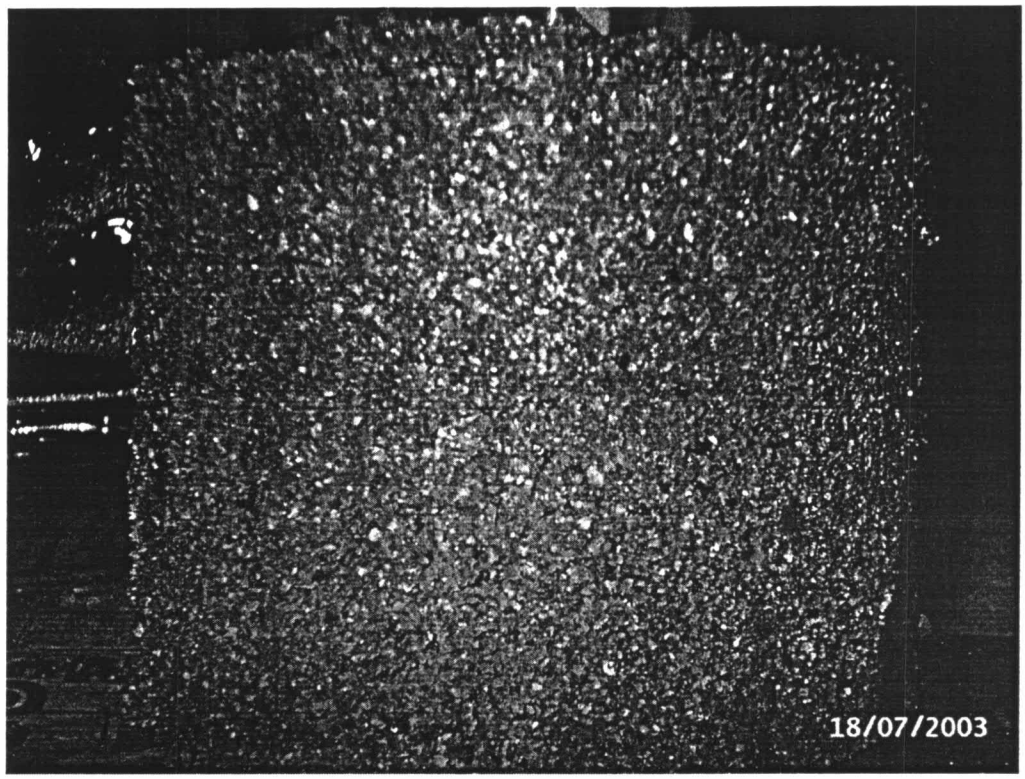


FIGURE 4.27 Show the detachment path with can observed from the outside of perpex.

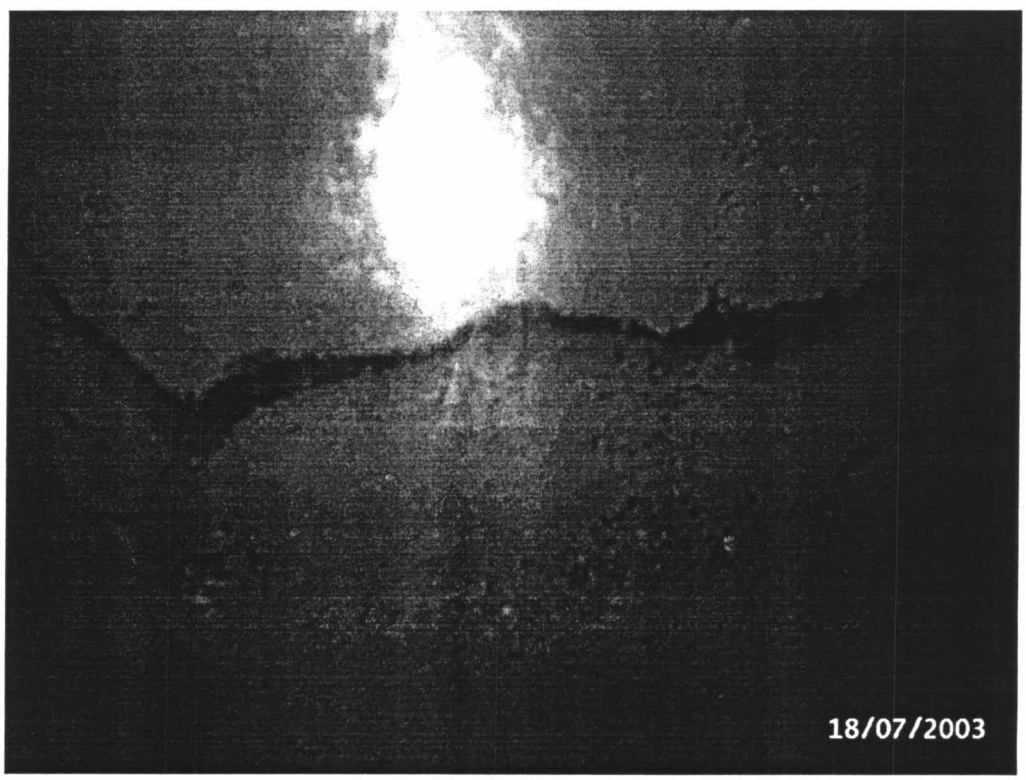


FIGURE 4.28 Show the fracture with can observed from the outside of perpex.

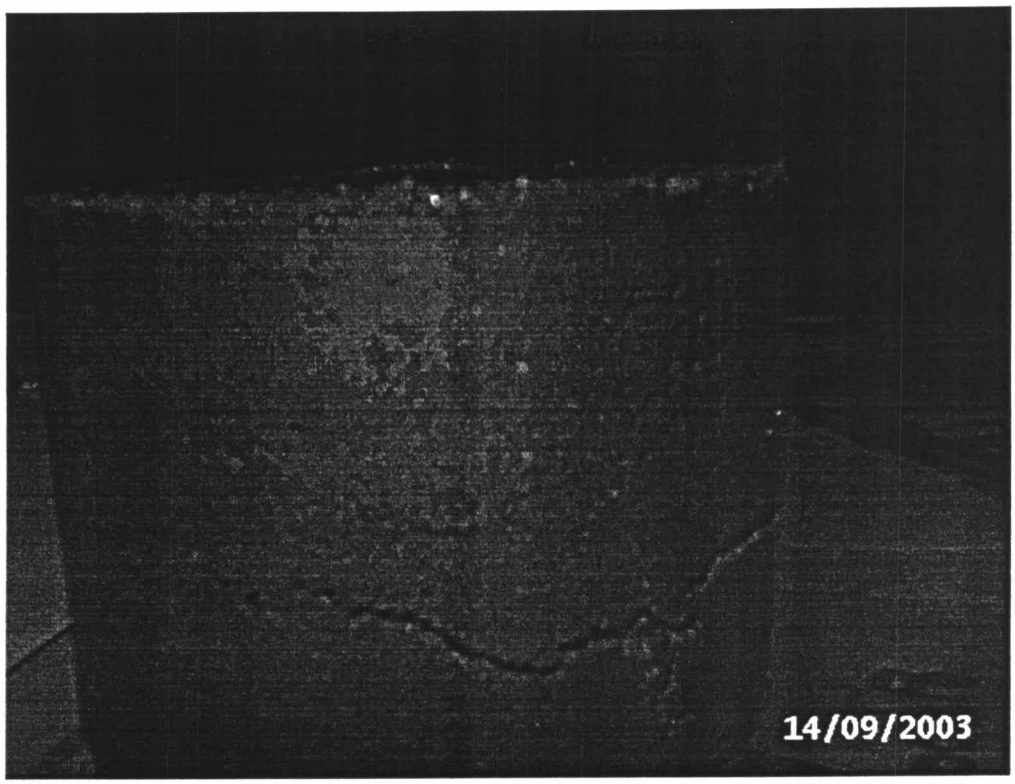
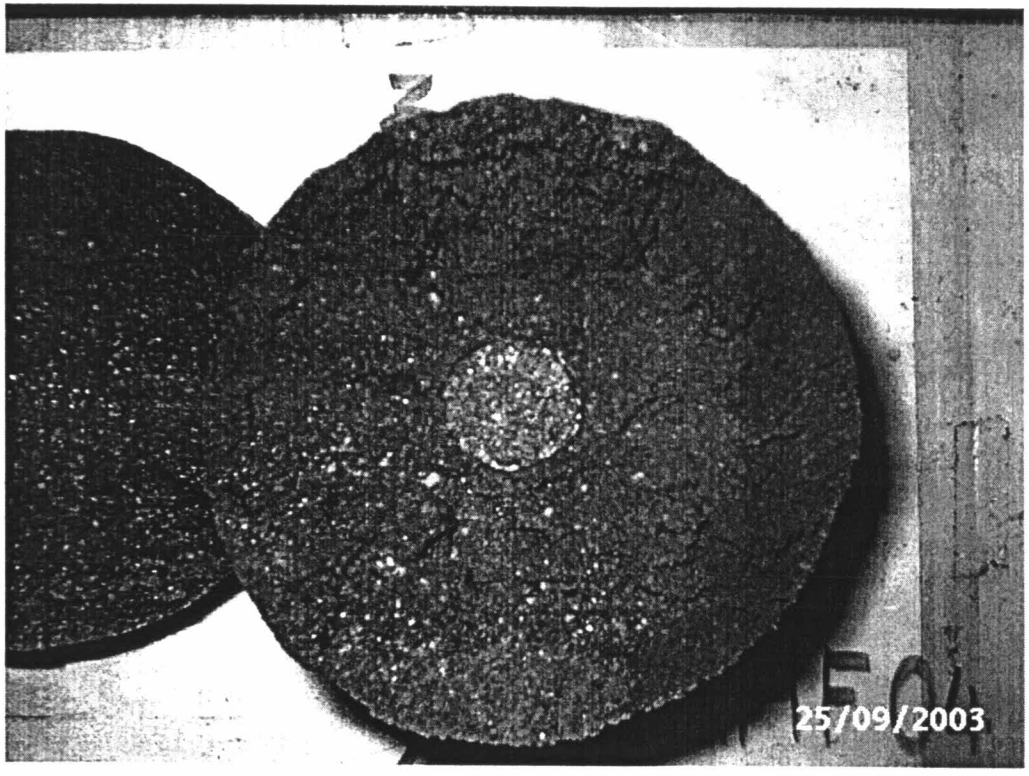
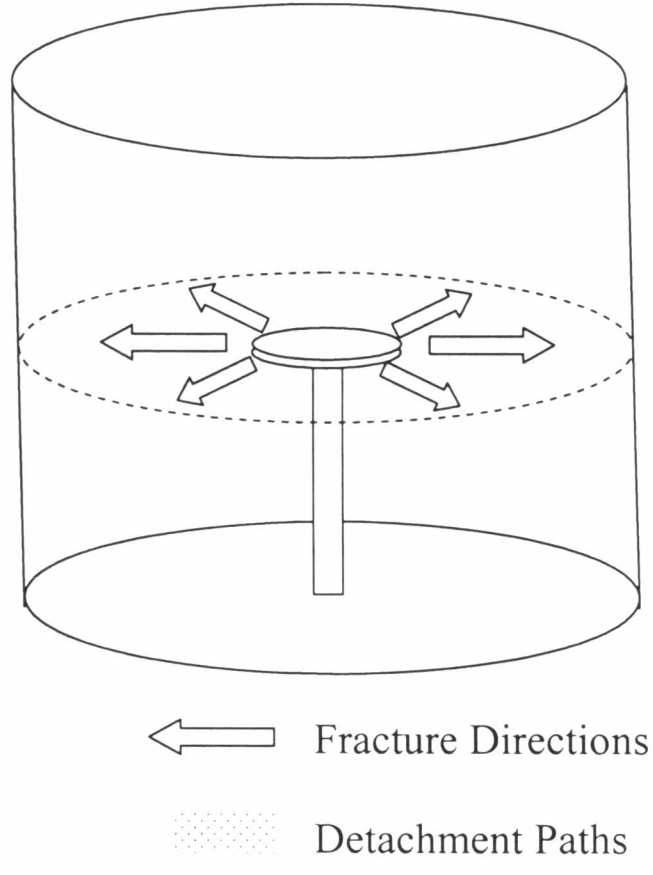


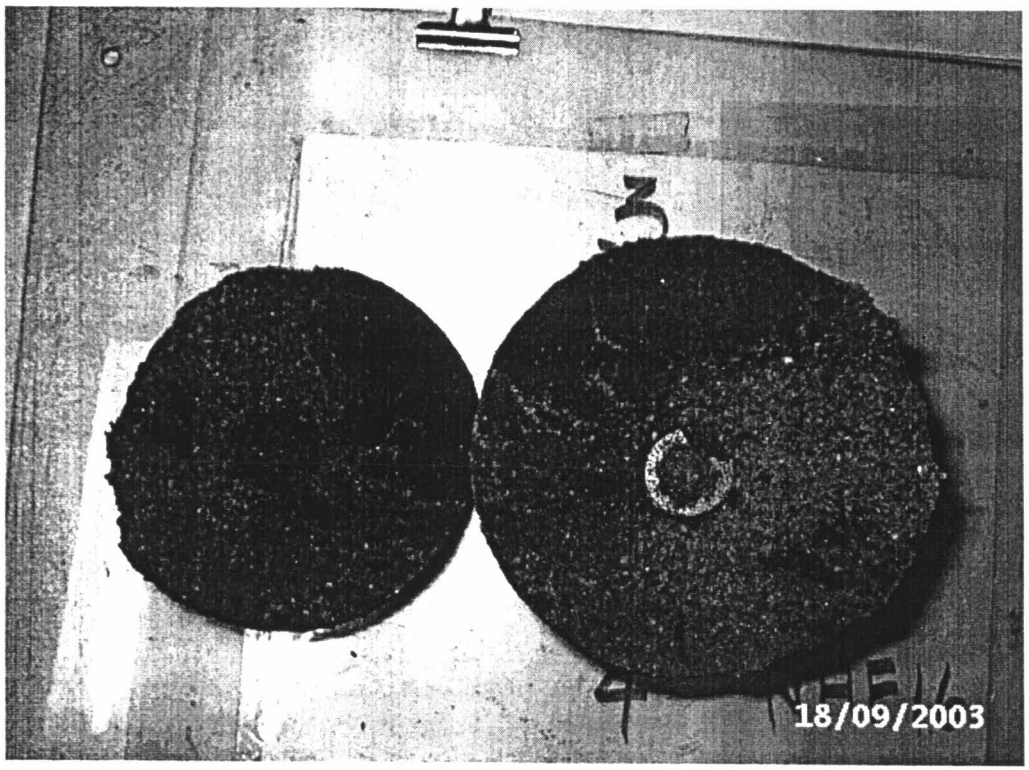
FIGURE 4.29 Show the fracture path with can observed from the outside of perpex.

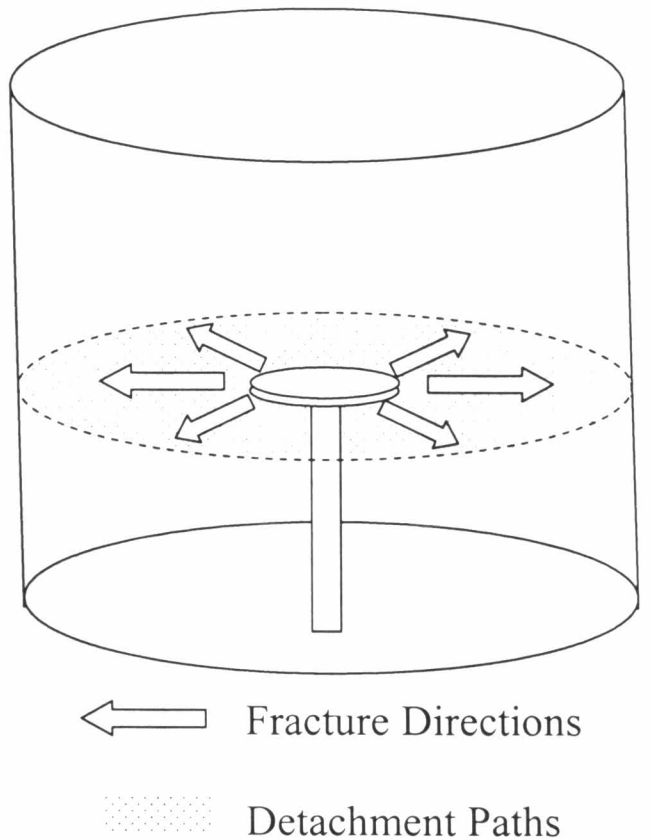




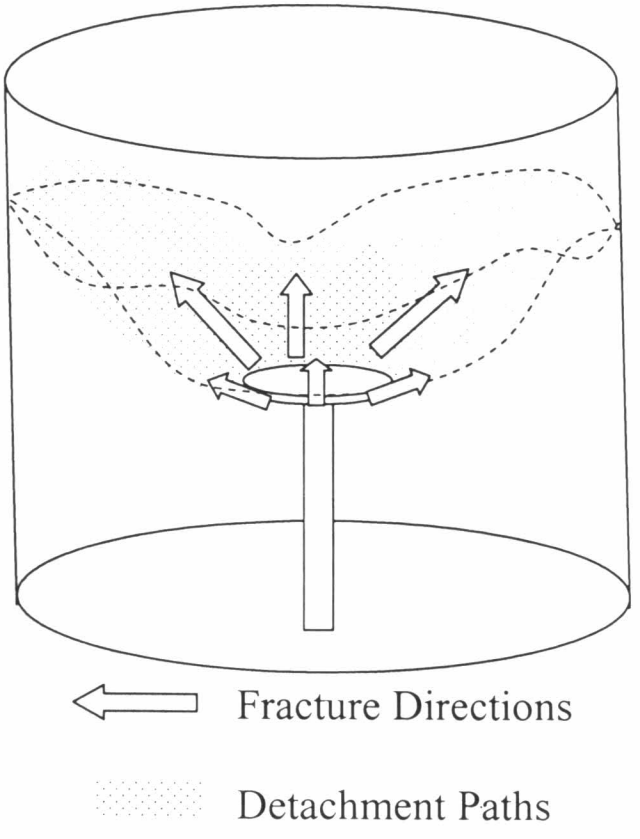
Symbol Type "G" (Gently dipping)

Figure 4.30 Gently dipping forms. The surface form is smooth flat in horizontal plane. Detachment path appears at the edge of sample.

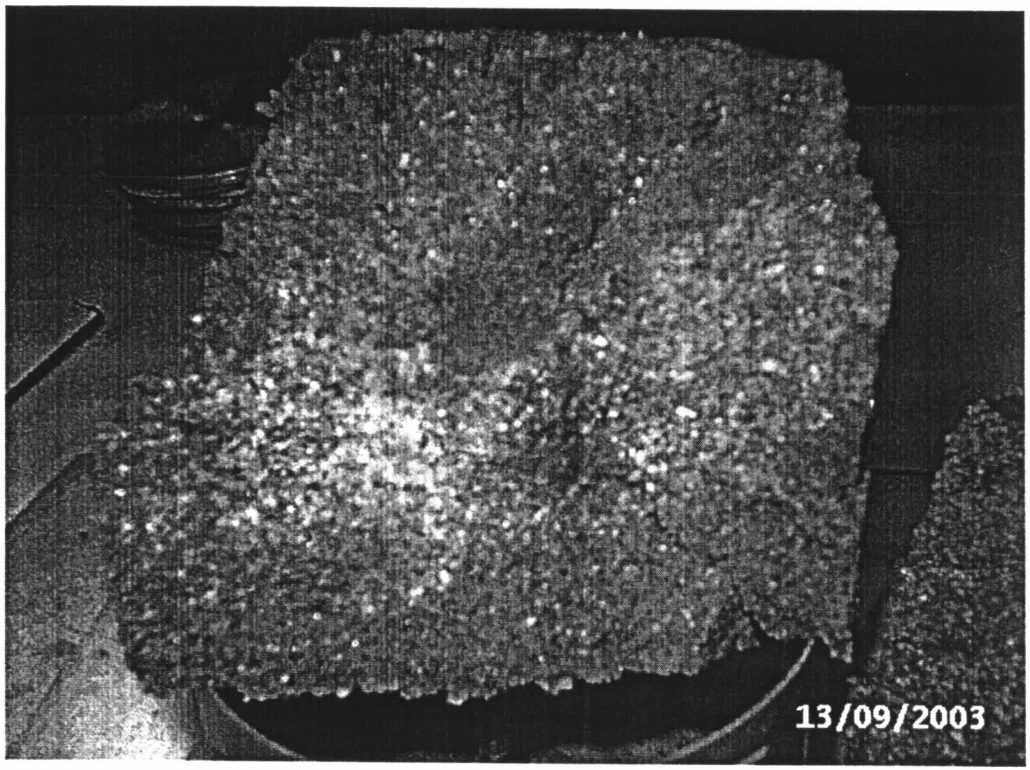


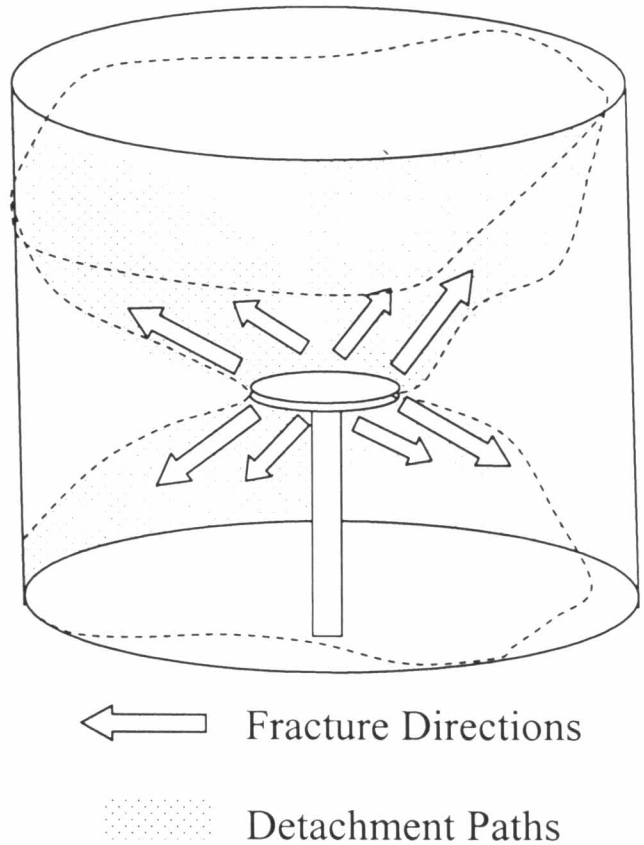


Symbol Type "G-D" (Gently dipping and Detachmant)
Figure 4.31 Gently dipping forms and detachment. The surface form is rough flat in horizontal plane with the detachment path.

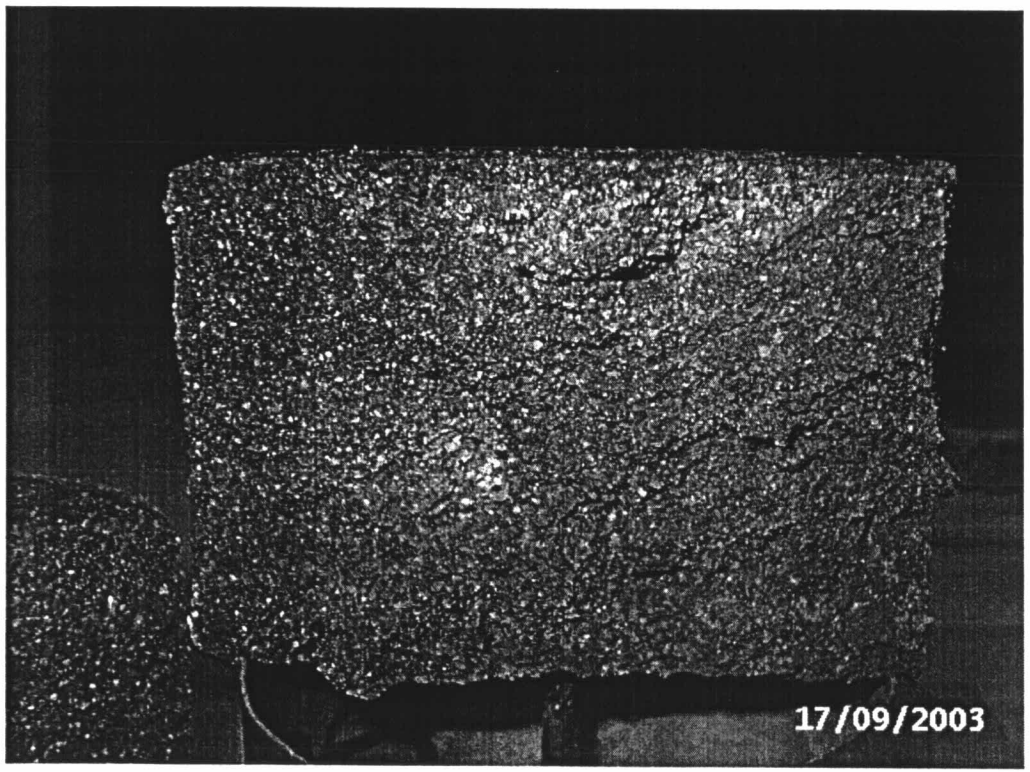


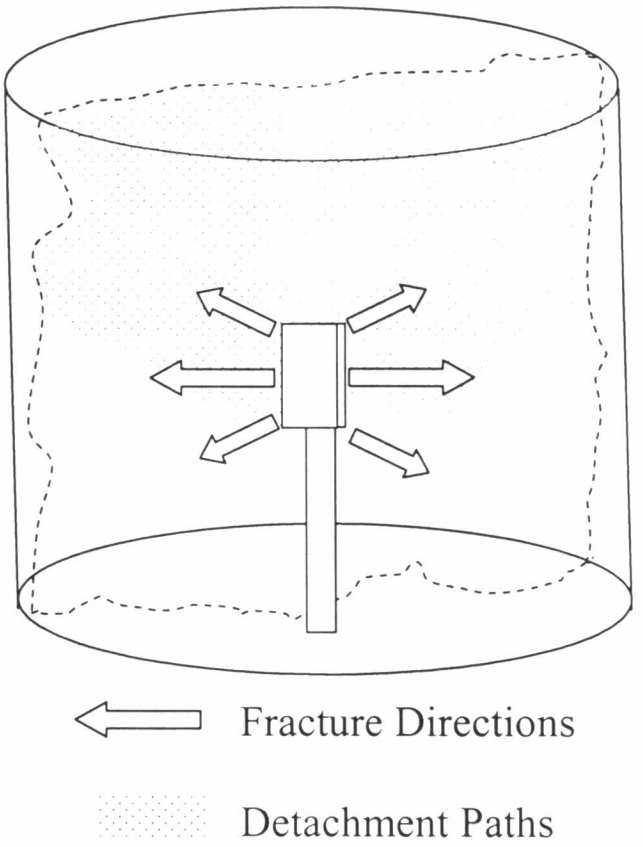
Symbol Type "S-D" (Steeply dipping and Detachment)
Figure 4.32 Steeply dipping and detachment forms. The surface form is rough and shows the detachment path.



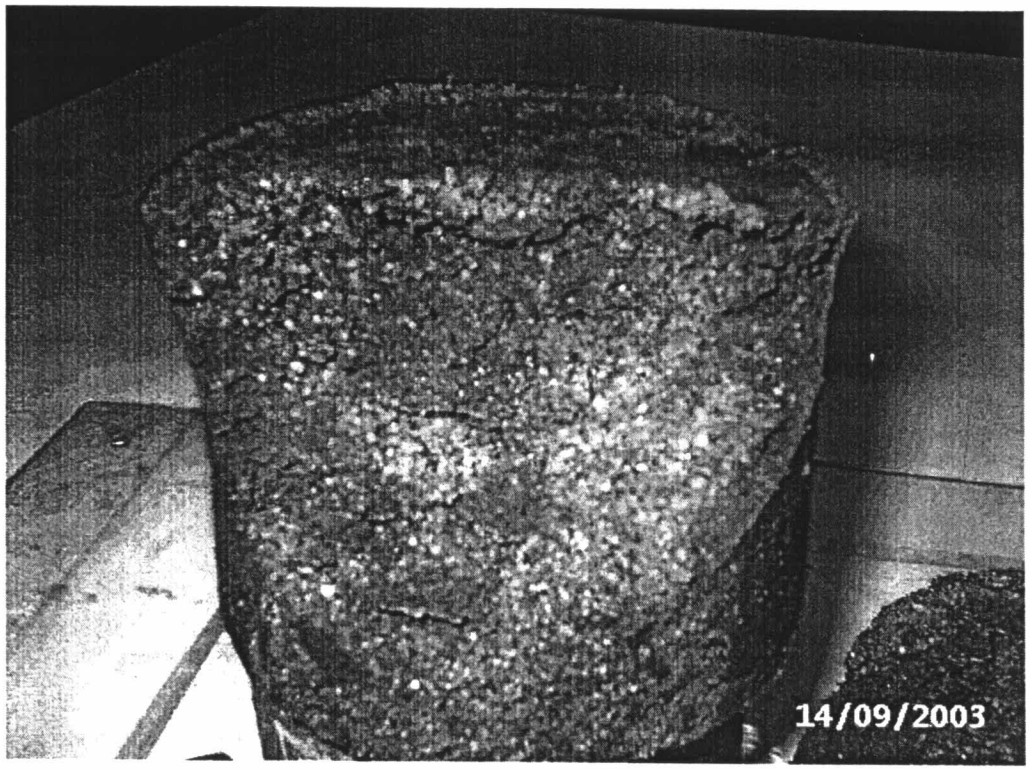


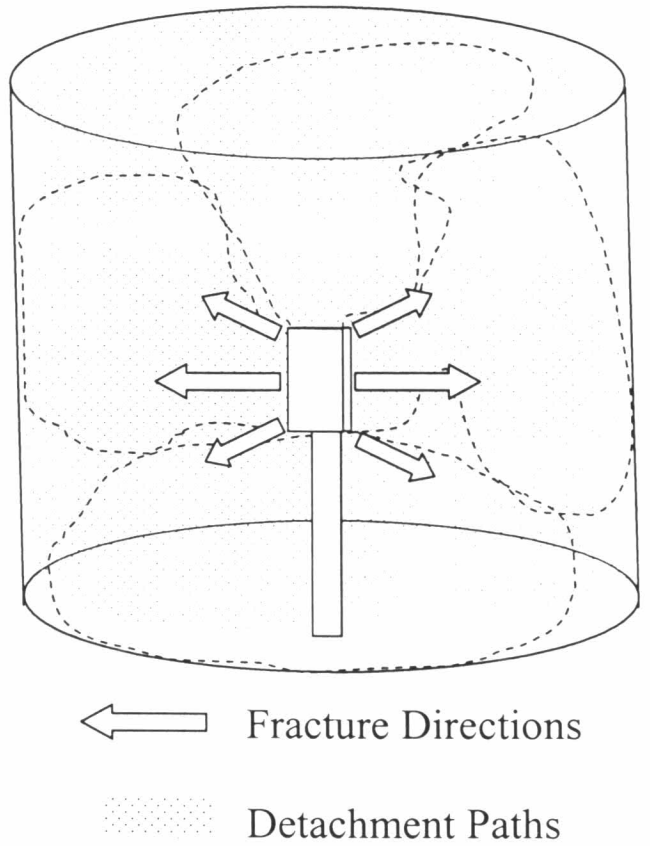
Symbol Type "2S-D" (2 directions steeply dipping and Detachment)
Figure 4.33 2 directions upper and lower of steeply dipping and detachment forms. The surface form is rough and shows the detachment path.





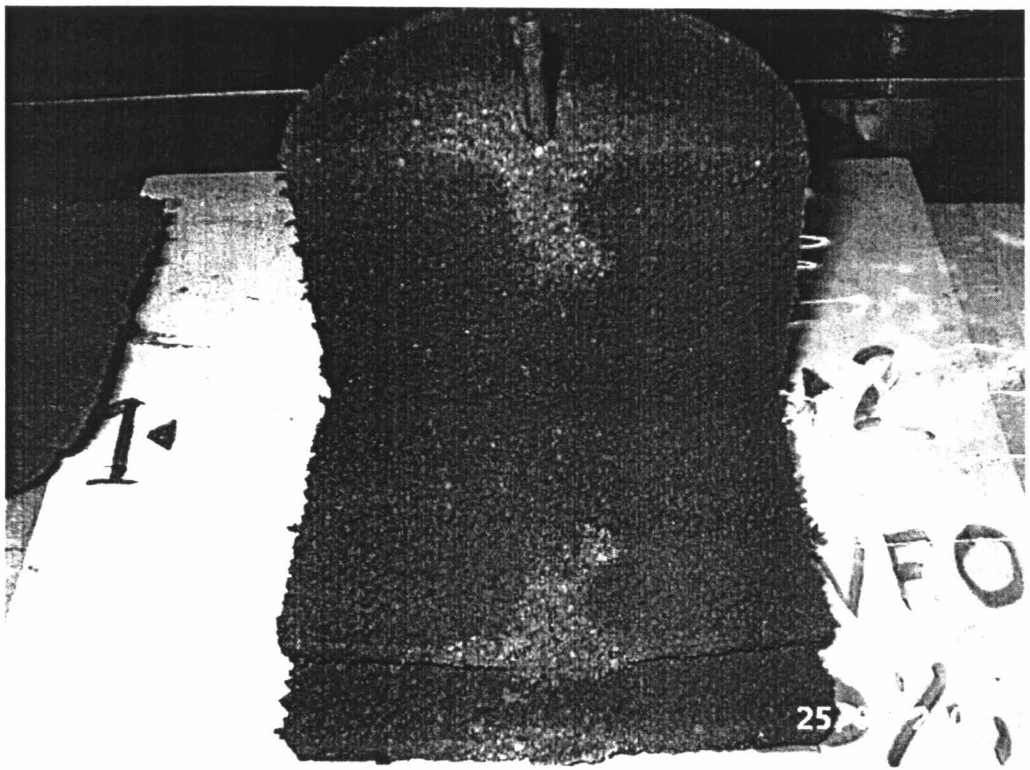
Symbol Type "VG-D" (Vertical gently dipping and Detachment)
Figure 4.34 Vertical gently dipping and detachment forms of sample. The surface form is rough flat in vertical plane and shows detachment path.

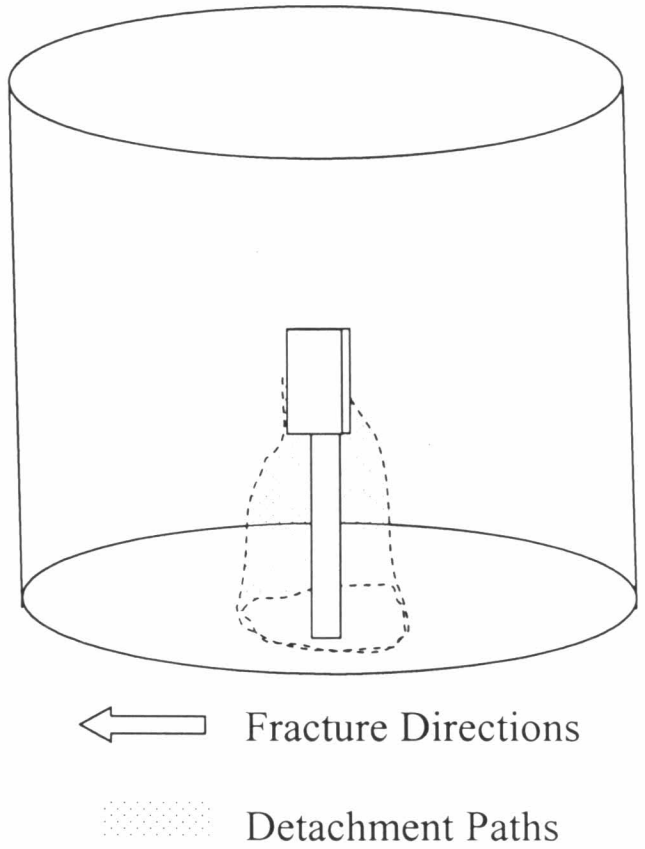




Symbol Type "FD" (Full Detachment)

Figure 4.35 Full detachment forms of sample. There are all surface detachment paths.





Symbol Type "VD" (Vertical Detachment)

Figure 4.36 Vertical detachment forms of sample. There is one detachment at the end of sample.

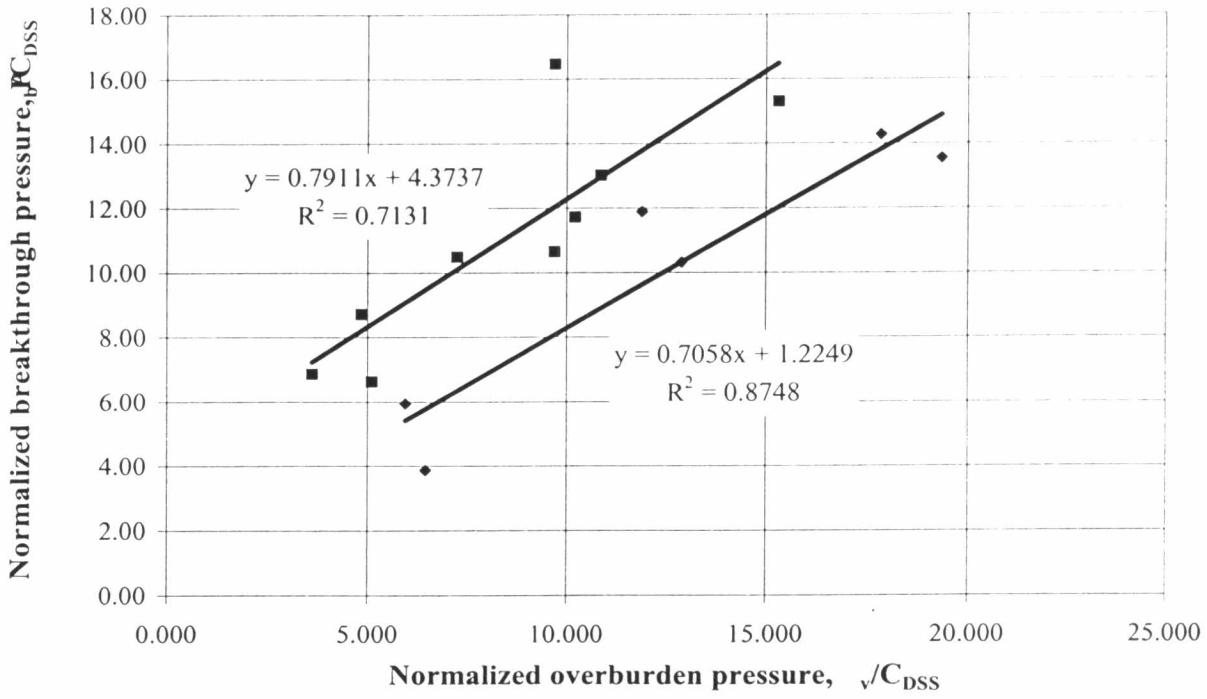


FIGURE 4.37 Normalized Pressures with Cohesion of Slow Rate Test on Horizontal Fracture Plane.

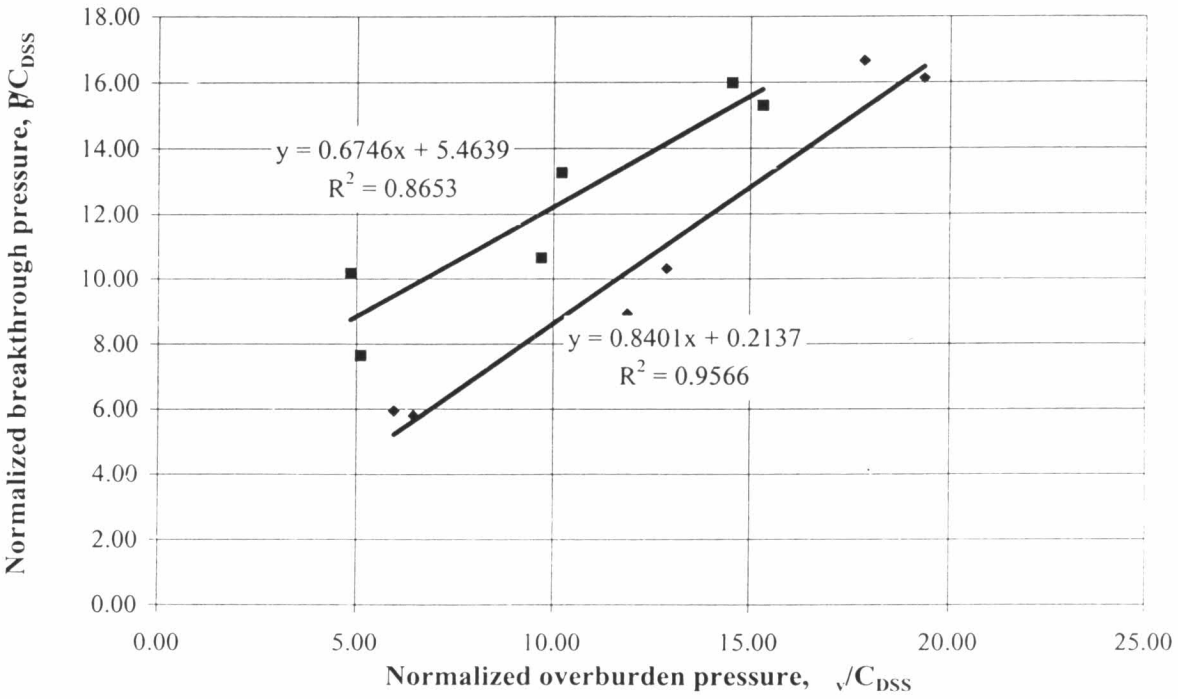


FIGURE 4.38 Normalized Pressures with Cohesion of Slow Rate Test on Vertical Fracture Plane.

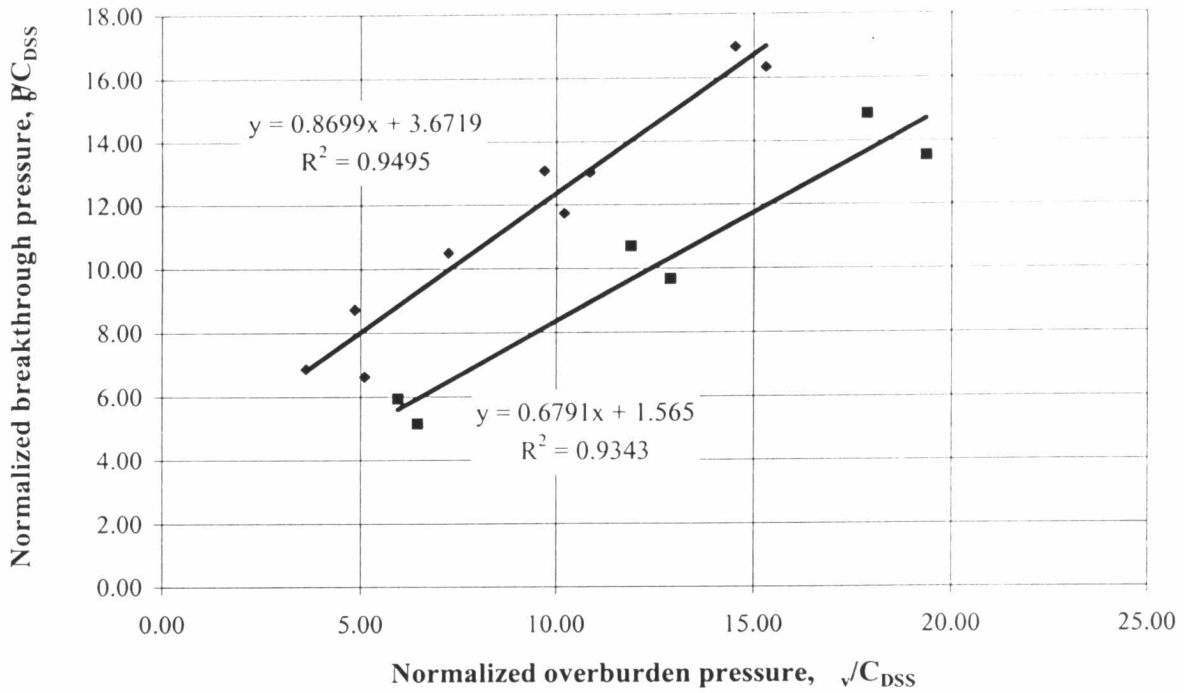


FIGURE 4.39 Normalized Pressures with Cohesion of Quick Rate Test on Horizontal Fracture Plane.

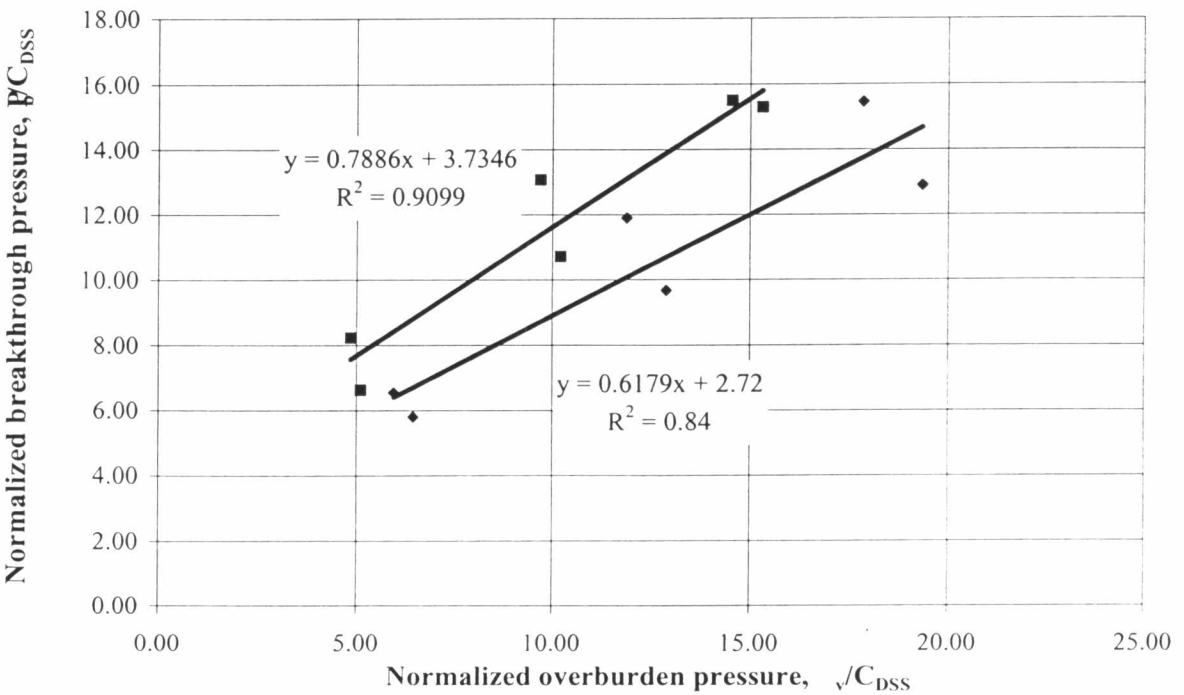


FIGURE 4.40 Normalized Pressures with Cohesion of Quick Rate Test on Vertical Fracture Plane.

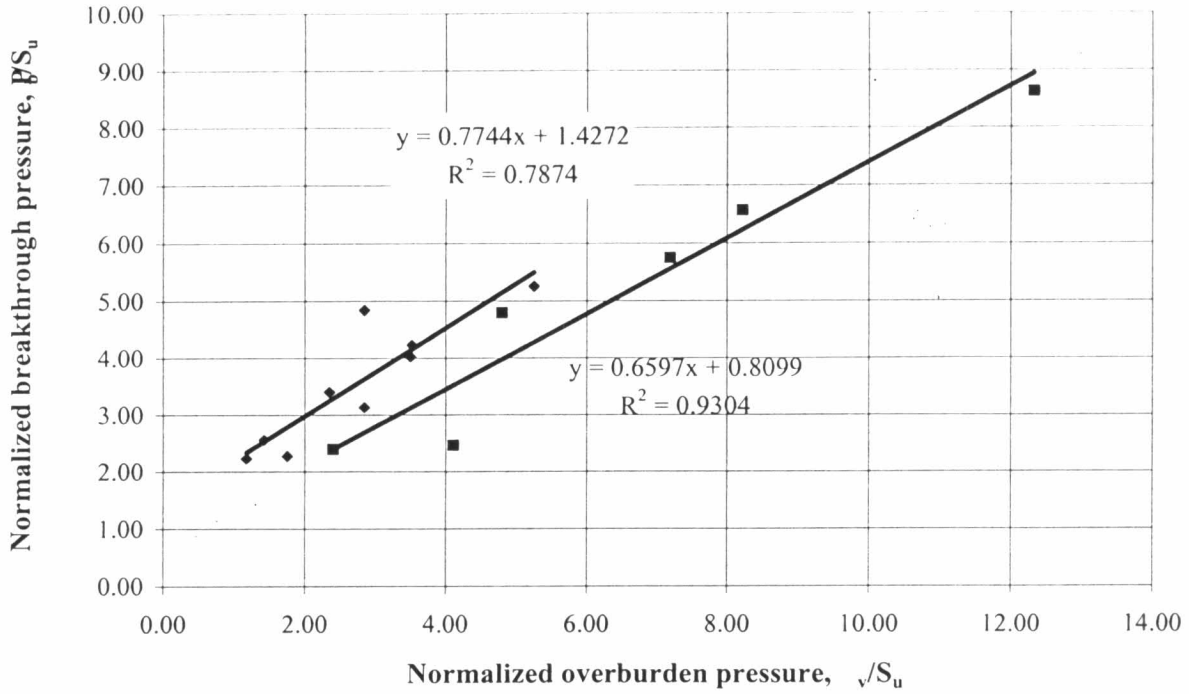


FIGURE 4.41 Normalized Pressures with Undrained Shear Strength of Slow Rate Test on Horizontal Fracture Plane.

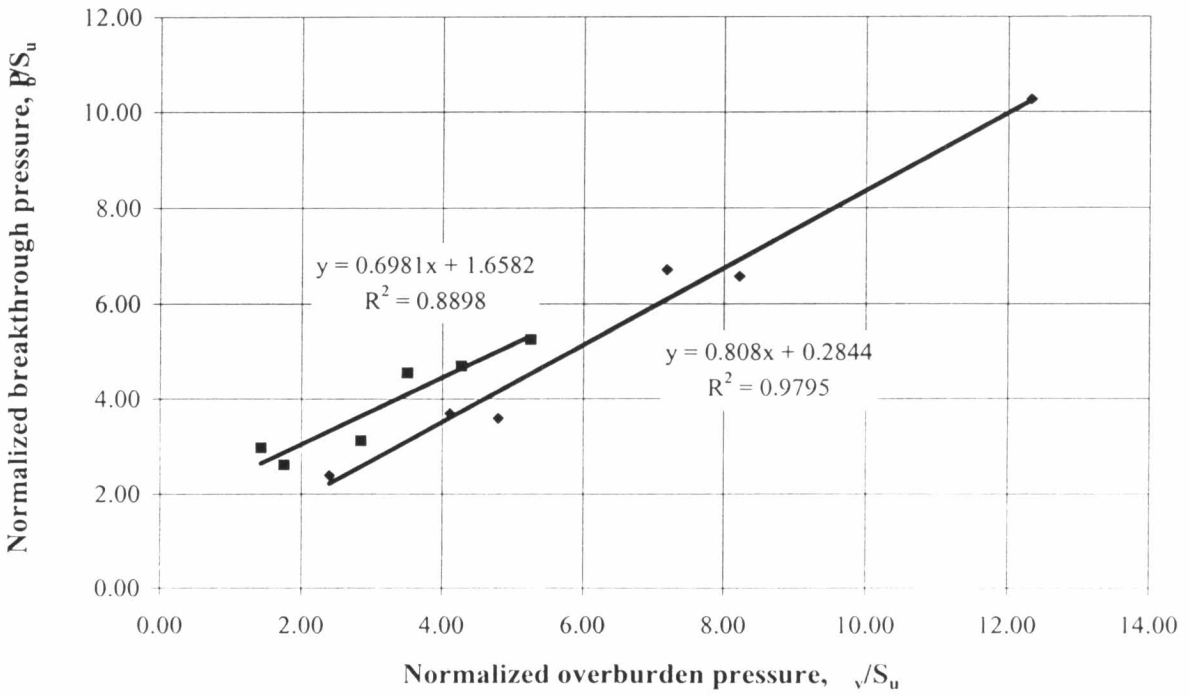


FIGURE 4.42 Normalized Pressures with Undrained Shear Strength of Slow Rate Test on Vertical Fracture Plane.

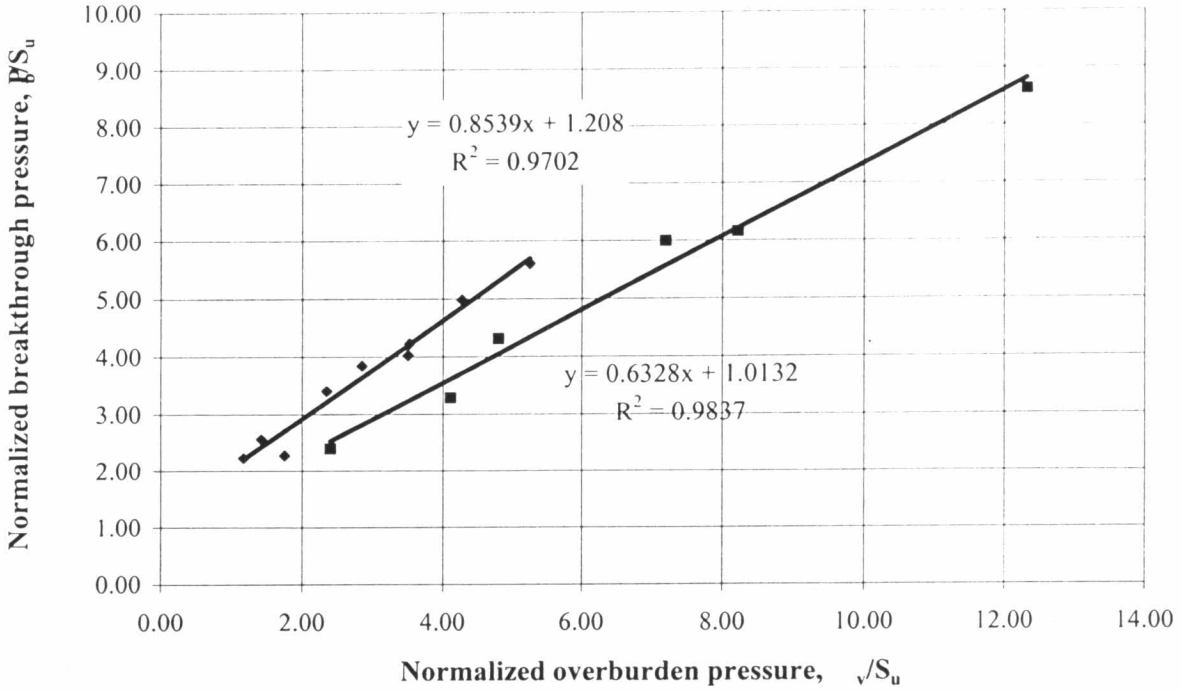


FIGURE 4.43 Normalized Pressures with Undrained Shear Strength of Quick Rate Test on Horizontal Fracture Plane.

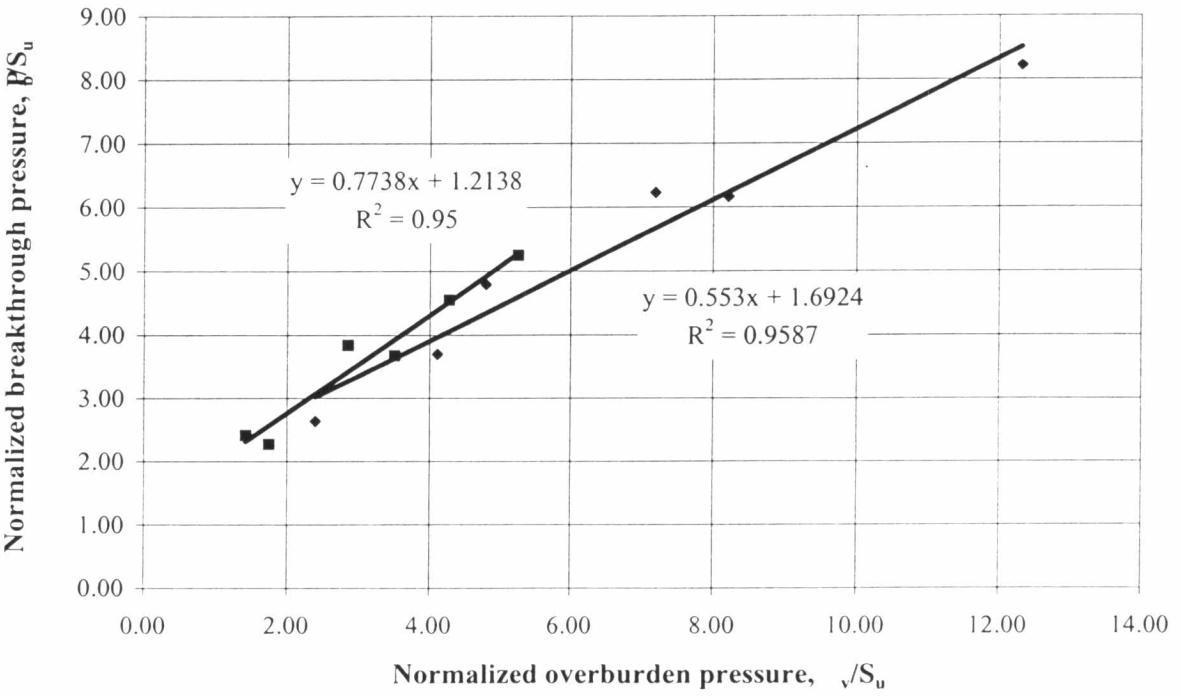


FIGURE 4.44 Normalized Pressures with Undrained Shear Strength of Quick Rate Test on Vertical Fracture Plane.

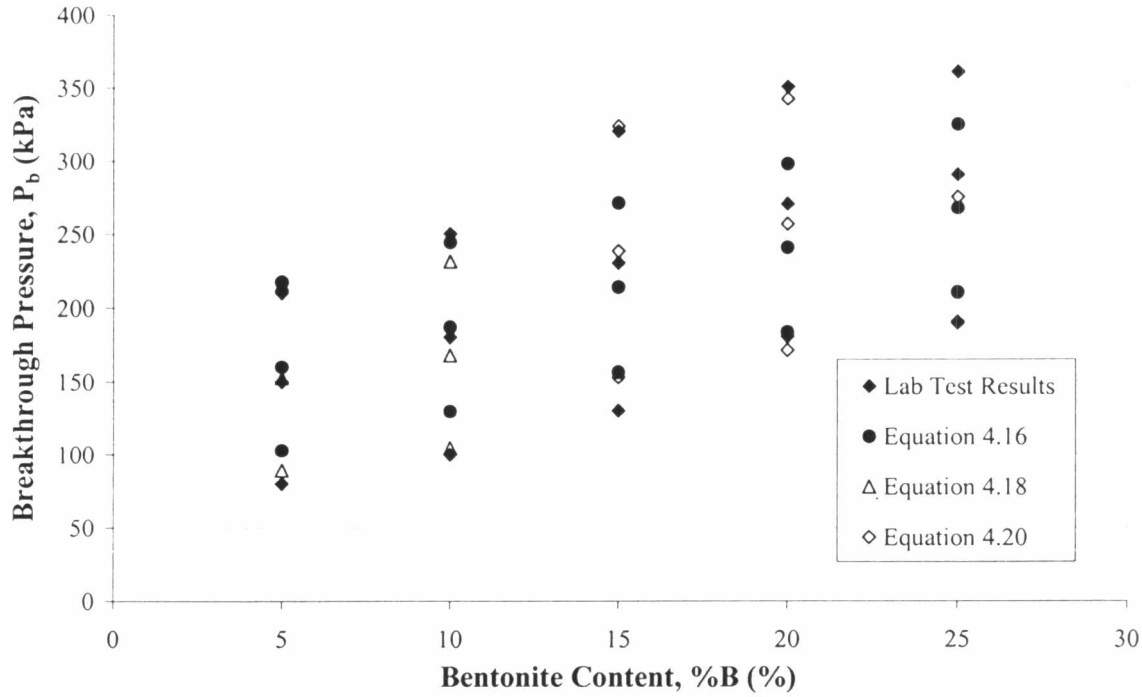


FIGURE 4.45 Raw Test Results Plotted with Results from Equation 4.16, 4.18, 4.20.

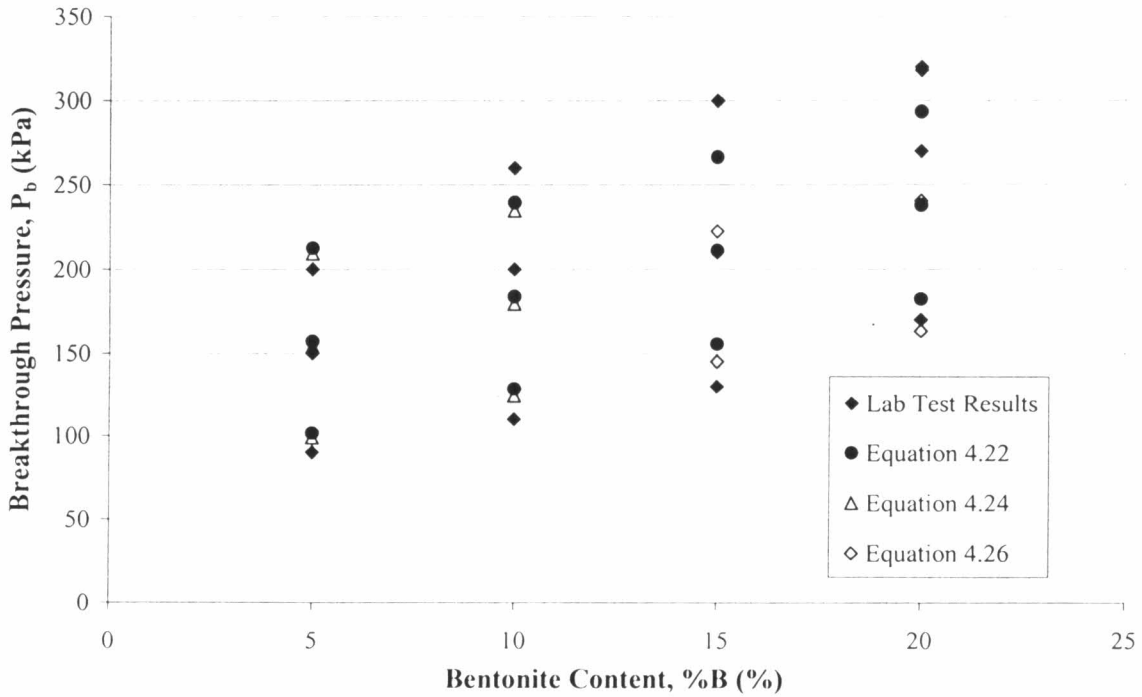


FIGURE 4.46 Raw Test Results Plotted with Results from Equation 4.22, 4.24, 4.26.

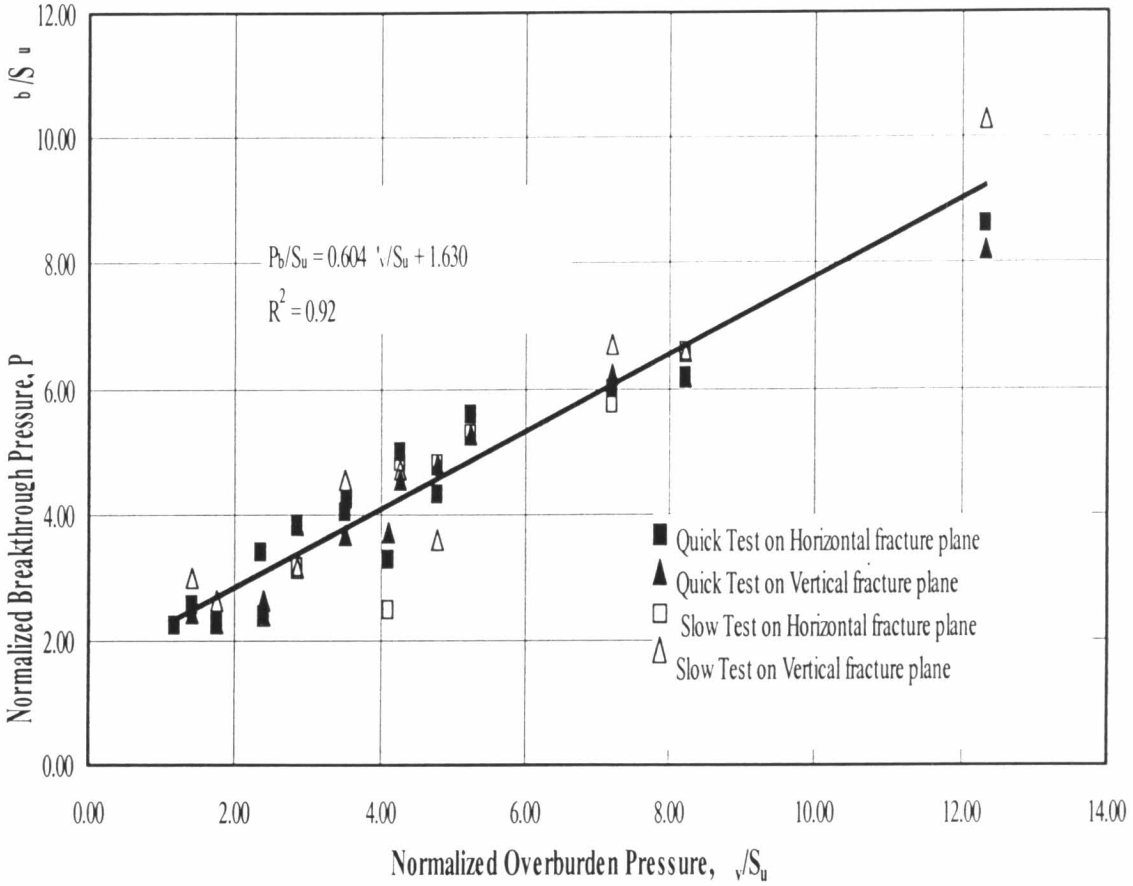


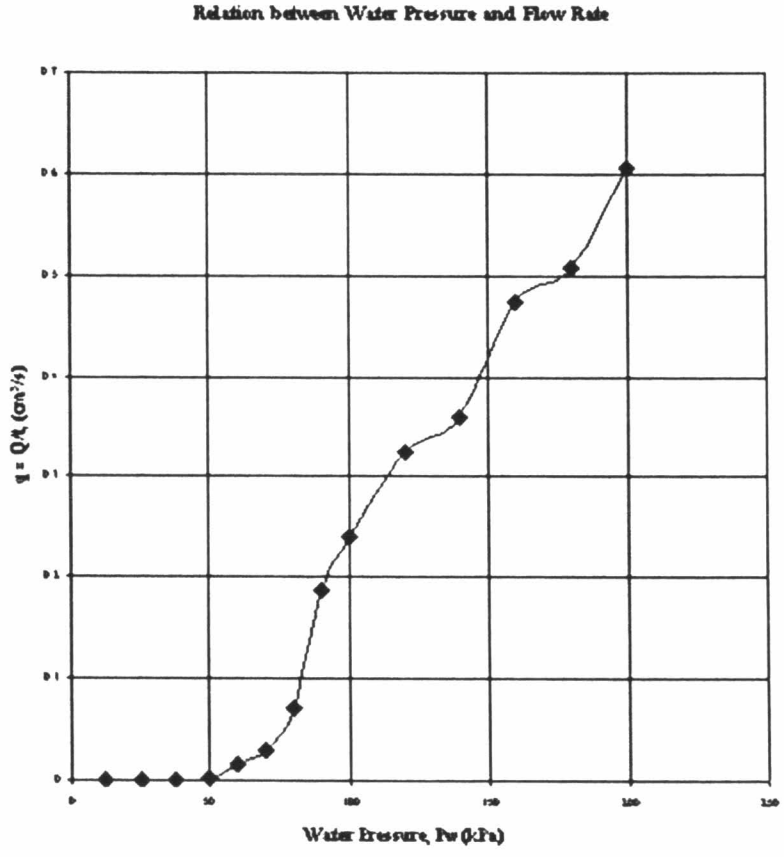
FIGURE 5.1 Normalized breakthrough and overburden pressure by undrained shear strength.

APPENDICES

APPENDIX A

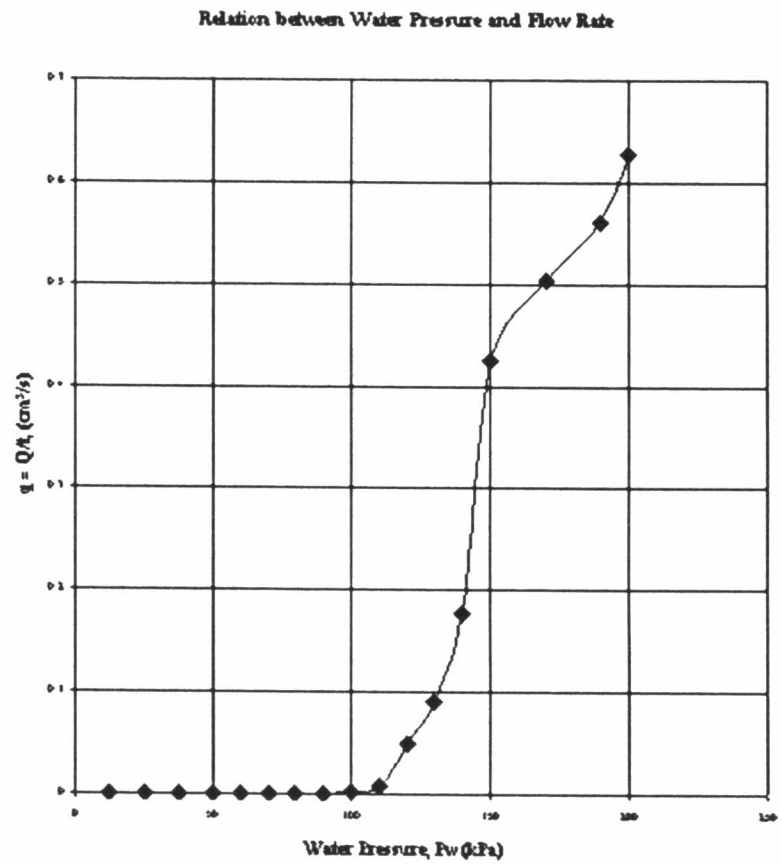
RAW DATA RECORDS AND CALCULATION

Description		Units	Test Results		
			Initial	Finish	Differential
Weight of sample		g	1093.90	974.50	119.40
Heigh of compacted sample		cm	7.99	7.50	0.48
Volume of compacted sample		cm3	622.24	583.67	38.57
Unit Weight of sample		t/m3	1.76	1.67	
Dry density of sample		t/m3	1.48	1.42	
Average water content		%	18.45	17.82	
Average water content, Top		%	18.45	18.92	
Average water content, Middle		%	18.45	17.45	
Average water content, Bottom		%	18.45	17.11	
Pw, (kPa)	q (cm3/s)	kn (cm/s)	Pw, (kPa)	q (cm3/s)	kn (cm/s)
12.5	0.0E+00	0.0E+00	140.0	3.6E-01	1.5E-03
25.0	0.0E+00	0.0E+00	160.0	4.7E-01	4.3E-04
37.5	9.4E-05	1.9E-06	180.0	5.1E-01	3.9E-04
50.0	2.1E-03	3.2E-05	200.0	6.1E-01	4.8E-04
60.0	1.6E-02	6.5E-05			
70.0	3.0E-02	1.2E-04			
80.0	7.0E-02	2.2E-04			
90.0	1.9E-01	3.6E-04			
100.0	2.4E-01	4.4E-04			
120.0	3.2E-01	4.3E-04			



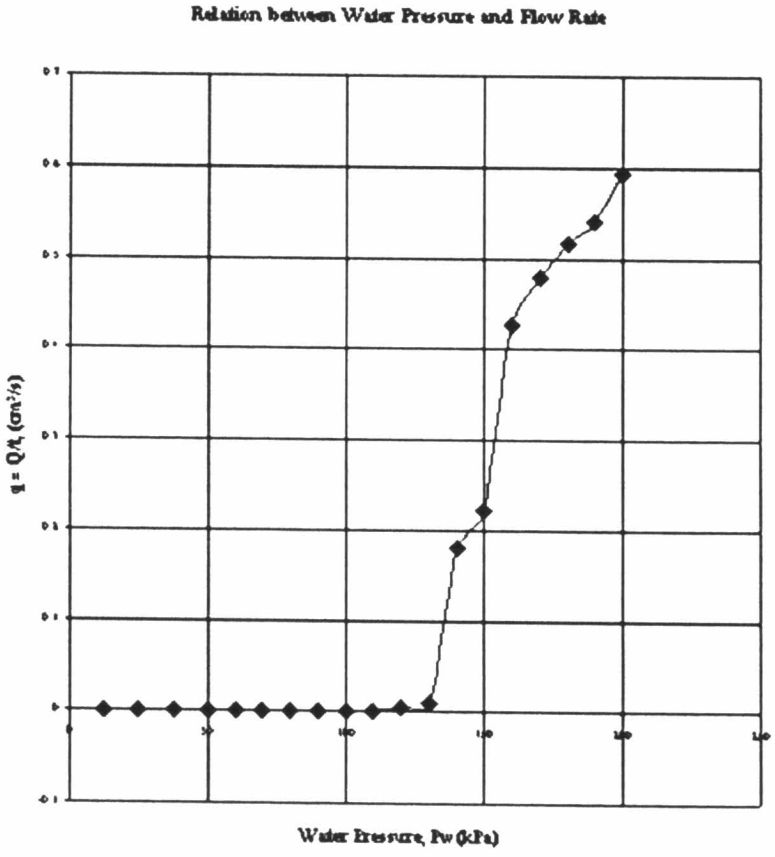
Appendix A. SHF 01 5% of Bentonite Content – Overburden Stress = 100 kPa.

Description		Units	Test Results		
			Initial	Finish	Differential
Weight of sample		g	1126.30	1020.10	106.20
Heigh of compacted sample		cm	8.53	8.04	0.48
Volume of compacted sample		cm3	668.66	625.71	42.95
Unit Weight of sample		t/m3	1.68	1.63	
Dry density of sample		t/m3	1.32	1.38	
Average water content		%	27.34	18.15	
Average water content, Top		%	27.34	18.11	
Average water content, Middle		%	27.34	18.44	
Average water content, Bottom		%	27.34	17.90	
Pw, (kPa)	q (cm3/s)	kn (cm/s)	Pw, (kPa)	q (cm3/s)	kn (cm/s)
12.5	0.0E+00	0.0E+00	90.0	5.6E-04	5.1E-06
12.5	0.0E+00	0.0E+00	100.0	2.8E-03	4.6E-06
12.5	0.0E+00	0.0E+00	110.0	7.3E-03	2.1E-05
25.0	0.0E+00	0.0E+00	120.0	5.0E-02	1.5E-04
37.5	0.0E+00	0.0E+00	130.0	9.0E-02	3.4E-04
37.5	0.0E+00	0.0E+00	140.0	1.8E-01	3.8E-04
50.0	0.0E+00	0.0E+00	150.0	4.3E-01	5.2E-04
60.0	0.0E+00	0.0E+00	170.0	5.0E-01	4.9E-04
70.0	0.0E+00	0.0E+00	190.0	5.6E-01	4.9E-04
80.0	0.0E+00	0.0E+00	200.0	6.3E-01	5.5E-04



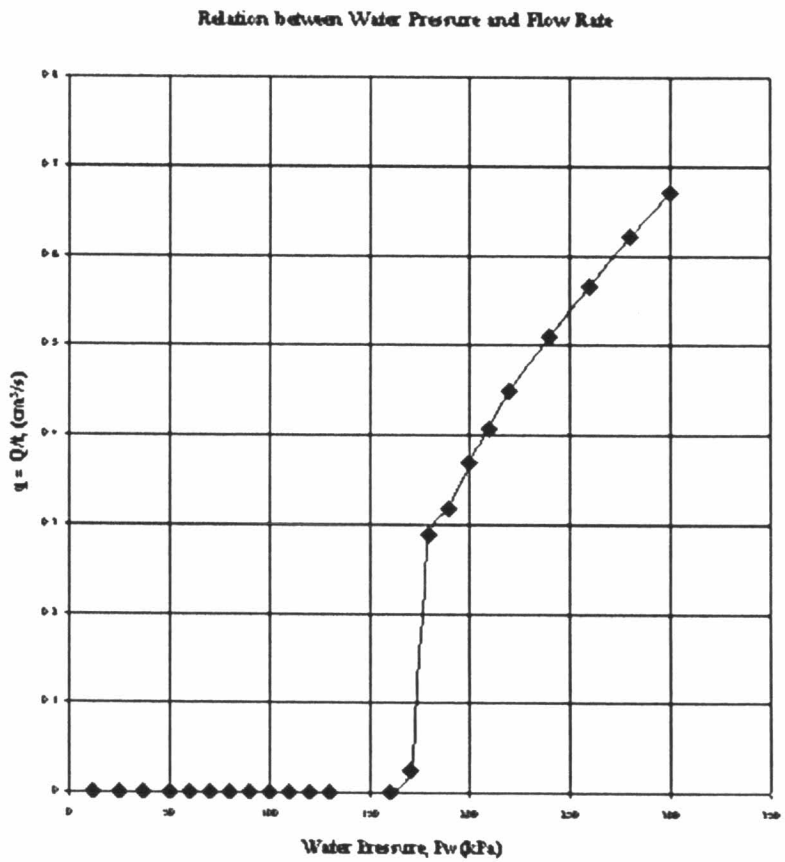
Appendix A. SHF 02 10% of Bentonite Content – Overburden Stress = 100 kPa.

Description		Units	Test Results		
			Initial	Finish	Differential
Weight of sample		g	1128.10	1000.80	127.30
Heigh of compacted sample		cm	8.39	7.91	0.48
Volume of compacted sample		cm3	653.53	615.44	38.09
Unit Weight of sample		t/m3	1.73	1.63	
Dry density of sample		t/m3	1.34	1.37	
Average water content		%	29.20	19.02	
Average water content, Top		%	29.20	19.40	
Average water content, Middle		%	29.20	18.72	
Average water content, Bottom		%	29.20	18.94	
Pw, (kPa)	q (cm3/s)	kn (cm/s)	Pw, (kPa)	q (cm3/s)	kn (cm/s)
12.5	0.0E+00	0.0E+00	120.0	3.8E-03	2.6E-05
25.0	0.0E+00	0.0E+00	130.0	9.6E-03	6.0E-05
37.5	0.0E+00	0.0E+00	140.0	1.8E-01	3.7E-04
50.0	0.0E+00	0.0E+00	150.0	2.2E-01	4.3E-04
60.0	0.0E+00	0.0E+00	160.0	4.3E-01	4.7E-04
70.0	0.0E+00	0.0E+00	170.0	4.8E-01	4.8E-04
80.0	0.0E+00	0.0E+00	180.0	5.2E-01	5.1E-04
90.0	0.0E+00	0.0E+00	190.0	5.4E-01	4.8E-04
100.0	0.0E+00	0.0E+00	200.0	5.9E-01	4.9E-04
110.0	8.5E-04	6.3E-06			



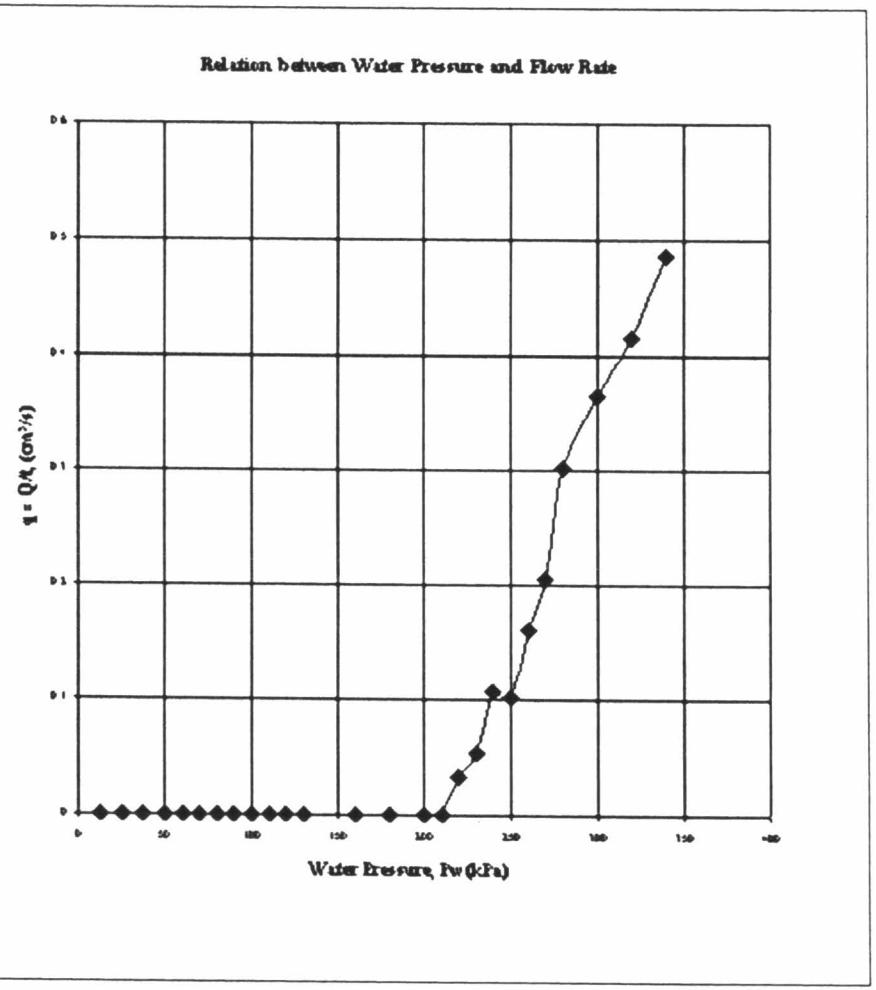
Appendix A. SHF 03 15% of Bentonite Content – Overburden Stress = 100 kPa.

Description		Units	Test Results		
			Initial	Finish	Differential
Weight of sample		g	1103.70	1013.00	90.70
Heigh of compacted sample		cm	8.17	7.85	0.32
Volume of compacted sample		cm3	634.53	610.51	24.02
Unit Weight of sample		t/m3	1.74	1.66	
Dry density of sample		t/m3	1.33	1.36	
Average water content		%	30.32	22.08	
Average water content, Top		%	30.32	21.55	
Average water content, Middle		%	30.32	23.97	
Average water content, Bottom		%	30.32	20.72	
Pw, (kPa)	q (cm3/s)	kn (cm/s)	Pw, (kPa)	q (cm3/s)	kn (cm/s)
12.5	0.0E+00	0.0E+00	170.0	2.4E-02	1.1E-04
25.0	0.0E+00	0.0E+00	180.0	2.9E-01	2.8E-04
37.5	0.0E+00	0.0E+00	190.0	3.2E-01	2.8E-04
37.5	0.0E+00	0.0E+00	200.0	3.7E-01	2.7E-04
50.0	0.0E+00	0.0E+00	210.0	4.1E-01	3.0E-04
50.0	0.0E+00	0.0E+00	220.0	4.5E-01	3.3E-04
50.0	0.0E+00	0.0E+00	240.0	5.1E-01	3.4E-04
50.0	0.0E+00	0.0E+00	260.0	5.7E-01	3.5E-04
50.0	0.0E+00	0.0E+00	280.0	6.2E-01	3.5E-04
50.0	0.0E+00	0.0E+00	300.0	6.7E-01	3.7E-04



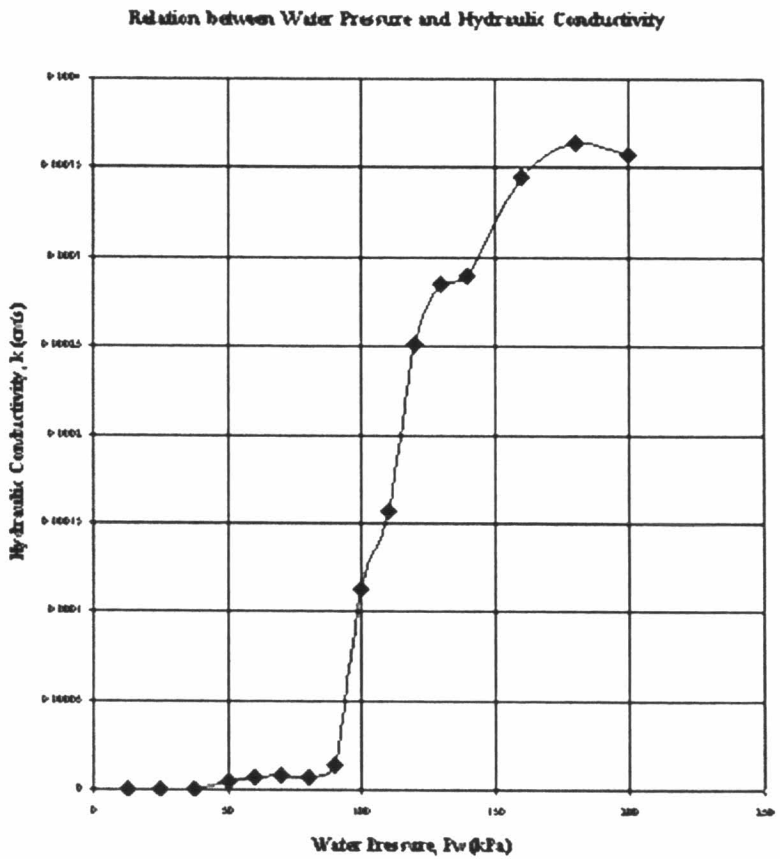
Appendix A. SHF 04 20% of Bentonite Content – Overburden Stress = 100 kPa.

Description		Units	Test Results		
			Initial	Finish	Differential
Weight of sample		g	1129.40	1041.90	87.50
Heigh of compacted sample		cm	8.35	8.11	0.25
Volume of compacted sample		cm3	655.19	630.77	24.43
Unit Weight of sample		t/m3	1.72	1.65	
Dry density of sample		t/m3	1.31	1.34	
Average water content		%	31.38	23.12	
Average water content, Top		%	31.38	22.53	
Average water content, Middle		%	31.38	25.55	
Average water content, Bottom		%	31.38	21.27	
Pw, (kPa)	q (cm3/s)	kn (cm/s)	Pw, (kPa)	q (cm3/s)	kn (cm/s)
12.5	0.0E+00	0.0E+00	220.0	3.3E-02	6.7E-05
25.0	0.0E+00	0.0E+00	230.0	5.4E-02	6.0E-05
37.5	0.0E+00	0.0E+00	240.0	1.1E-01	6.9E-05
50.0	0.0E+00	0.0E+00	250.0	1.0E-01	5.9E-05
60.0	0.0E+00	0.0E+00	260.0	1.6E-01	5.0E-05
160.0	0.0E+00	0.0E+00	270.0	2.1E-01	4.1E-05
180.0	0.0E+00	0.0E+00	280.0	3.0E-01	5.9E-05
200.0	0.0E+00	5.3E-05	300.0	3.7E-01	5.2E-05
210.0	9.4E-05	2.1E-04	320.0	4.2E-01	5.7E-05
210.0	1.9E-04	2.7E-04	340.0	4.9E-01	4.9E-05



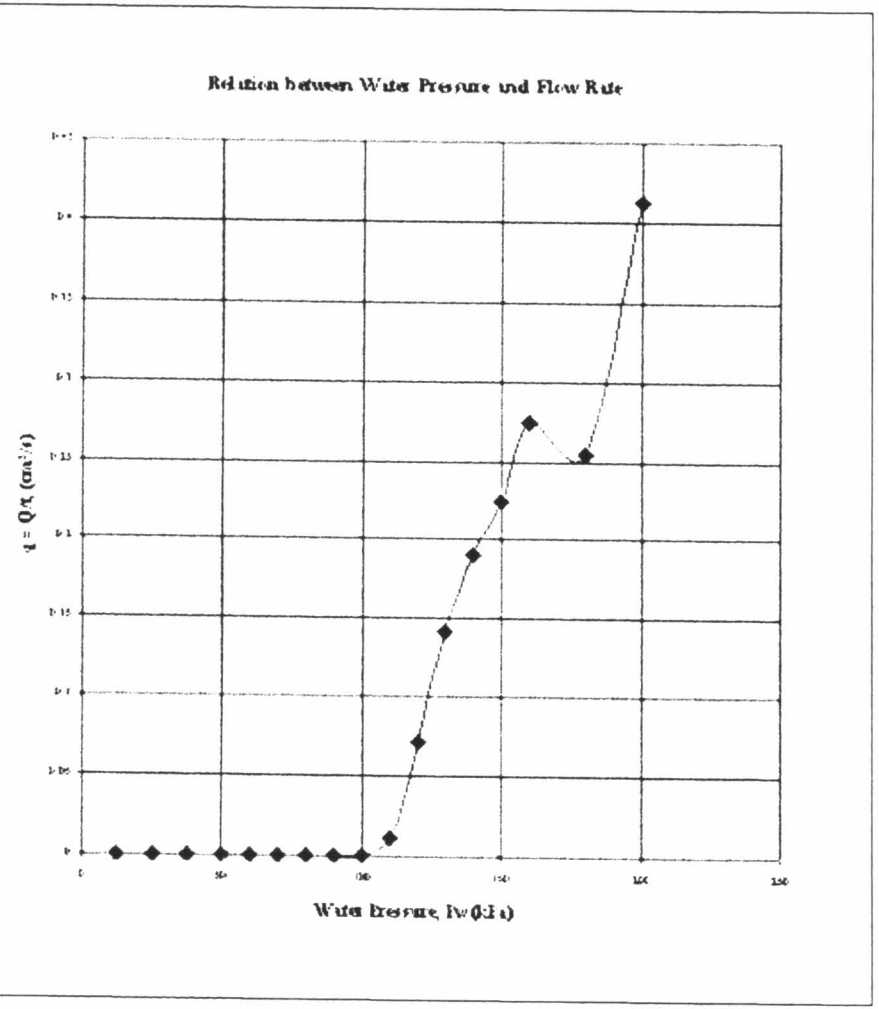
Appendix A. SHF 05 25% of Bentonite Content – Overburden Stress = 100 kPa.

Description		Units	Test Results		
			Initial	Finish	Differential
Weight of sample		g	1096.80	978.30	118.50
Heigh of compacted sample		cm	7.86	7.49	0.38
Volume of compacted sample		cm3	612.76	584.26	28.50
Unit Weight of sample		t/m3	1.79	1.67	
Dry density of sample		t/m3	1.51	1.42	
Average water content		%	18.17	17.55	
Average water content, Top		%	18.17	17.72	
Average water content, Middle		%	18.17	17.49	
Average water content, Bottom		%	18.17	17.45	
Pw, (kPa)	q (cm3/s)	kn (cm/s)	Pw, (kPa)	q (cm3/s)	kn (cm/s)
37.5	0.0E+00	0.0E+00	140.0	2.7E-01	2.9E-04
50.0	2.8E-04	4.3E-06	160.0	3.5E-01	3.4E-04
60.0	5.6E-04	7.2E-06	180.0	3.4E-01	3.6E-04
70.0	7.5E-04	8.2E-06	200.0	4.8E-01	3.6E-04
80.0	7.5E-04	7.2E-06			
90.0	1.6E-03	1.4E-05			
100.0	4.5E-02	1.1E-04			
110.0	1.2E-01	1.6E-04			
120.0	1.9E-01	2.5E-04			
130.0	2.3E-01	2.9E-04			



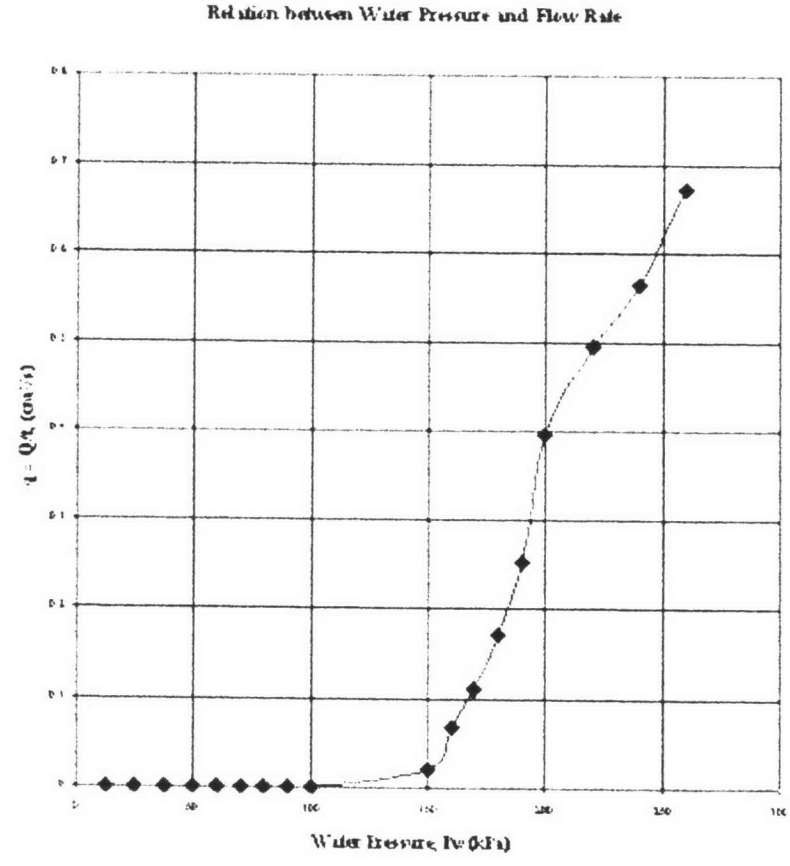
Appendix A. SVF 01 05% of Bentonite Content – Overburden Stress = 100 kPa.

Description		Units	Test Results		
			Initial	Finish	Diffirential
Weight of sample		g	1101.90	1007.90	94.00
Heigh of compacted sample		cm	8.22	7.88	0.34
Volume of compacted sample		cm3	645.00	615.11	29.89
Unit Weight of sample		t/m3	1.71	1.64	
Dry density of sample		t/m3	1.43	1.38	
Average water content		%	19.07	18.40	
Average water content, Top		%	19.07	18.76	
Average water content, Middle		%	19.07	17.88	
Average water content, Bottom		%	19.07	18.55	
Pw, (kPa)	q (cm3/s)	kn (cm/s)	Pw, (kPa)	q (cm3/s)	kn (cm/s)
37.5	0.0E+00	0.0E+00	140.0	1.9E-01	2.6E-04
50.0	0.0E+00	0.0E+00	150.0	2.2E-01	2.8E-04
60.0	0.0E+00	0.0E+00	160.0	2.7E-01	3.1E-04
70.0	0.0E+00	0.0E+00	180.0	2.5E-01	3.0E-04
80.0	0.0E+00	0.0E+00	200.0	4.1E-01	3.3E-04
90.0	0.0E+00	0.0E+00			
100.0	0.0E+00	0.0E+00			
110.0	1.1E-02	3.7E-05			
120.0	7.2E-02	1.3E-04			
130.0	1.4E-01	2.0E-04			



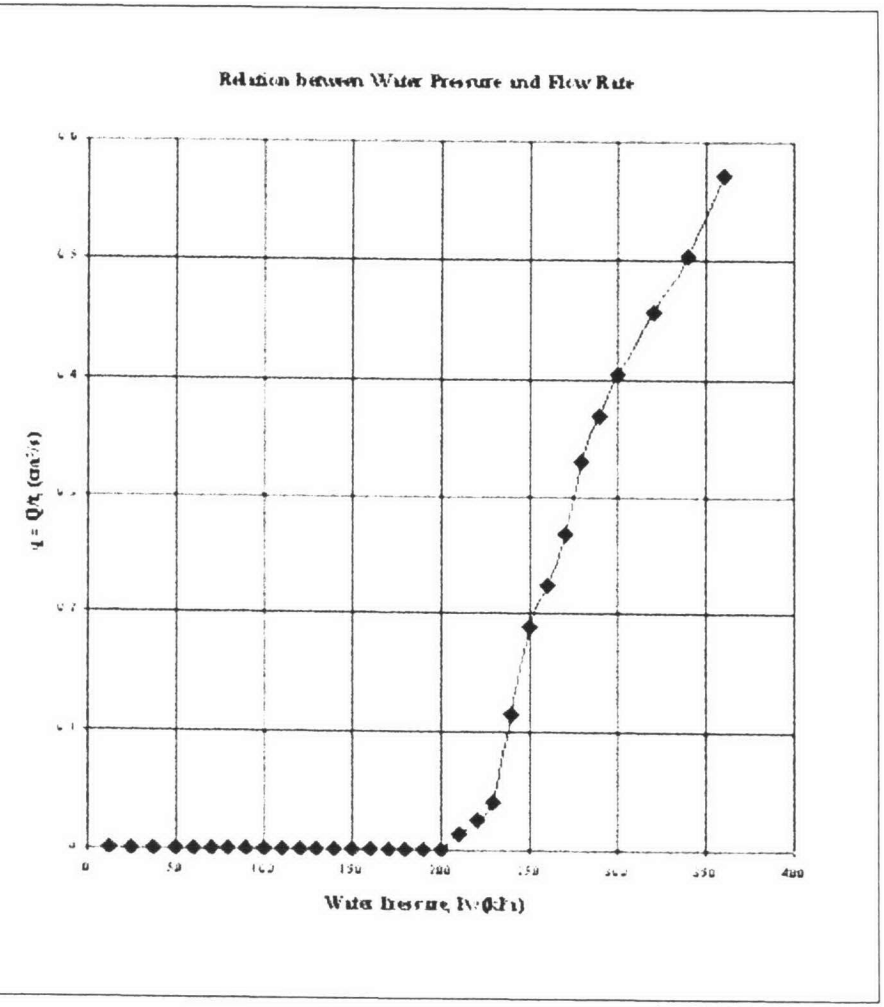
Appendix A. SVF 02 10% of Bentonite Content – Overburden Stress = 100 kPa.

Description		Units	Test Results		
			Initial	Finish	Diffirential
Weight of sample		g	1104.20	1014.70	89.50
Heigh of compacted sample		cm	8.15	7.81	0.34
Volume of compacted sample		cm3	632.72	609.23	23.48
Unit Weight of sample		t/m3	1.75	1.67	
Dry density of sample		t/m3	1.46	1.39	
Average water content		%	19.50	19.56	
Average water content, Top		%	19.50	20.16	
Average water content, Middle		%	19.50	19.64	
Average water content, Bottom		%	19.50	18.88	
Pw, (kPa)	q (cm3 s)	kn (cm/s)	Pw, (kPa)	q (cm3/s)	kn (cm/s)
37.5	0.0E-00	0.0E+00	180.0	1.7E-01	1.9E-04
50.0	0.0E-00	0.0E+00	190.0	2.5E-01	2.3E-04
60.0	0.0E-00	0.0E+00	200.0	3.9E-01	3.4E-04
70.0	0.0E-00	0.0E+00	220.0	4.9E-01	3.7E-04
80.0	0.0E-00	0.0E+00	240.0	5.7E-01	3.7E-04
90.0	0.0E-00	0.0E+00	260.0	6.7E-01	4.5E-04
100.0	0.0E-00	0.0E+00			
150.0	1.9E-02	3.9E-05			
160.0	6.8E-02	8.4E-05			
170.0	1.1E-01	1.3E-04			



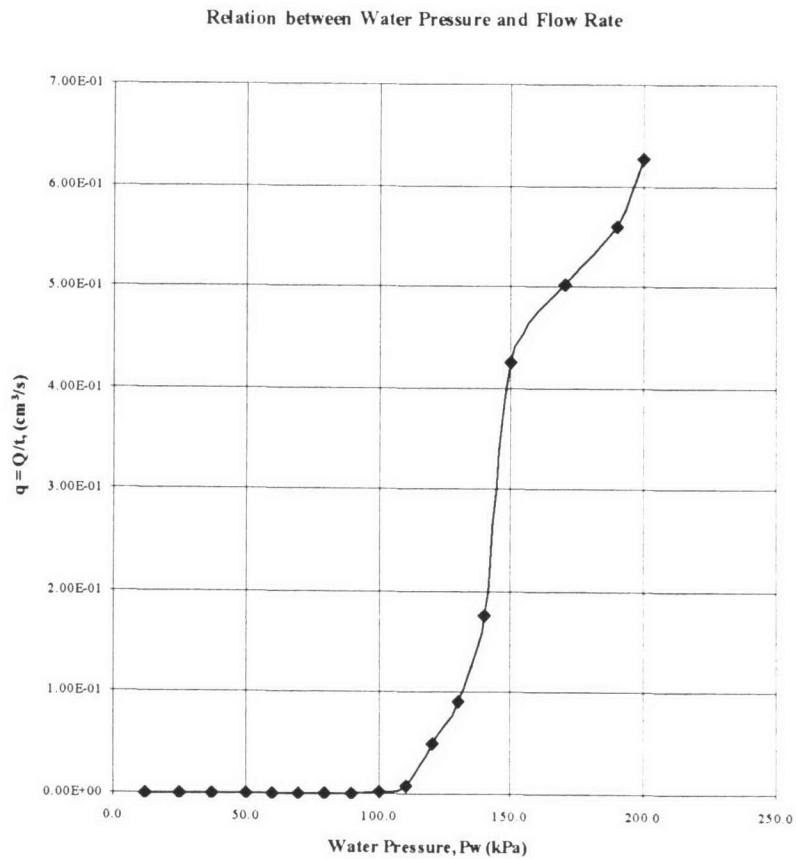
Appendix A. SVF 03 15% of Bentonite Content – Overburden Stress = 100 kPa.

Description		Units	Test Results		
			Initial	Finish	Diffirential
Weight of sample		g	1114.30	1013.70	100.60
Heigh of compacted sample		cm	8.26	7.95	0.31
Volume of compacted sample		cm3	647.87	620.18	27.69
Unit Weight of sample		t/m3	1.72	1.63	
Dry density of sample		t/m3	1.43	1.36	
Average water content		%	19.92	20.12	
Average water content, Top		%	19.92	20.09	
Average water content, Middle		%	19.92	19.75	
Average water content, Bottom		%	19.92	20.52	
Pw, (kPa)	q (cm3/s)	kn (cm/s)	Pw, (kPa)	q (cm3/s)	kn (cm/s)
140.0	0.0E+00	0.0E+00	240.0	1.1E-01	8.3E-05
150.0	0.0E+00	0.0E+00	250.0	1.9E-01	1.4E-04
160.0	0.0E+00	0.0E+00	260.0	2.2E-01	1.4E-04
170.0	0.0E+00	0.0E+00	270.0	2.7E-01	1.7E-04
180.0	0.0E+00	0.0E+00	280.0	3.3E-01	1.9E-04
190.0	0.0E+00	0.0E+00	290.0	3.7E-01	2.0E-04
200.0	1.9E-04	7.5E-07	300.0	4.0E-01	2.1E-04
210.0	1.3E-02	1.5E-05	320.0	4.6E-01	2.3E-04
220.0	2.5E-02	3.2E-05	340.0	5.0E-01	2.4E-04
230.0	4.0E-02	4.7E-05	360.0	5.7E-01	2.5E-04



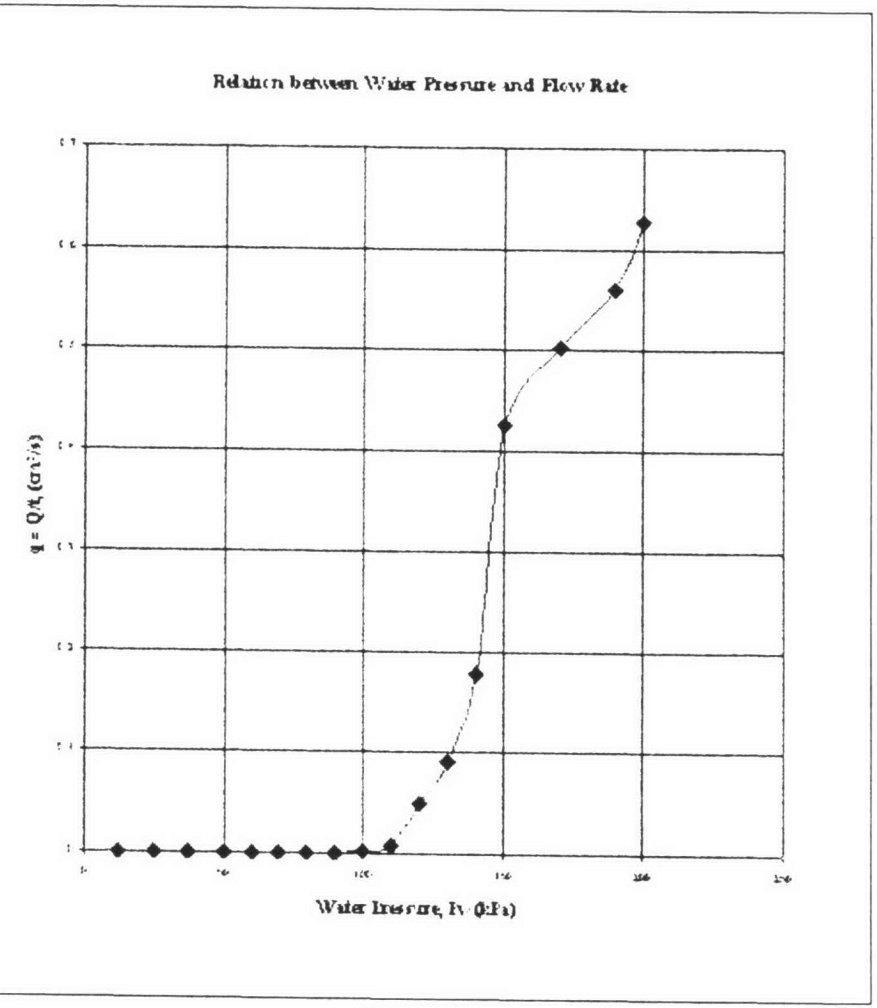
Appendix A. SHF 09 20% of Bentonite Content – Overburden Stress = 100 kPa.

Description		Units	Test Results		
			Initial	Finish	Diffirential
Weight of sample		g	1126.30	1020.10	106.20
Heigh of compacted sample		cm	8.53	8.04	0.48
Volume of compacted sample		cm3	668.66	625.71	42.95
Unit Weight of sample		t/m3	1.68	1.63	-0.05
Dry density of sample		t/m3	1.42	1.38	-0.04
Average water content		%	18.23	18.15	-0.08
Average water content, Top		%	18.23	18.11	-0.12
Average water content, Middle		%	18.23	18.44	0.21
Average water content, Bottom		%	18.23	17.90	-0.32
Pw, (kPa)	q (cm3/s)	kn (cm/s)	Pw, (kPa)	q (cm3/s)	kn (cm/s)
12.5	0.00E+00	0.00E+00	110.0	7.27E-03	2.10E-05
25.0	0.00E+00	0.00E+00	120.0	4.98E-02	1.54E-04
37.5	0.00E+00	0.00E+00	130.0	9.01E-02	3.37E-04
37.5	0.00E+00	0.00E+00	140.0	1.77E-01	3.83E-04
50.0	0.00E+00	0.00E+00	150.0	4.25E-01	5.17E-04
60.0	0.00E+00	0.00E+00	170.0	5.03E-01	4.89E-04
70.0	0.00E+00	0.00E+00	190.0	5.60E-01	4.86E-04
80.0	0.00E+00	0.00E+00	200.0	6.27E-01	5.54E-04
90.0	5.60E-04	5.14E-06			
100.0	2.80E-03	4.63E-06			



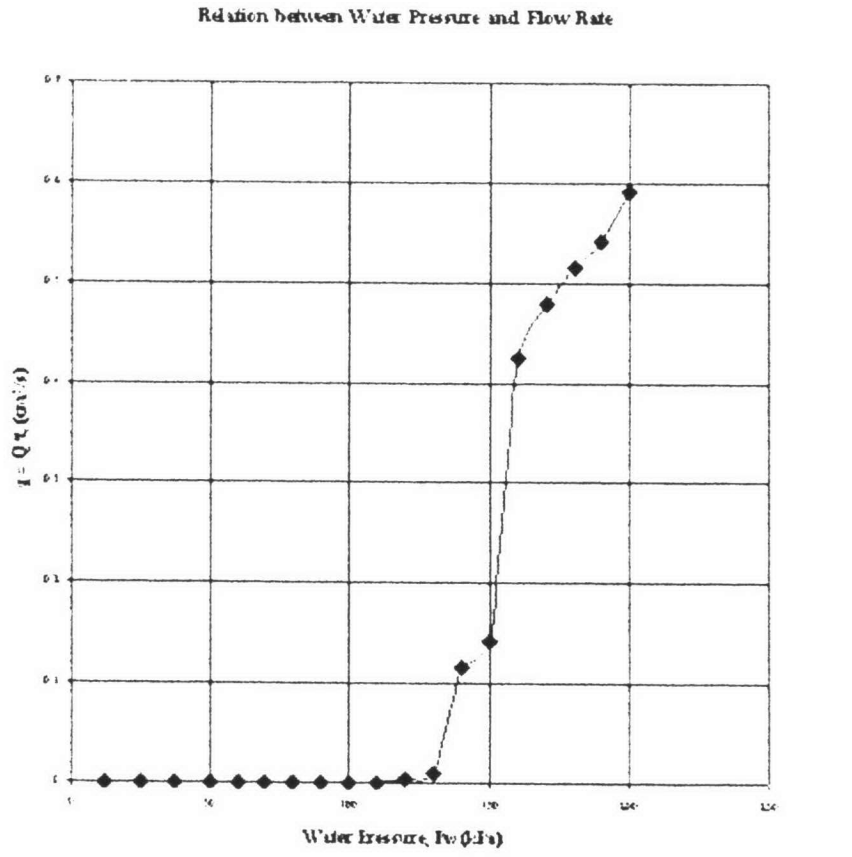
Appendix A. QHF 01 5% of Bentonite Content – Overburden Stress = 100 kPa.

Description		Units	Test Results		
			Initial	Finish	Diffirential
Weight of sample		g	1126.30	1020.10	106.20
Heigh of compacted sample		cm	8.53	8.04	0.48
Volume of compacted sample		cm3	668.66	625.71	42.95
Unit Weight of sample		t/m3	1.68	1.63	
Dry density of sample		t/m3	1.42	1.38	
Average water content		%	18.23	18.15	
Average water content, Top		%	18.23	18.11	
Average water content, Middle		%	18.23	18.44	
Average water content, Bottom		%	18.23	17.90	
Pw, (kPa)	q (cm3/s)	kn (cm/s)	Pw, (kPa)	q (cm3/s)	kn (cm/s)
12.5	0.0E+00	0.0E+00	110.0	7.3E-03	2.1E-05
25.0	0.0E+00	0.0E+00	120.0	5.0E-02	1.5E-04
37.5	0.0E+00	0.0E+00	130.0	9.0E-02	3.4E-04
37.5	0.0E+00	0.0E+00	140.0	1.8E-01	3.8E-04
50.0	0.0E+00	0.0E+00	150.0	4.3E-01	5.2E-04
60.0	0.0E+00	0.0E+00	170.0	5.0E-01	4.9E-04
70.0	0.0E+00	0.0E+00	190.0	5.6E-01	4.9E-04
80.0	0.0E+00	0.0E+00	200.0	6.3E-01	5.5E-04
90.0	5.6E-04	5.1E-06			
100.0	2.8E-03	4.6E-06			



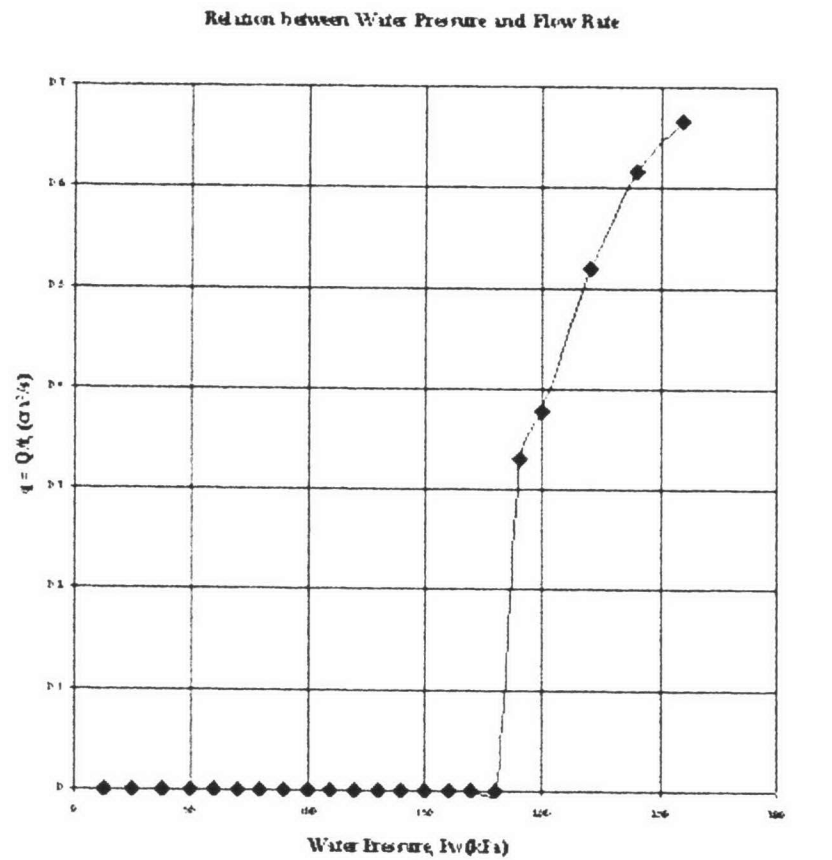
Appendix A. QHF 02 5% of Bentonite Content – Overburden Stress = 200 kPa.

Description		Units	Test Results		
			Initial	Finish	Diffirential
Weight of sample		g	1128.10	1000.80	127.30
Heigh of compacted sample		cm	8.39	7.91	0.48
Volume of compacted sample		cm3	653.53	615.44	38.09
Unit Weight of sample		t/m3	1.73	1.63	
Dry density of sample		t/m3	1.44	1.37	
Average water content		%	19.47	19.02	
Average water content, Top		%	19.47	19.40	
Average water content, Middle		%	19.47	18.72	
Average water content, Bottom		%	19.47	18.94	
Pw, (kPa)	q (cm3/s)	kn (cm/s)	Pw, (kPa)	q (cm3/s)	kn (cm/s)
12.5	0.0E+00	0.0E+00	120.0	3.8E-03	2.6E-05
25.0	0.0E+00	0.0E+00	130.0	9.6E-03	6.0E-05
37.5	0.0E+00	0.0E+00	140.0	1.2E-01	3.4E-04
50.0	0.0E+00	0.0E+00	150.0	1.4E-01	4.1E-04
60.0	0.0E+00	0.0E+00	160.0	4.3E-01	4.7E-04
70.0	0.0E+00	0.0E+00	170.0	4.8E-01	4.8E-04
80.0	0.0E+00	0.0E+00	180.0	5.2E-01	5.1E-04
90.0	0.0E+00	0.0E+00	190.0	5.4E-01	4.8E-04
100.0	0.0E+00	0.0E+00	200.0	5.9E-01	4.9E-04
110.0	8.5E-04	6.3E-06			



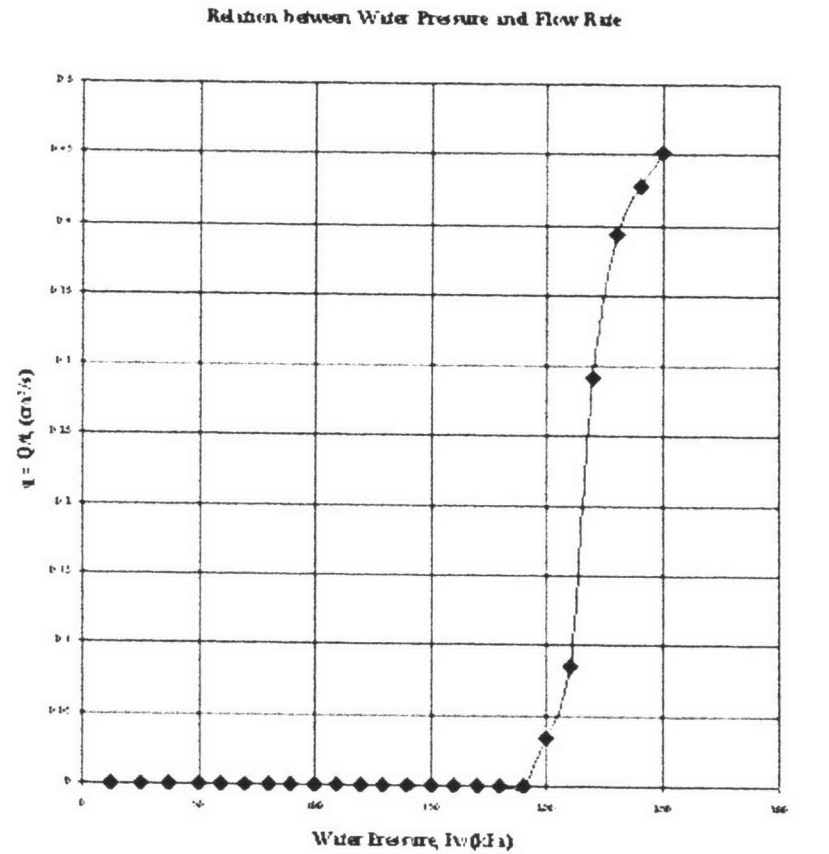
Appendix A. QHF 03 5% of Bentonite Content – Overburden Stress = 300 kPa.

Description		Units	Test Results		
			Initial	Finish	Diffirential
Weight of sample		g	1135.30	1043.20	92.10
Heigh of compacted sample		cm	8.45	8.11	0.34
Volume of compacted sample		cm3	662.78	630.90	31.88
Unit Weight of sample		t/m3	1.71	1.65	
Dry density of sample		t/m3	1.32	0.81	
Average water content		%	19.99	19.64	
Average water content, Top		%	19.99	19.73	
Average water content, Middle		%	19.99	20.54	
Average water content, Bottom		%	19.99	18.66	
Pw, (kPa)	q (cm3 s)	kn (cm/s)	Pw, (kPa)	q (cm3/s)	kn (cm/s)
12.5	0.0E+00	0.0E+00	140.0	0.0E+00	0.0E+00
25.0	0.0E+00	0.0E+00	150.0	0.0E+00	0.0E+00
37.5	0.0E+00	0.0E+00	160.0	0.0E+00	0.0E+00
50.0	0.0E+00	0.0E+00	170.0	0.0E+00	0.0E+00
60.0	0.0E+00	0.0E+00	180.0	0.0E+00	0.0E+00
70.0	0.0E+00	0.0E+00	190.0	3.3E-01	3.5E-04
80.0	0.0E+00	0.0E+00	200.0	3.8E-01	3.0E-04
90.0	0.0E+00	0.0E+00	220.0	5.2E-01	4.1E-04
100.0	0.0E+00	0.0E+00	240.0	6.2E-01	4.2E-04
110.0	0.0E+00	0.0E+00	260.0	6.7E-01	4.3E-04



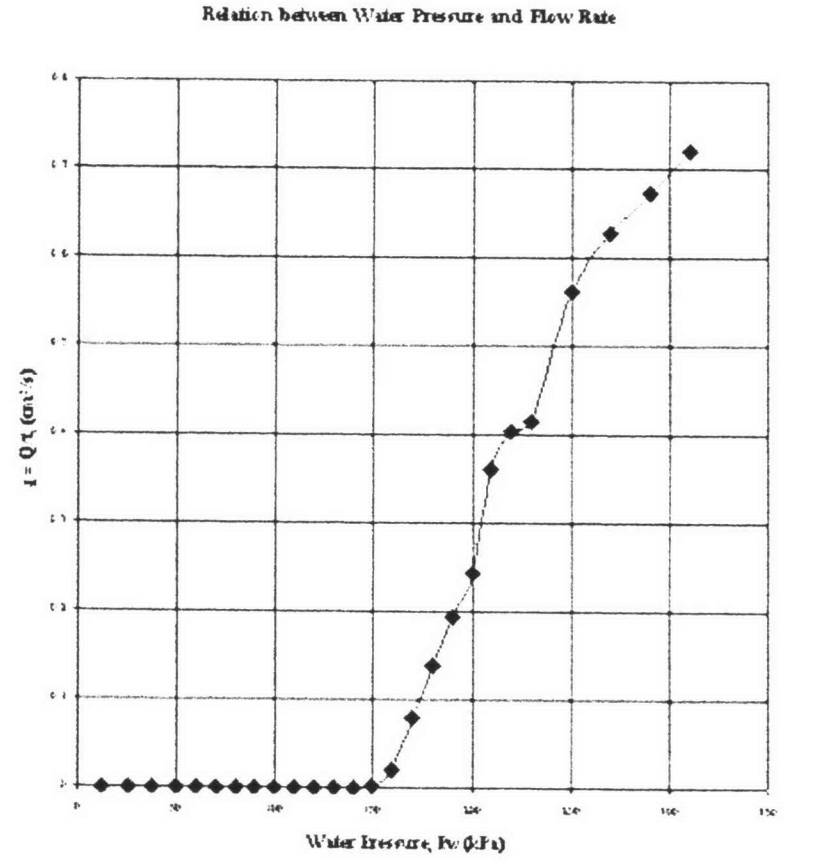
Appendix A. QHF 04 10% of Bentonite Content – Overburden Stress = 100 kPa.

Description		Units	Test Results		
			Initial	Finish	Diffirential
Weight of sample		g	1157.40	1069.50	87.90
Heigh of compacted sample		cm	8.52	8.20	0.32
Volume of compacted sample		cm3	661.84	637.87	23.97
Unit Weight of sample		t/m3	1.75	1.68	
Dry density of sample		t/m3	1.33	1.40	
Average water content		%	19.50	19.70	
Average water content, Top		%	19.50	20.29	
Average water content, Middle		%	19.50	19.36	
Average water content, Bottom		%	19.50	19.44	
Pw, (kPa)	q (cm3/s)	kn (cm/s)	Pw, (kPa)	q (cm3/s)	kn (cm/s)
12.5	0.0E+00	0.0E+00	160.0	0.0E+00	0.0E+00
25.0	0.0E+00	0.0E+00	170.0	0.0E+00	0.0E+00
37.5	0.0E+00	0.0E+00	180.0	0.0E+00	0.0E+00
50.0	0.0E+00	0.0E+00	190.0	0.0E+00	0.0E+00
60.0	0.0E+00	0.0E+00	200.0	3.3E-02	5.2E-05
70.0	0.0E+00	0.0E+00	210.0	8.5E-02	6.7E-05
80.0	0.0E+00	0.0E+00	220.0	2.9E-01	2.9E-04
90.0	0.0E+00	0.0E+00	230.0	3.9E-01	2.9E-04
100.0	0.0E+00	0.0E+00	240.0	4.3E-01	3.1E-04
110.0	0.0E+00	0.0E+00	250.0	4.5E-01	3.1E-04



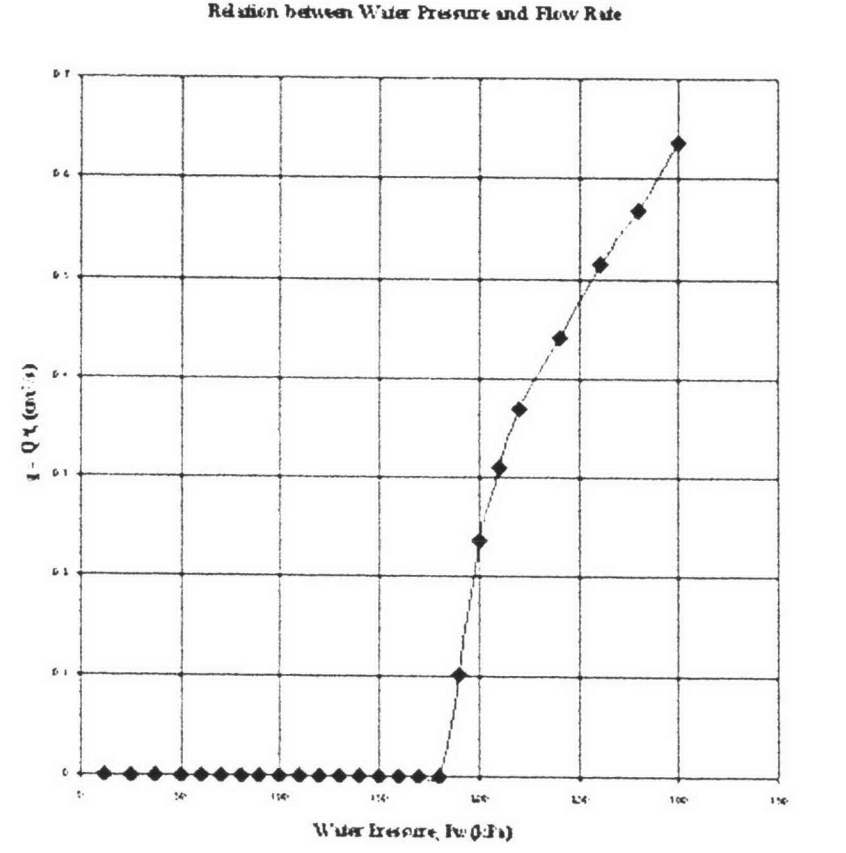
Appendix A. QHF 05 10% of Bentonite Content – Overburden Stress = 200 kPa.

Description		Units	Test Results		
			Initial	Finish	Diffirential
Weight of sample		g	1091.20	968.20	123.00
Heigh of compacted sample		cm	8.03	7.34	0.69
Volume of compacted sample		cm3	625.61	572.94	52.67
Unit Weight of sample		t/m3	1.74	1.69	
Dry density of sample		t/m3	1.48	1.43	
Average water content		%	18.30	19.25	
Average water content, Top		%	18.30	22.44	
Average water content, Middle		%	18.30	18.26	
Average water content, Bottom		%	18.30	17.06	
Pw, (kPa)	q (cm3 s)	kn (cm/s)	Pw, (kPa)	q (cm3/s)	kn (cm/s)
12.5	0.0E-00	0.0E+00	180.0	1.4E-01	2.0E-04
25.0	0.0E-00	0.0E+00	190.0	1.9E-01	2.5E-04
37.5	0.0E-00	0.0E+00	200.0	2.4E-01	3.4E-04
50.0	0.0E-00	0.0E+00	210.0	3.6E-01	3.2E-04
60.0	0.0E-00	0.0E+00	220.0	4.0E-01	3.5E-04
70.0	0.0E-00	0.0E+00	230.0	4.2E-01	3.3E-04
80.0	0.0E-00	0.0E+00	250.0	5.6E-01	3.4E-04
90.0	0.0E-00	0.0E+00	270.0	6.3E-01	3.5E-04
100.0	0.0E-00	0.0E+00	290.0	6.7E-01	3.5E-04
120.0	1.9E-04	1.2E-06	310.0	7.2E-01	3.6E-04



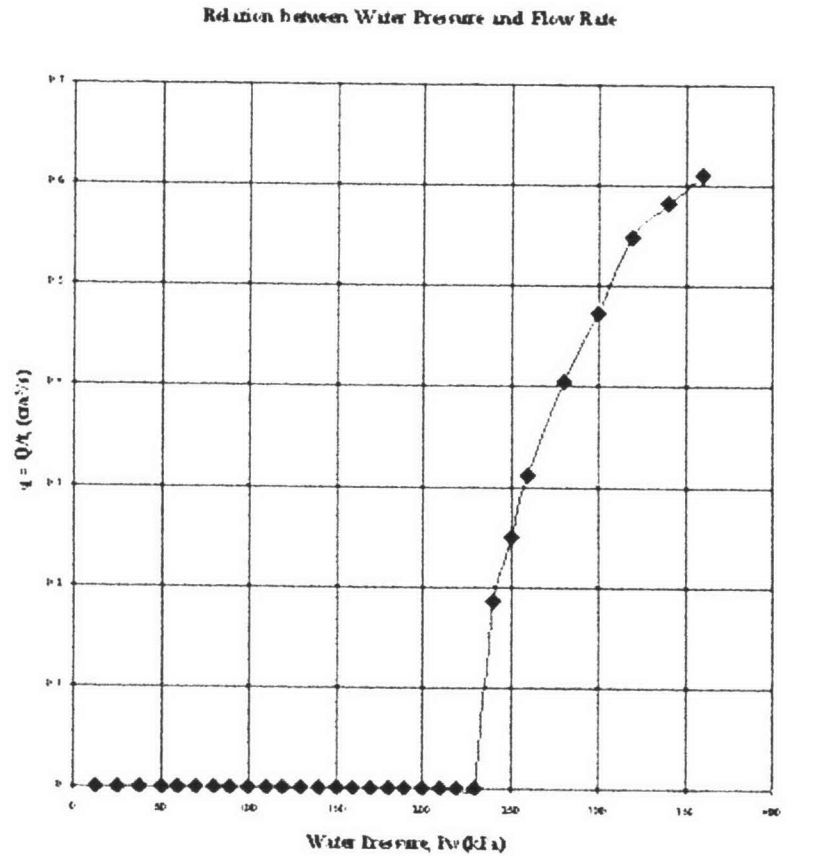
Appendix A. QHF 06 10% of Bentonite Content – Overburden Stress = 300 kPa.

Description		Units	Test Results		
			Initial	Finish	Diffirential
Weight of sample		g	1104.10	998.00	106.10
Heigh of compacted sample		cm	8.33	7.73	0.59
Volume of compacted sample		cm3	653.23	603.53	49.70
Unit Weight of sample		t/m3	1.69	1.65	
Dry density of sample		t/m3	1.43	1.40	
Average water content		%	18.00	19.59	
Average water content, Top		%	18.00	22.44	
Average water content, Middle		%	18.00	18.28	
Average water content, Bottom		%	18.00	18.06	
Pw, (kPa)	q (cm3 s)	kn (cm/s)	Pw, (kPa)	q (cm3/s)	kn (cm/s)
12.5	0.0E+00	0.0E+00	170.0	0.0E+00	0.0E+00
25.0	0.0E+00	0.0E+00	180.0	0.0E+00	0.0E+00
37.5	0.0E+00	0.0E+00	190.0	1.0E-01	1.6E-04
50.0	0.0E+00	0.0E+00	200.0	2.4E-01	2.1E-04
60.0	0.0E+00	0.0E+00	210.0	3.1E-01	2.7E-04
70.0	0.0E+00	0.0E+00	220.0	3.7E-01	2.7E-04
80.0	0.0E+00	0.0E+00	240.0	4.4E-01	3.0E-04
90.0	0.0E+00	0.0E+00	260.0	5.1E-01	3.1E-04
100.0	0.0E+00	0.0E+00	280.0	5.7E-01	3.2E-04
110.0	0.0E+00	0.0E+00	300.0	6.4E-01	3.6E-04



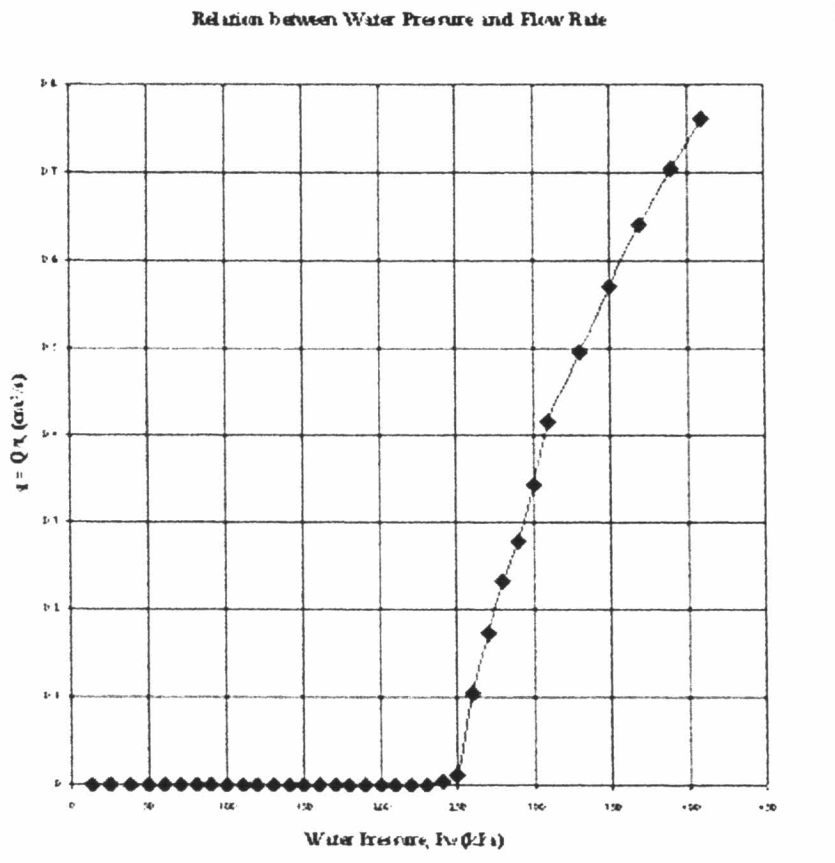
Appendix A. QHF 07 15% of Bentonite Content – Overburden Stress = 100 kPa.

Description		Units	Test Results		
			Initial	Finish	Diffirential
Weight of sample		g	1107.50	1008.10	99.40
Heigh of compacted sample		cm	8.23	7.75	0.47
Volume of compacted sample		cm3	638.93	604.94	33.99
Unit Weight of sample		t/m3	1.73	1.67	
Dry density of sample		t/m3	1.47	1.41	
Average water content		%	18.00	19.24	
Average water content, Top		%	18.00	18.26	
Average water content, Middle		%	18.00	19.25	
Average water content, Bottom		%	18.00	20.20	
Pw, (kPa)	q (cm3 s)	kn (cm/s)	Pw, (kPa)	q (cm3/s)	kn (cm/s)
12.5	0.0E+00	0.0E+00	220.0	0.0E+00	0.0E+00
25.0	0.0E+00	0.0E+00	230.0	0.0E+00	0.0E+00
37.5	0.0E+00	0.0E+00	240.0	1.9E-01	1.2E-04
50.0	0.0E+00	0.0E+00	250.0	2.5E-01	1.6E-04
60.0	0.0E+00	0.0E+00	260.0	3.1E-01	2.0E-04
70.0	0.0E+00	0.0E+00	280.0	4.1E-01	2.3E-04
80.0	0.0E+00	0.0E+00	300.0	4.7E-01	2.7E-04
90.0	0.0E+00	0.0E+00	320.0	5.5E-01	2.7E-04
100.0	0.0E+00	0.0E+00	340.0	5.8E-01	2.7E-04
110.0	0.0E+00	0.0E+00	360.0	6.1E-01	2.5E-04



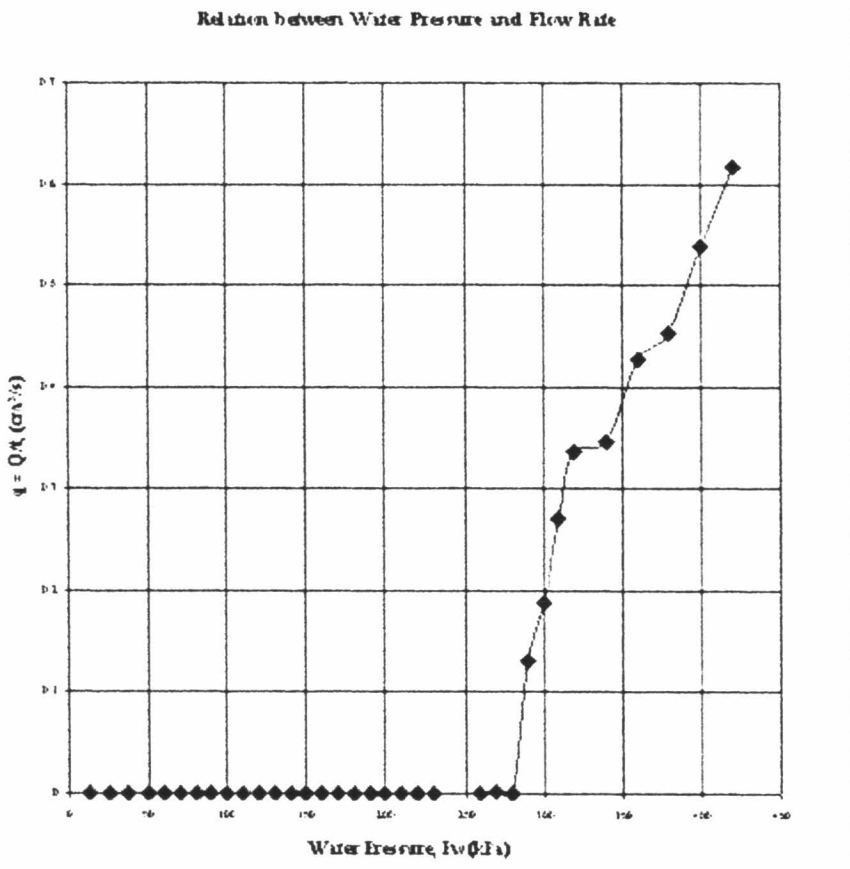
Appendix A. QHF 08 15% of Bentonite Content – Overburden Stress = 200 kPa.

Description		Units	Test Results		
			Initial	Finish	Diffirential
Weight of sample		g	1105.60	995.10	110.50
Heigh of compacted sample		cm	8.36	7.88	0.48
Volume of compacted sample		cm3	655.59	612.87	42.72
Unit Weight of sample		t/m3	1.69	1.62	
Dry density of sample		t/m3	1.40	1.55	
Average water content		%	20.18	22.07	
Average water content, Top		%	20.18	22.40	
Average water content, Middle		%	20.18	23.50	
Average water content, Bottom		%	20.18	20.30	
Pw, (kPa)	q (cm3/s)	kn (cm/s)	Pw, (kPa)	q (cm3/s)	kn (cm/s)
12.5	0.0E+00	0.0E+00	270.0	1.7E-01	1.2E-04
25.0	0.0E+00	0.0E+00	280.0	2.3E-01	1.3E-04
37.5	0.0E+00	0.0E+00	290.0	2.8E-01	1.6E-04
50.0	0.0E+00	0.0E+00	300.0	3.4E-01	1.8E-04
60.0	0.0E+00	0.0E+00	310.0	4.2E-01	2.3E-04
70.0	0.0E+00	0.0E+00	330.0	5.0E-01	2.5E-04
80.0	0.0E+00	0.0E+00	350.0	5.7E-01	2.6E-04
90.0	0.0E+00	0.0E+00	370.0	6.4E-01	2.9E-04
100.0	0.0E+00	0.0E+00	390.0	7.1E-01	3.0E-04
110.0	0.0E+00	0.0E+00	410.0	7.6E-01	3.0E-04



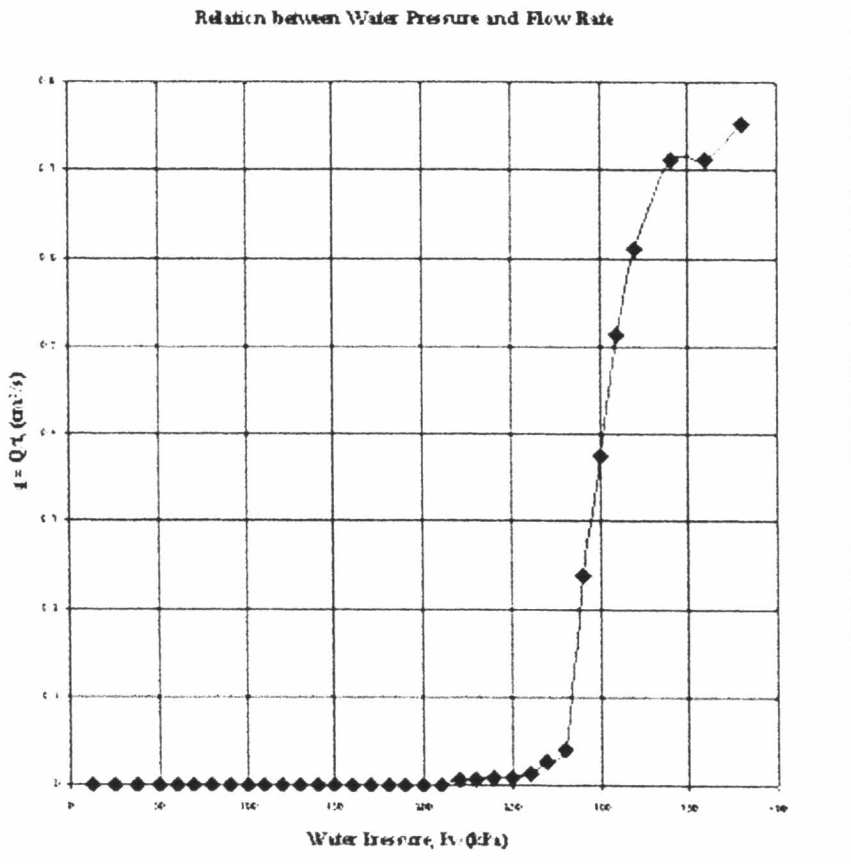
Appendix A. QHF 09 15% of Bentonite Content – Overburden Stress = 300 kPa.

Description		Units	Test Results		
			Initial	Finish	Diffirential
Weight of sample		g	1103.60	1000.80	102.80
Heigh of compacted sample		cm	8.15	7.69	0.46
Volume of compacted sample		cm3	633.36	598.45	34.91
Unit Weight of sample		t/m3	1.74	1.67	
Dry density of sample		t/m3	1.44	1.54	
Average water content		%	20.95	21.73	
Average water content, Top		%	20.95	21.00	
Average water content, Middle		%	20.95	22.00	
Average water content, Bottom		%	20.95	22.20	
Pw, (kPa)	q (cm3 s)	kn (cm/s)	Pw, (kPa)	q (cm3/s)	kn (cm/s)
12.5	0.0E+00	0.0E+00	270.0	2.3E-03	6.6E-06
25.0	0.0E+00	0.0E+00	290.0	1.3E-01	8.6E-05
37.5	0.0E+00	0.0E+00	300.0	1.9E-01	1.2E-04
50.0	0.0E+00	0.0E+00	310.0	2.7E-01	1.4E-04
60.0	0.0E+00	0.0E+00	320.0	3.4E-01	1.7E-04
70.0	0.0E+00	0.0E+00	340.0	3.5E-01	1.6E-04
80.0	0.0E+00	0.0E+00	360.0	4.3E-01	1.9E-04
90.0	0.0E+00	0.0E+00	380.0	4.5E-01	2.1E-04
100.0	0.0E+00	0.0E+00	400.0	5.4E-01	2.2E-04
110.0	0.0E+00	0.0E+00	420.0	6.2E-01	2.3E-04



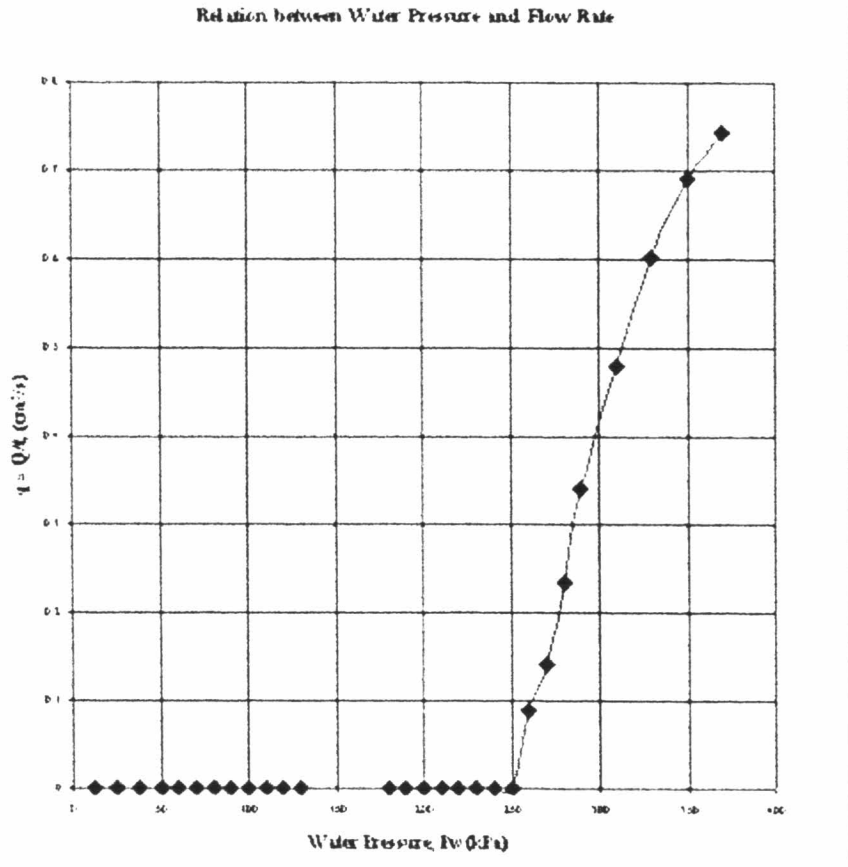
Appendix A. QHF 10 20% of Bentonite Content – Overburden Stress = 100 kPa.

Description		Units	Test Results		
			Initial	Finish	Diffirential
Weight of sample		g	1093.40	969.60	123.80
Heigh of compacted sample		cm	8.07	7.48	0.59
Volume of compacted sample		cm3	628.73	583.61	45.12
Unit Weight of sample		t/m3	1.74	1.66	
Dry density of sample		t/m3	1.47	1.41	
Average water content		%	18.25	21.64	
Average water content, Top		%	18.25	19.26	
Average water content, Middle		%	18.25	22.69	
Average water content, Bottom		%	18.25	22.96	
Pw, (kPa)	q (cm3/s)	kn (cm/s)	Pw, (kPa)	q (cm3/s)	kn (cm/s)
12.5	0.0E+00	0.0E+00	260.0	1.3E-02	1.2E-05
25.0	0.0E+00	0.0E+00	270.0	2.6E-02	1.5E-05
37.5	0.0E+00	0.0E+00	280.0	4.1E-02	2.5E-05
37.5	0.0E+00	0.0E+00	290.0	2.4E-01	1.5E-04
50.0	0.0E+00	0.0E+00	300.0	3.8E-01	2.1E-04
60.0	0.0E+00	0.0E+00	310.0	5.1E-01	2.7E-04
70.0	0.0E+00	0.0E+00	320.0	6.1E-01	3.3E-04
80.0	0.0E+00	0.0E+00	340.0	7.1E-01	3.2E-04
90.0	0.0E+00	0.0E+00	360.0	7.1E-01	3.0E-04
100.0	0.0E+00	0.0E+00	380.0	7.5E-01	2.9E-04



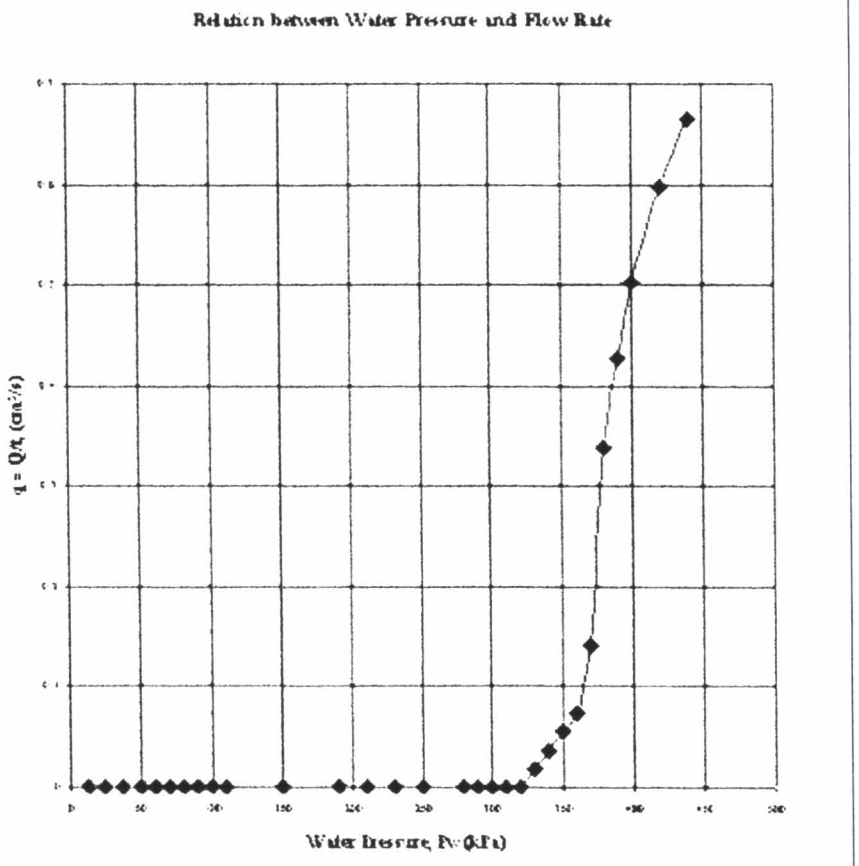
Appendix A. QHF 11 20% of Bentonite Content – Overburden Stress = 200 kPa.

Description		Units	Test Results		
			Initial	Finish	Diffirential
Weight of sample		g	1106.70	1000.40	106.30
Heigh of compacted sample		cm	8.25	7.71	0.54
Volume of compacted sample		cm3	647.35	601.97	45.38
Unit Weight of sample		t/m3	1.71	1.66	
Dry density of sample		t/m3	1.45	1.41	
Average water content		%	18.65	18.97	
Average water content, Top		%	18.65	19.22	
Average water content, Middle		%	18.65	18.60	
Average water content, Bottom		%	18.65	19.10	
Pw, (kPa)	q (cm3/s)	kn (cm/s)	Pw, (kPa)	q (cm3/s)	kn (cm/s)
12.5	0.0E+00	0.0E+00	240.0	0.0E+00	0.0E+00
25.0	0.0E+00	0.0E+00	250.0	9.3E-04	3.0E-06
37.5	0.0E+00	0.0E+00	260.0	8.8E-02	6.5E-05
37.5	0.0E+00	0.0E+00	270.0	1.4E-01	9.9E-05
50.0	0.0E+00	0.0E+00	280.0	2.3E-01	1.4E-04
60.0	0.0E+00	0.0E+00	290.0	3.4E-01	2.0E-04
70.0	0.0E+00	0.0E+00	310.0	4.8E-01	2.6E-04
80.0	0.0E+00	0.0E+00	330.0	6.0E-01	3.0E-04
90.0	0.0E+00	0.0E+00	350.0	6.9E-01	3.3E-04
100.0	0.0E+00	0.0E+00	370.0	7.4E-01	3.7E-04



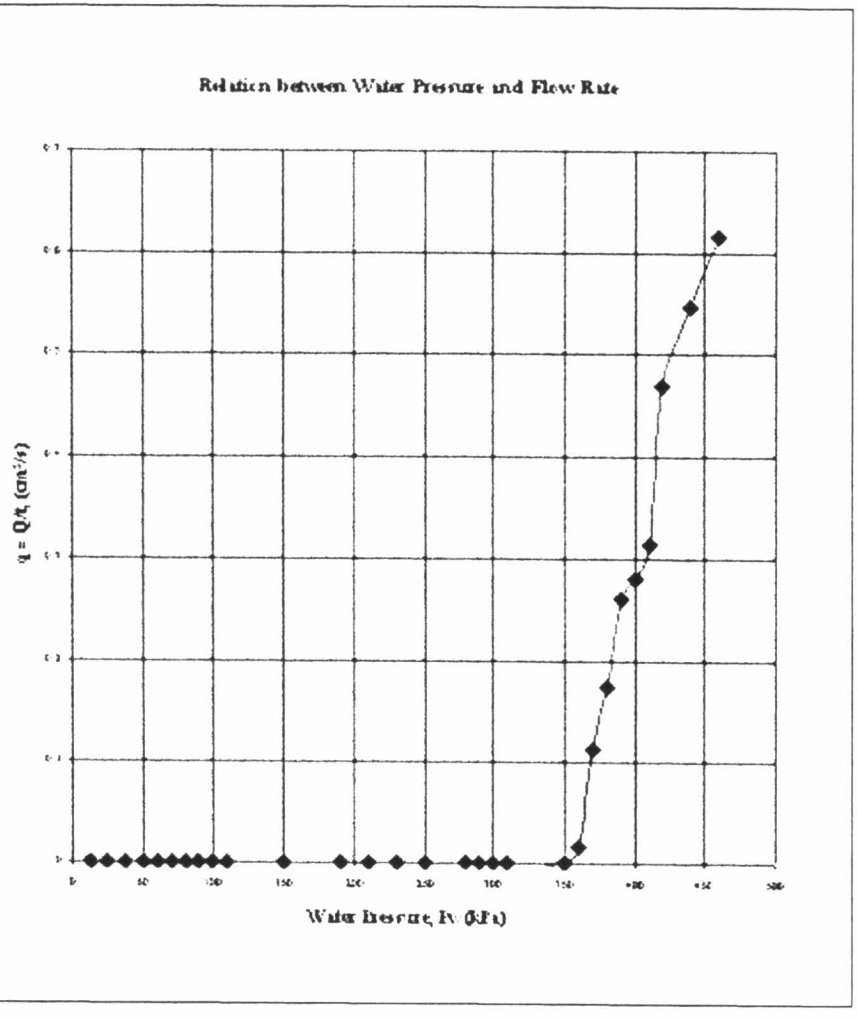
Appendix A. QHF 12 20% of Bentonite Content – Overburden Stress = 300 kPa.

Description		Units	Test Results		
			Initial	Finish	Diffirential
Weight of sample		g	1107.30	1008.30	99.00
Heigh of compacted sample		cm	8.17	7.60	0.57
Volume of compacted sample		cm3	634.66	592.97	41.69
Unit Weight of sample		t/m3	1.71	1.66	
Dry density of sample		t/m3	1.45	1.41	
Average water content		%	18.65	21.62	
Average water content, Top		%	18.65	19.26	
Average water content, Middle		%	18.65	22.64	
Average water content, Bottom		%	18.65	22.96	
Pw, (kPa)	q (cm3/s)	kn (cm/s)	Pw, (kPa)	q (cm3/s)	kn (cm/s)
12.5	0.0E+00	0.0E+00	330.0	1.8E-02	1.5E-05
25.0	0.0E+00	0.0E+00	340.0	3.6E-02	3.3E-05
37.5	0.0E+00	0.0E+00	350.0	5.5E-02	4.3E-05
37.5	0.0E+00	0.0E+00	360.0	7.3E-02	5.9E-05
50.0	0.0E+00	0.0E+00	370.0	1.4E-01	1.4E-04
60.0	0.0E+00	0.0E+00	380.0	3.4E-01	1.5E-04
70.0	0.0E+00	0.0E+00	390.0	4.3E-01	2.1E-04
80.0	0.0E+00	0.0E+00	400.0	5.0E-01	2.1E-04
90.0	0.0E+00	0.0E+00	420.0	6.0E-01	2.3E-04
100.0	0.0E+00	0.0E+00	440.0	6.6E-01	2.4E-04



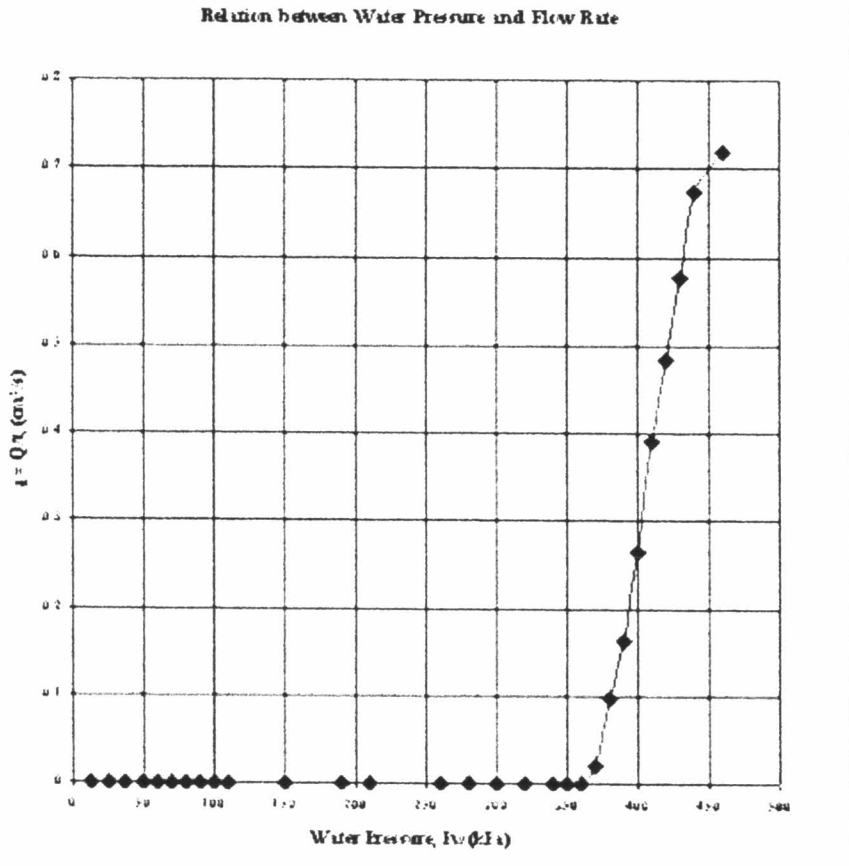
Appendix A. QHF 13 25% of Bentonite Content – Overburden Stress = 100 kPa.

Description		Units	Test Results		
			Initial	Finish	Diffirential
Weight of sample		g	1105.70	994.60	111.10
Heigh of compacted sample		cm	8.21	7.73	0.48
Volume of compacted sample		cm3	643.56	602.88	40.68
Unit Weight of sample		t/m3	1.71	1.66	
Dry density of sample		t/m3	1.45	1.41	
Average water content		%	18.65	21.62	
Average water content, Top		%	18.65	19.26	
Average water content, Middle		%	18.65	22.64	
Average water content, Bottom		%	18.65	22.96	
Pw, (kPa)	q (cm3/s)	kn (cm/s)	Pw, (kPa)	q (cm3/s)	kn (cm/s)
12.5	0.0E+00	0.0E+00	350.0	1.9E-04	4.2E-07
25.0	0.0E+00	0.0E+00	360.0	1.6E-02	1.6E-05
37.5	0.0E+00	0.0E+00	370.0	1.1E-01	6.0E-05
37.5	0.0E+00	0.0E+00	380.0	1.7E-01	8.2E-05
50.0	0.0E+00	0.0E+00	390.0	2.6E-01	1.1E-04
60.0	0.0E+00	0.0E+00	400.0	2.8E-01	1.1E-04
70.0	0.0E+00	0.0E+00	410.0	3.1E-01	1.3E-04
80.0	0.0E+00	0.0E+00	420.0	4.7E-01	1.9E-04
90.0	0.0E+00	0.0E+00	440.0	5.5E-01	2.0E-04
100.0	0.0E+00	0.0E+00	460.0	6.1E-01	2.1E-04



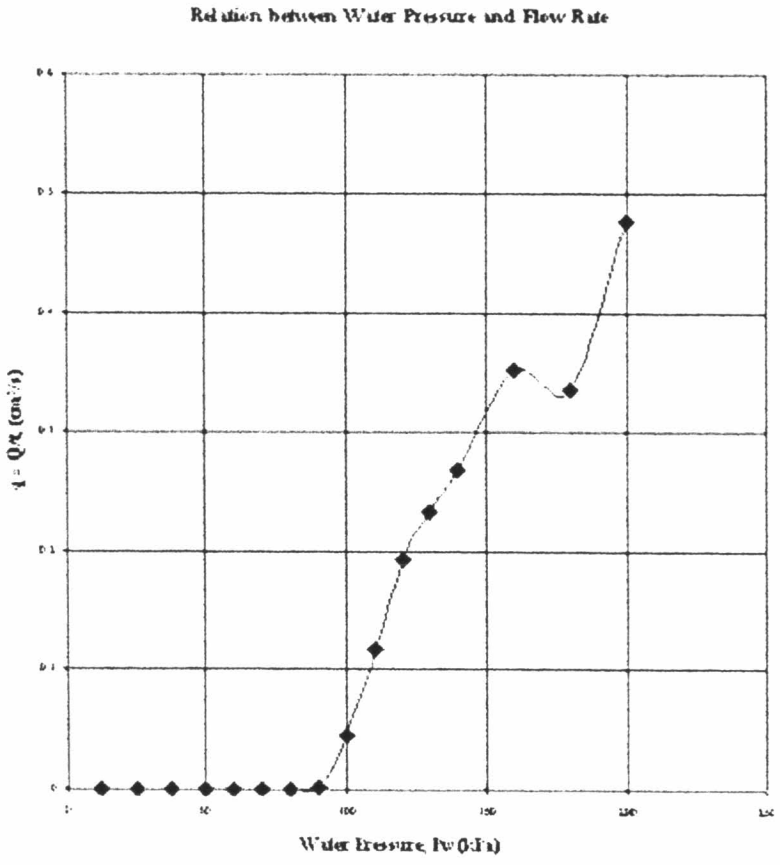
Appendix A. QHF 14 25% of Bentonite Content – Overburden Stress = 200 kPa.

Description		Units	Test Results		
			Initial	Finish	Diffirential
Weight of sample		g	1104.80	995.80	109.00
Heigh of compacted sample		cm	8.13	7.66	0.47
Volume of compacted sample		cm3	631.55	597.65	33.90
Unit Weight of sample		t/m3	1.71	1.66	
Dry density of sample		t/m3	1.45	1.41	
Average water content		%	18.65	20.33	
Average water content, Top		%	18.65	21.20	
Average water content, Middle		%	18.65	20.00	
Average water content, Bottom		%	18.65	19.80	
Pw, (kPa)	q (cm3/s)	kn (cm/s)	Pw, (kPa)	q (cm3/s)	kn (cm/s)
12.5	0.0E+00	0.0E+00	360.0	0.0E+00	0.0E+00
25.0	0.0E+00	0.0E+00	370.0	2.0E-02	2.4E-05
37.5	0.0E+00	0.0E+00	380.0	9.6E-02	4.7E-05
37.5	0.0E+00	0.0E+00	390.0	1.6E-01	7.5E-05
50.0	0.0E+00	0.0E+00	400.0	2.6E-01	1.1E-04
60.0	0.0E+00	0.0E+00	410.0	3.9E-01	1.5E-04
70.0	0.0E+00	0.0E+00	420.0	4.8E-01	1.9E-04
80.0	0.0E+00	0.0E+00	430.0	5.8E-01	2.1E-04
90.0	0.0E+00	0.0E+00	440.0	6.7E-01	2.4E-04
100.0	0.0E+00	0.0E+00	460.0	7.2E-01	2.5E-04



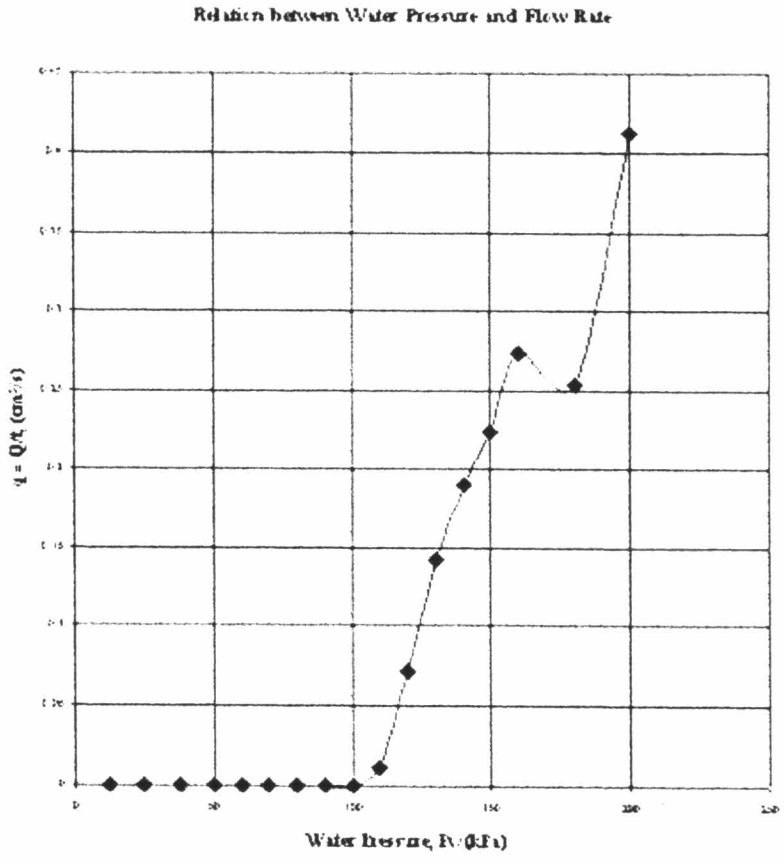
Appendix A. QHF 15 25% of Bentonite Content – Overburden Stress = 300 kPa.

Description		Units	Test Results		
			Initial	Finish	Diffirential
Weight of sample		g	1096.80	978.30	118.50
Heigh of compacted sample		cm	7.86	7.49	0.38
Volume of compacted sample		cm3	612.76	584.26	28.50
Unit Weight of sample		t/m3	1.79	1.67	
Dry density of sample		t/m3	1.51	1.42	
Average water content		%	18.17	17.55	
Average water content, Top		%	18.17	17.72	
Average water content, Middle		%	18.17	17.49	
Average water content, Bottom		%	18.17	17.45	
Pw, (kPa)	q (cm3/s)	kn (cm/s)	Pw, (kPa)	q (cm3/s)	kn (cm/s)
12.5	0.0E+00	0.0E+00	130.0	2.3E-01	2.9E-04
37.5	0.0E+00	0.0E+00	140.0	2.7E-01	2.9E-04
50.0	2.8E-04	4.3E-06	160.0	3.5E-01	3.4E-04
60.0	5.6E-04	7.2E-06	180.0	3.4E-01	3.6E-04
70.0	7.5E-04	8.2E-06	200.0	4.8E-01	3.6E-04
80.0	7.5E-04	7.2E-06			
90.0	1.6E-03	1.4E-05			
100.0	4.5E-02	1.1E-04			
110.0	1.2E-01	1.6E-04			
120.0	1.9E-01	2.5E-04			



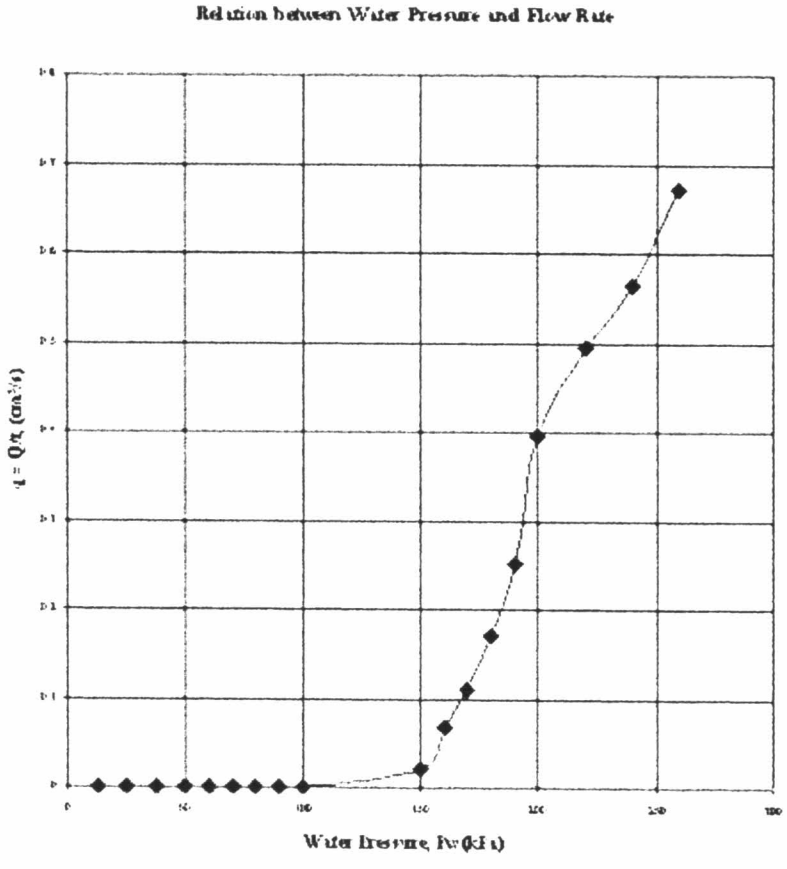
Appendix A. QVF 01 5% of Bentonite Content – Overburden Stress = 100 kPa.

Description		Units	Test Results		
			Initial	Finish	Diffirential
Weight of sample		g	1101.90	1007.90	94.00
Heigh of compacted sample		cm	8.22	7.88	0.34
Volume of compacted sample		cm3	645.00	615.11	29.89
Unit Weight of sample		t/m3	1.71	1.64	
Dry density of sample		t/m3	1.43	1.38	
Average water content		%	19.07	18.40	
Average water content, Top		%	19.07	18.76	
Average water content, Middle		%	19.07	17.88	
Average water content, Bottom		%	19.07	18.55	
Pw, (kPa)	q (cm3/s)	kn (cm/s)	Pw, (kPa)	q (cm3/s)	kn (cm/s)
37.5	0.0E+00	0.0E+00	140.0	1.9E-01	2.6E-04
50.0	0.0E+00	0.0E+00	150.0	2.2E-01	2.8E-04
60.0	0.0E+00	0.0E+00	160.0	2.7E-01	3.1E-04
70.0	0.0E+00	0.0E+00	180.0	2.5E-01	3.0E-04
80.0	0.0E+00	0.0E+00	200.0	4.1E-01	3.3E-04
90.0	0.0E+00	0.0E+00			
100.0	0.0E+00	0.0E+00			
110.0	1.1E-02	3.7E-05			
120.0	7.2E-02	1.3E-04			
130.0	1.4E-01	2.0E-04			



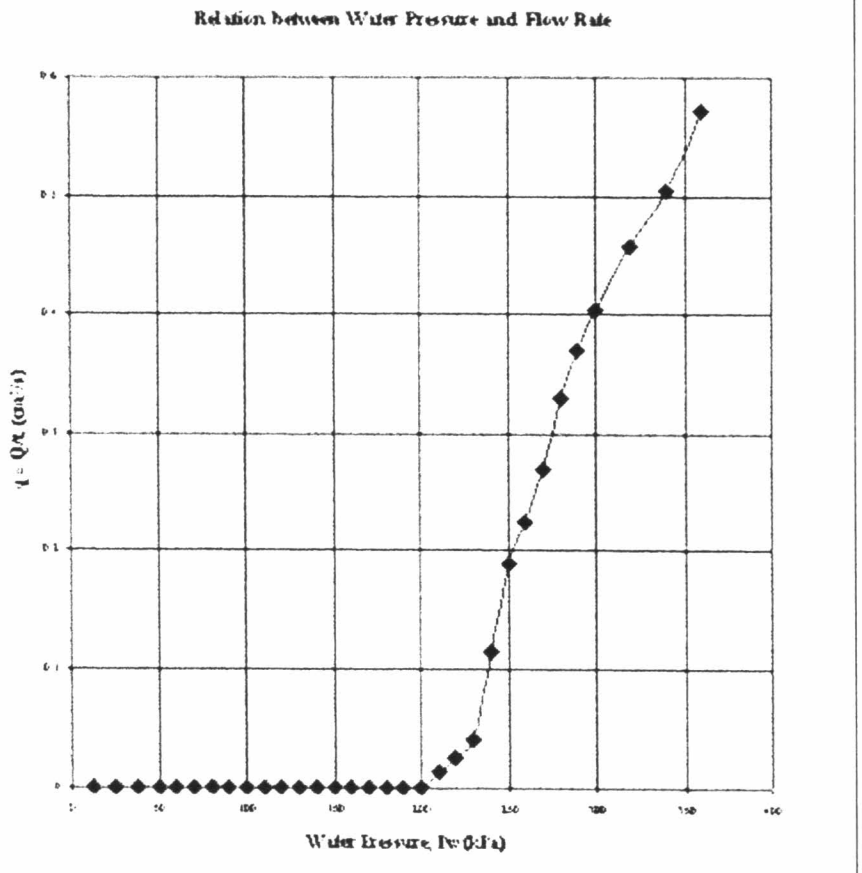
Appendix A. QVF 02 5% of Bentonite Content – Overburden Stress = 200 kPa.

Description		Units	Test Results		
			Initial	Finish	Diffirential
Weight of sample		g	1104.20	1014.70	89.50
Heigh of compacted sample		cm	8.15	7.81	0.34
Volume of compacted sample		cm3	632.72	609.23	23.48
Unit Weight of sample		t/m3	1.75	1.67	
Dry density of sample		t/m3	1.46	1.39	
Average water content		%	19.50	19.56	
Average water content, Top		%	19.50	20.16	
Average water content, Middle		%	19.50	19.64	
Average water content, Bottom		%	19.50	18.88	
Pw, (kPa)	q (cm3/s)	kn (cm/s)	Pw, (kPa)	q (cm3/s)	kn (cm/s)
37.5	0.0E+00	0.0E+00	180.0	1.7E-01	1.9E-04
50.0	0.0E+00	0.0E+00	190.0	2.5E-01	2.3E-04
60.0	0.0E+00	0.0E+00	200.0	3.9E-01	3.4E-04
70.0	0.0E+00	0.0E+00	220.0	4.9E-01	3.7E-04
80.0	0.0E+00	0.0E+00	240.0	5.7E-01	3.7E-04
90.0	0.0E+00	0.0E+00	260.0	6.7E-01	4.5E-04
100.0	0.0E+00	0.0E+00			
150.0	1.9E-02	3.9E-05			
160.0	6.8E-02	8.4E-05			
170.0	1.1E-01	1.3E-04			



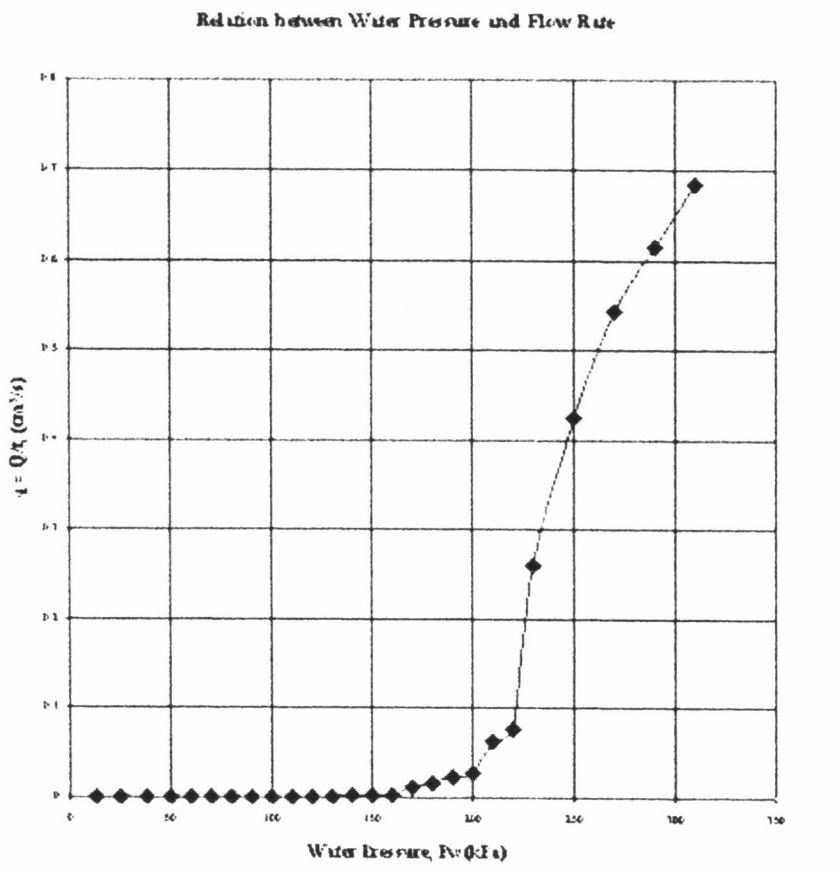
Appendix A. QVF 03 5% of Bentonite Content – Overburden Stress = 300 kPa.

Description		Units	Test Results		
			Initial	Finish	Diffirential
Weight of sample		g	1114.30	1013.70	100.60
Heigh of compacted sample		cm	8.26	7.95	0.31
Volume of compacted sample		cm3	647.87	620.18	27.69
Unit Weight of sample		t/m3	1.72	1.63	
Dry density of sample		t/m3	1.43	1.36	
Average water content		%	19.92	20.12	
Average water content, Top		%	19.92	20.09	
Average water content, Middle		%	19.92	19.75	
Average water content, Bottom		%	19.92	20.52	
Pw, (kPa)	q (cm3 s)	kn (cm/s)	Pw, (kPa)	q (cm3/s)	kn (cm/s)
140.0	0.0E+00	0.0E+00	240.0	1.1E-01	8.3E-05
150.0	0.0E+00	0.0E+00	250.0	1.9E-01	1.4E-04
160.0	0.0E+00	0.0E+00	260.0	2.2E-01	1.4E-04
170.0	0.0E+00	0.0E+00	270.0	2.7E-01	1.7E-04
180.0	0.0E+00	0.0E+00	280.0	3.3E-01	1.9E-04
190.0	0.0E+00	0.0E+00	290.0	3.7E-01	2.0E-04
200.0	1.9E-04	7.5E-07	300.0	4.0E-01	2.1E-04
210.0	1.3E-02	1.5E-05	320.0	4.6E-01	2.3E-04
220.0	2.5E-02	3.2E-05	340.0	5.0E-01	2.4E-04
230.0	4.0E-02	4.7E-05	360.0	5.7E-01	2.5E-04



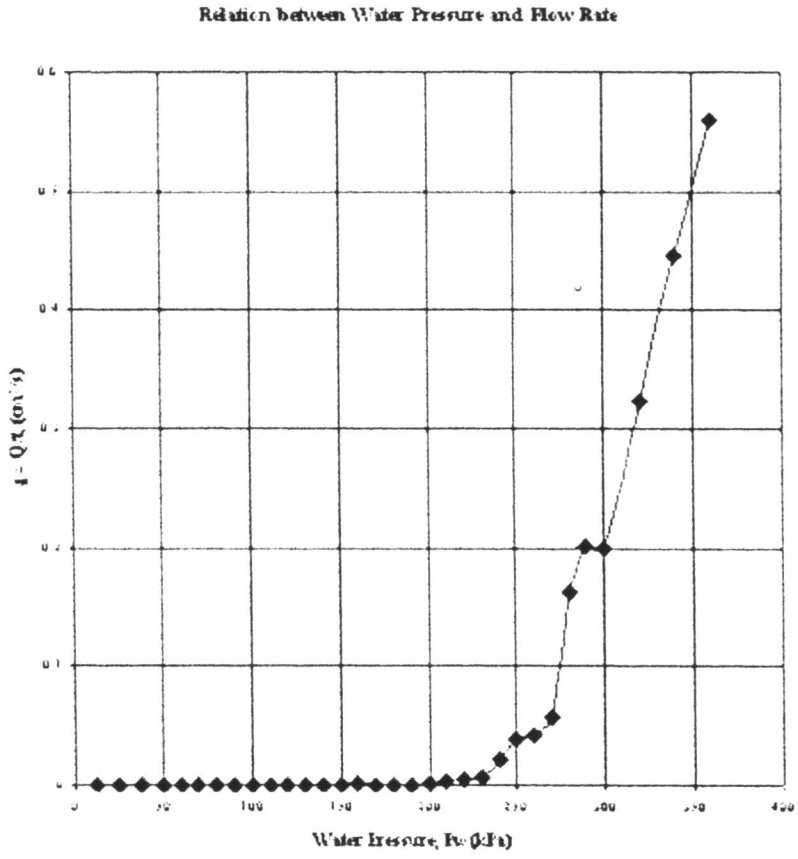
Appendix A. QVF 04 10% of Bentonite Content – Overburden Stress = 100 kPa.

Description		Units	Test Results		
			Initial	Finish	Diffirential
Weight of sample		g	1096.50	975.50	121.00
Heigh of compacted sample		cm	8.03	7.41	0.62
Volume of compacted sample		cm3	625.48	578.14	47.34
Unit Weight of sample		t/m3	1.75	1.69	
Dry density of sample		t/m3	1.45	2.25	
Average water content		%	20.69	21.47	
Average water content, Top		%	20.69	19.26	
Average water content, Middle		%	20.69	22.69	
Average water content, Bottom		%	20.69	22.46	
Pw, (kPa)	q (cm3/s)	kn (cm/s)	Pw, (kPa)	q (cm3/s)	kn (cm/s)
37.5	0.0E+00	0.0E+00	180.0	1.5E-02	2.2E-05
50.0	0.0E+00	0.0E+00	190.0	2.2E-02	3.4E-05
60.0	0.0E+00	0.0E+00	200.0	2.8E-02	3.5E-05
70.0	0.0E+00	0.0E+00	210.0	6.3E-02	4.5E-05
80.0	0.0E+00	0.0E+00	220.0	7.5E-02	6.7E-05
90.0	0.0E+00	0.0E+00	230.0	2.6E-01	1.7E-04
140.0	1.1E-03	6.2E-06	250.0	4.2E-01	2.8E-04
150.0	1.5E-03	7.7E-06	270.0	5.4E-01	3.2E-04
160.0	2.0E-03	9.5E-06	290.0	6.2E-01	3.3E-04
170.0	1.1E-02	1.8E-05	310.0	6.8E-01	3.6E-04



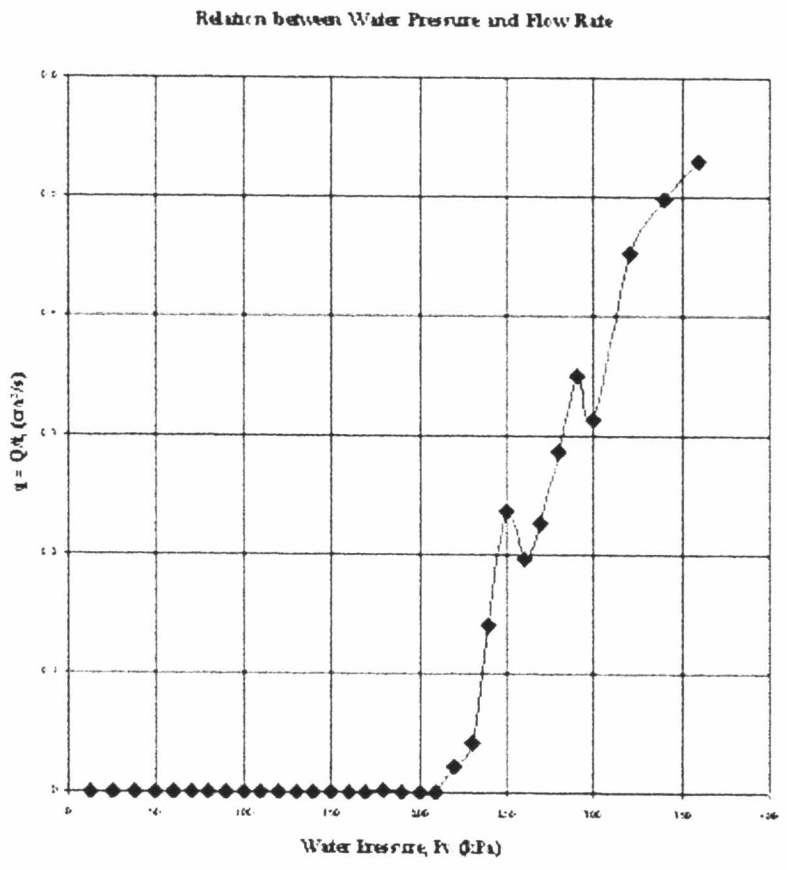
Appendix A. QVF 05 10% of Bentonite Content – Overburden Stress = 200 kPa.

Description		Units	Test Results		
			Initial	Finish	Diffirential
Weight of sample		g	1105.70	999.20	106.50
Heigh of compacted sample		cm	8.24	7.65	0.59
Volume of compacted sample		cm3	646.57	597.16	49.41
Unit Weight of sample		t/m3	1.71	1.67	
Dry density of sample		t/m3	1.43	2.23	
Average water content		%	19.18	19.53	
Average water content, Top		%	19.18	20.18	
Average water content, Middle		%	19.18	20.20	
Average water content, Bottom		%	19.18	18.20	
Pw, (kPa)	q (cm3/s)	kn (cm/s)	Pw, (kPa)	q (cm3/s)	kn (cm/s)
140.0	1.9E-04	1.1E-06	240.0	2.2E-02	1.9E-05
150.0	3.7E-04	2.0E-06	250.0	3.9E-02	1.8E-05
160.0	9.3E-04	4.6E-06	260.0	4.3E-02	2.7E-05
170.0	3.7E-04	1.7E-06	270.0	5.7E-02	3.3E-05
180.0	3.7E-04	1.6E-06	280.0	1.6E-01	1.0E-04
190.0	4.7E-04	1.9E-06	290.0	2.0E-01	1.0E-04
200.0	2.0E-03	2.2E-06	300.0	2.0E-01	9.8E-05
210.0	3.6E-03	4.2E-06	320.0	3.2E-01	1.7E-04
220.0	4.2E-03	5.0E-06	340.0	4.5E-01	2.3E-04
230.0	7.3E-03	9.7E-06	360.0	5.6E-01	2.5E-04



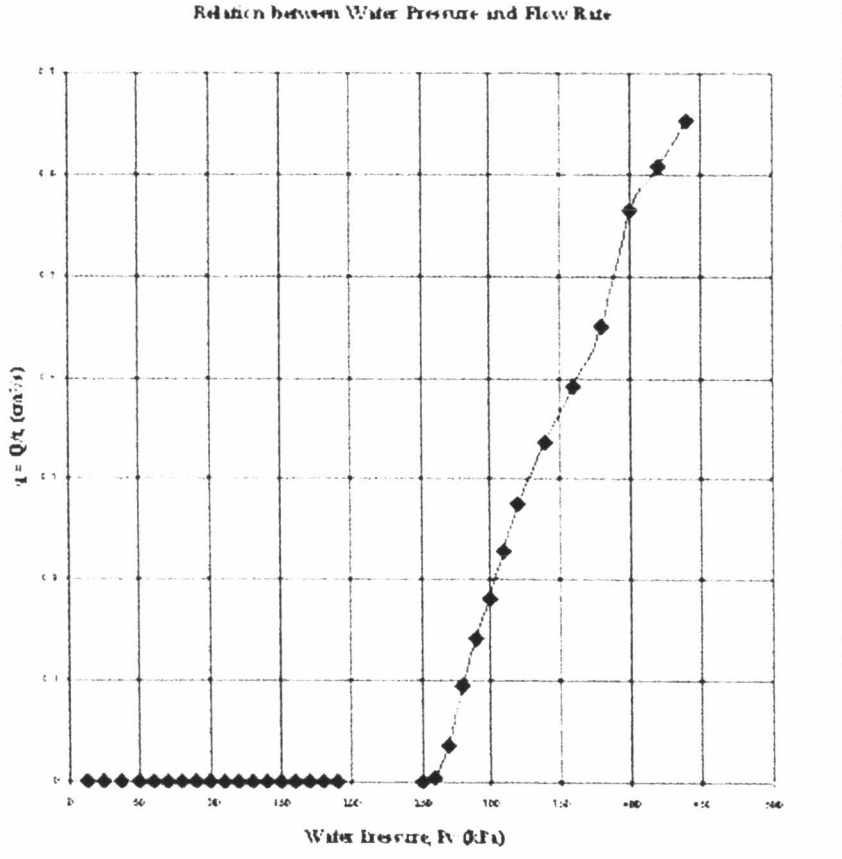
Appendix A. QVF 06 10% of Bentonite Content – Overburden Stress = 300 kPa.

Description		Units	Test Results		
			Initial	Finish	Diffirential
Weight of sample		g	1125.90	1018.80	107.10
Heigh of compacted sample		cm	8.31	7.86	0.45
Volume of compacted sample		cm3	645.79	613.52	32.27
Unit Weight of sample		t/m3	1.74	1.66	
Dry density of sample		t/m3	1.46	2.21	
Average water content		%	19.78	19.18	
Average water content, Top		%	19.78	19.36	
Average water content, Middle		%	19.78	18.68	
Average water content, Bottom		%	19.78	19.50	
Pw, (kPa)	q (cm3/s)	kn (cm/s)	Pw, (kPa)	q (cm3/s)	kn (cm/s)
140.0	0.0E-00	0.0E+00	240.0	1.4E-01	1.2E-04
150.0	9.4E-05	5.1E-07	250.0	2.4E-01	1.8E-04
160.0	1.9E-04	9.5E-07	260.0	2.0E-01	1.2E-04
170.0	3.8E-04	1.8E-06	270.0	2.3E-01	1.4E-04
180.0	9.4E-04	4.2E-06	280.0	2.9E-01	1.8E-04
190.0	3.8E-04	1.6E-06	290.0	3.5E-01	2.0E-04
200.0	3.8E-04	1.5E-06	300.0	3.1E-01	2.1E-04
210.0	6.6E-04	2.5E-06	320.0	4.5E-01	2.4E-04
220.0	2.3E-02	3.1E-05	340.0	5.0E-01	2.4E-04
230.0	4.2E-02	5.2E-05	360.0	5.3E-01	2.3E-04



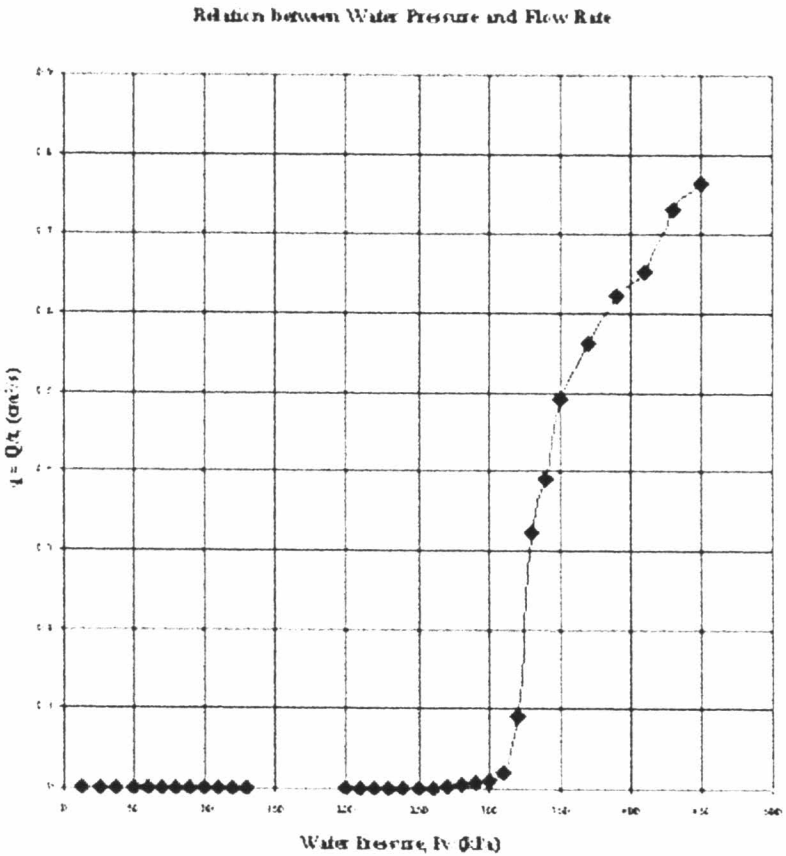
Appendix A. QVF 07 15% of Bentonite Content – Overburden Stress = 100 kPa.

Description		Units	Test Results		
			Initial	Finish	Diffirential
Weight of sample		g	1102.90	983.30	119.60
Heigh of compacted sample		cm	8.23	7.67	0.56
Volume of compacted sample		cm3	641.46	598.96	42.50
Unit Weight of sample		t/m3	1.72	1.64	
Dry density of sample		t/m3	1.87	1.24	
Average water content		%	20.56	21.47	
Average water content, Top		%	20.56	19.26	
Average water content, Middle		%	20.56	22.69	
Average water content, Bottom		%	20.56	22.46	
Pw, (kPa)	q (cm3/s)	kn (cm/s)	Pw, (kPa)	q (cm3/s)	kn (cm/s)
140.0	0.0E+00	0.0E+00	290.0	1.4E-01	8.0E-05
150.0	0.0E+00	0.0E+00	300.0	1.8E-01	9.8E-05
160.0	0.0E+00	0.0E+00	310.0	2.3E-01	1.4E-04
170.0	0.0E+00	0.0E+00	320.0	2.8E-01	1.4E-04
180.0	0.0E+00	0.0E+00	340.0	3.4E-01	1.6E-04
190.0	0.0E+00	0.0E+00	360.0	3.9E-01	1.7E-04
250.0	0.0E+00	0.0E+00	380.0	4.5E-01	1.9E-04
260.0	4.3E-03	1.3E-05	400.0	5.6E-01	2.2E-04
270.0	3.5E-02	4.0E-05	420.0	6.1E-01	2.3E-04
280.0	9.4E-02	5.8E-05	440.0	6.5E-01	2.2E-04



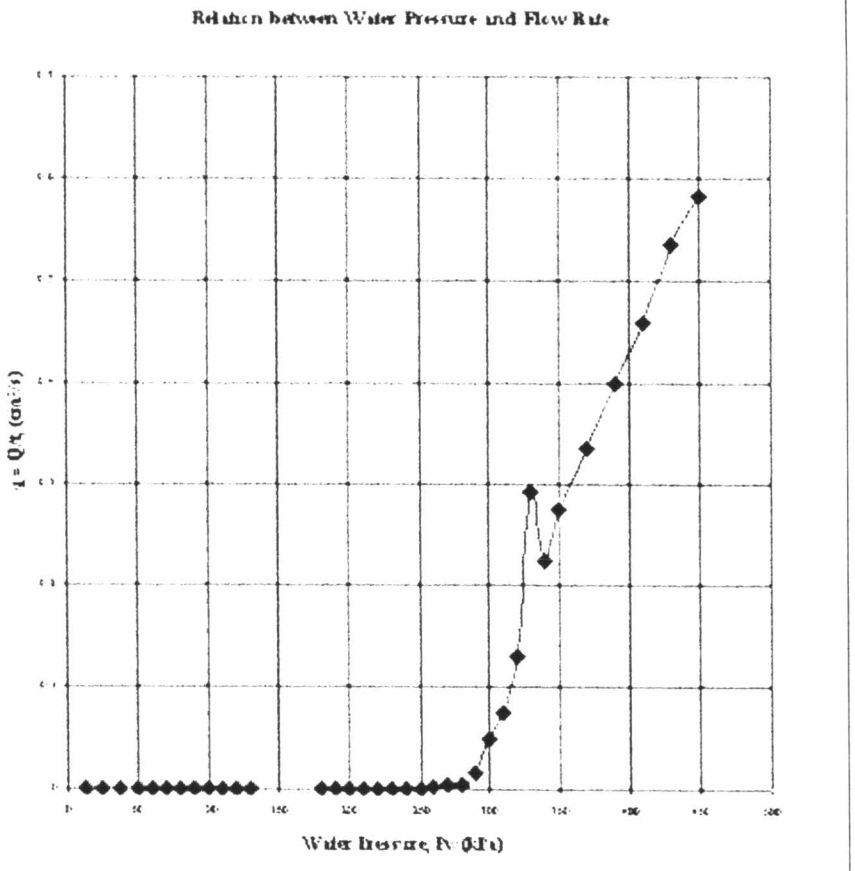
Appendix A. QVF 08 15% of Bentonite Content – Overburden Stress = 200 kPa.

Description		Units	Test Results		
			Initial	Finish	Diffirential
Weight of sample		g	1096.90	979.00	117.90
Heigh of compacted sample		cm	7.94	7.45	0.49
Volume of compacted sample		cm3	618.47	581.53	36.95
Unit Weight of sample		t/m3	1.77	1.68	
Dry density of sample		t/m3	1.50	2.24	
Average water content		%	17.91	19.80	
Average water content, Top		%	17.91	19.80	
Average water content, Middle		%	17.91	19.60	
Average water content, Bottom		%	17.91	20.00	
Pw, (kPa)	q (cm3/s)	kn (cm/s)	Pw, (kPa)	q (cm3/s)	kn (cm/s)
210.0	9.4E-05	3.4E-07	310.0	2.1E-02	2.0E-05
220.0	1.9E-04	6.6E-07	320.0	9.0E-02	8.1E-05
230.0	3.8E-04	1.3E-06	330.0	3.2E-01	1.6E-04
240.0	3.8E-04	1.2E-06	340.0	3.9E-01	1.7E-04
250.0	1.1E-03	3.5E-06	350.0	4.9E-01	2.2E-04
260.0	1.1E-03	3.3E-06	370.0	5.6E-01	2.3E-04
270.0	1.3E-03	3.7E-06	390.0	6.2E-01	2.5E-04
280.0	6.2E-03	6.2E-06	410.0	6.5E-01	2.4E-04
290.0	8.5E-03	7.5E-06	430.0	7.3E-01	2.6E-04
300.0	1.0E-02	7.2E-06	450.0	7.7E-01	2.5E-04



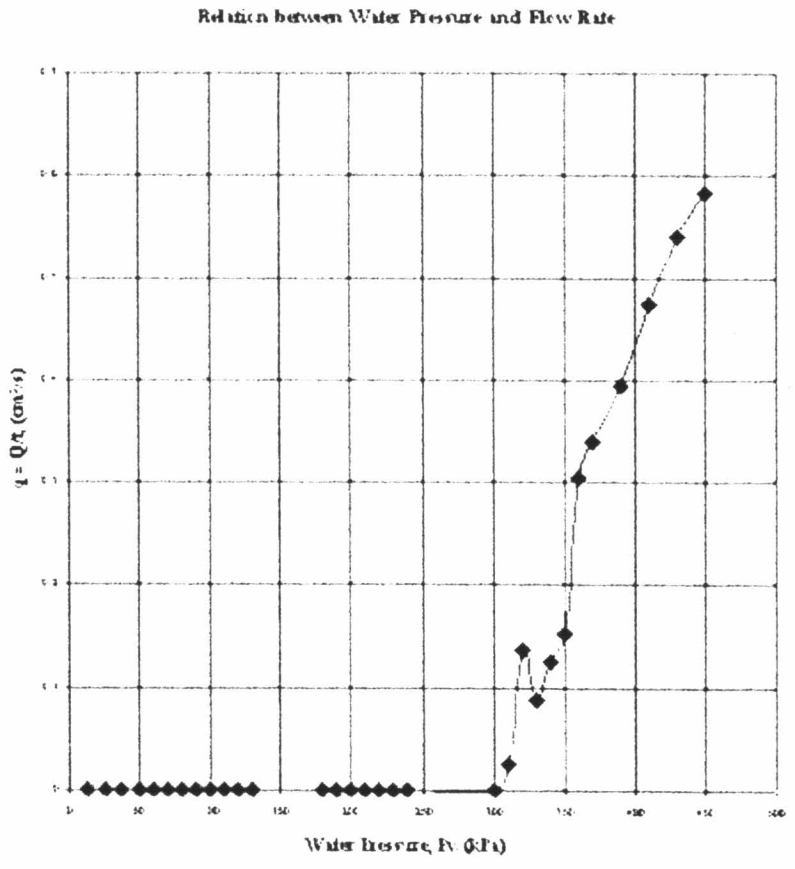
Appendix A. QVF 09 15% of Bentonite Content – Overburden Stress = 300 kPa.

Description		Units	Test Results		
			Initial	Finish	Differential
Weight of sample		g	1101.80	989.00	112.80
Heigh of compacted sample		cm	8.17	7.64	0.53
Volume of compacted sample		cm3	641.08	596.25	44.83
Unit Weight of sample		t/m3	1.72	1.66	
Dry density of sample		t/m3	1.45	2.21	
Average water content		%	18.68	20.13	
Average water content, Top		%	18.68	20.10	
Average water content, Middle		%	18.68	19.80	
Average water content, Bottom		%	18.68	20.50	
Pw, (kPa)	q (cm3/s)	kn (cm/s)	Pw, (kPa)	q (cm3/s)	kn (cm/s)
210.0	0.0E+00	0.0E+00	310.0	7.4E-02	3.7E-05
220.0	0.0E+00	0.0E+00	320.0	1.3E-01	7.2E-05
230.0	0.0E+00	0.0E+00	330.0	2.9E-01	8.3E-05
240.0	0.0E+00	0.0E+00	340.0	2.2E-01	1.0E-04
250.0	2.8E-04	8.8E-07	350.0	2.8E-01	1.3E-04
260.0	2.2E-03	1.7E-06	370.0	3.3E-01	1.4E-04
270.0	3.1E-03	3.3E-06	390.0	4.0E-01	1.8E-04
280.0	3.6E-03	3.9E-06	410.0	4.6E-01	2.2E-04
290.0	1.5E-02	1.4E-05	430.0	5.3E-01	2.1E-04
300.0	4.8E-02	4.7E-05	450.0	5.8E-01	2.0E-04



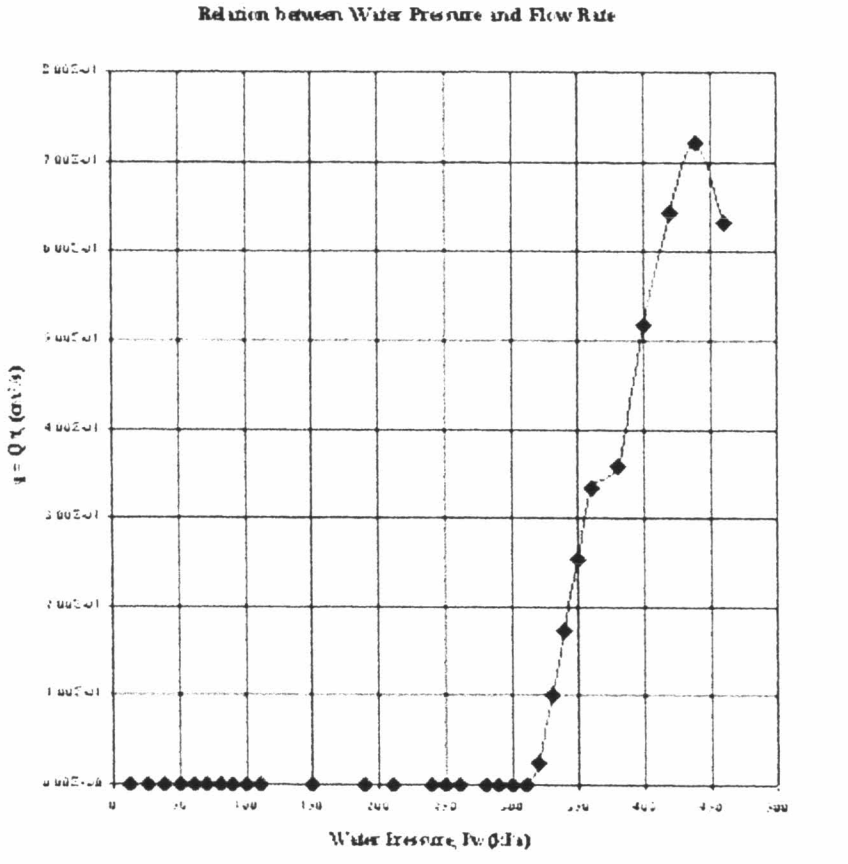
Appendix A. QVF 10 20% of Bentonite Content – Overburden Stress = 100 kPa.

Description		Units	Test Results		
			Initial	Finish	Diffirential
Weight of sample		g	1106.80	1011.10	95.70
Heigh of compacted sample		cm	8.21	7.72	0.49
Volume of compacted sample		cm3	637.51	602.21	35.30
Unit Weight of sample		t/m3	1.74	1.68	
Dry density of sample		t/m3	1.45	2.24	
Average water content		%	19.79	654.80	
Average water content, Top		%	19.79	1925.00	
Average water content, Middle		%	19.79	19.80	
Average water content, Bottom		%	19.79	19.60	
Pw, (kPa)	q (cm3 s)	kn (cm/s)	Pw, (kPa)	q (cm3/s)	kn (cm/s)
37.5	0.0E+00	0.0E+00	320.0	1.4E-01	9.0E-05
180.0	0.0E+00	0.0E+00	330.0	8.8E-02	7.9E-05
190.0	0.0E+00	0.0E+00	340.0	1.2E-01	9.2E-05
200.0	0.0E+00	0.0E+00	350.0	1.5E-01	1.2E-04
210.0	0.0E+00	0.0E+00	360.0	3.0E-01	1.5E-04
220.0	0.0E+00	0.0E+00	370.0	3.4E-01	1.7E-04
230.0	0.0E+00	0.0E+00	390.0	3.9E-01	1.6E-04
240.0	0.0E+00	0.0E+00	410.0	4.7E-01	1.9E-04
300.0	6.6E-04	1.7E-06	430.0	5.4E-01	2.0E-04
310.0	2.5E-02	2.3E-05	450.0	5.8E-01	2.1E-04



Appendix A. QVF 11 20% of Bentonite Content – Overburden Stress = 200 kPa.

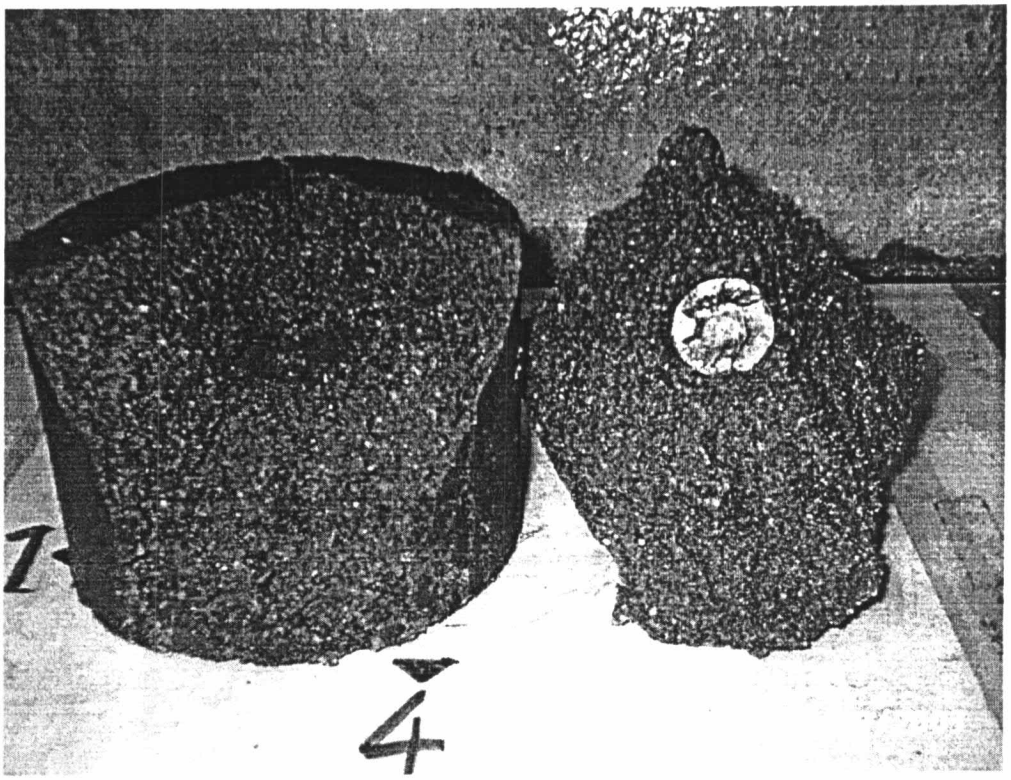
Description		Units	Test Results		
			Initial	Finish	Diffirential
Weight of sample		g	1102.20	980.20	122.00
Heigh of compacted sample		cm	8.11	7.58	0.53
Volume of compacted sample		cm3	632.11	591.41	40.69
Unit Weight of sample		t/m3	1.74	1.66	
Dry density of sample		t/m3	1.48	1.40	
Average water content		%	18.00	19.60	
Average water content, Top		%	18.00	19.50	
Average water content, Middle		%	18.00	19.30	
Average water content, Bottom		%	18.00	20.00	
Pw, (kPa)	q (cm3/s)	kn (cm/s)	Pw, (kPa)	q (cm3/s)	kn (cm/s)
150.0	0.0E+00	0.0E+00	320.0	2.5E-02	2.8E-05
190.0	0.0E+00	0.0E+00	330.0	1.0E-01	4.8E-05
210.0	0.0E+00	0.0E+00	340.0	1.7E-01	9.1E-05
240.0	0.0E+00	0.0E+00	350.0	2.5E-01	1.3E-04
250.0	0.0E+00	0.0E+00	360.0	3.3E-01	1.5E-04
260.0	0.0E+00	0.0E+00	380.0	3.6E-01	2.1E-04
280.0	0.0E+00	0.0E+00	400.0	5.2E-01	2.2E-04
290.0	0.0E+00	0.0E+00	420.0	6.4E-01	2.5E-04
300.0	0.0E+00	0.0E+00	440.0	7.2E-01	2.6E-04
310.0	0.0E+00	0.0E+00	460.0	6.3E-01	2.7E-04



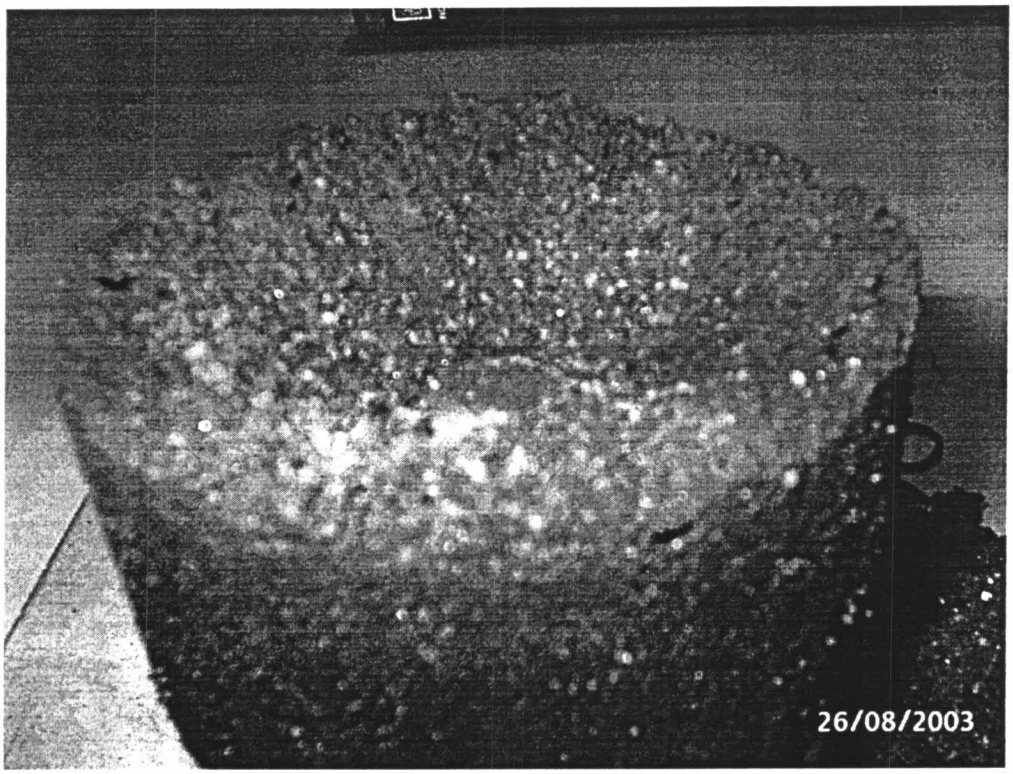
Appendix A. QVF 12 20% of Bentonite Content – Overburden Stress = 300 kPa.

APPENDIX B

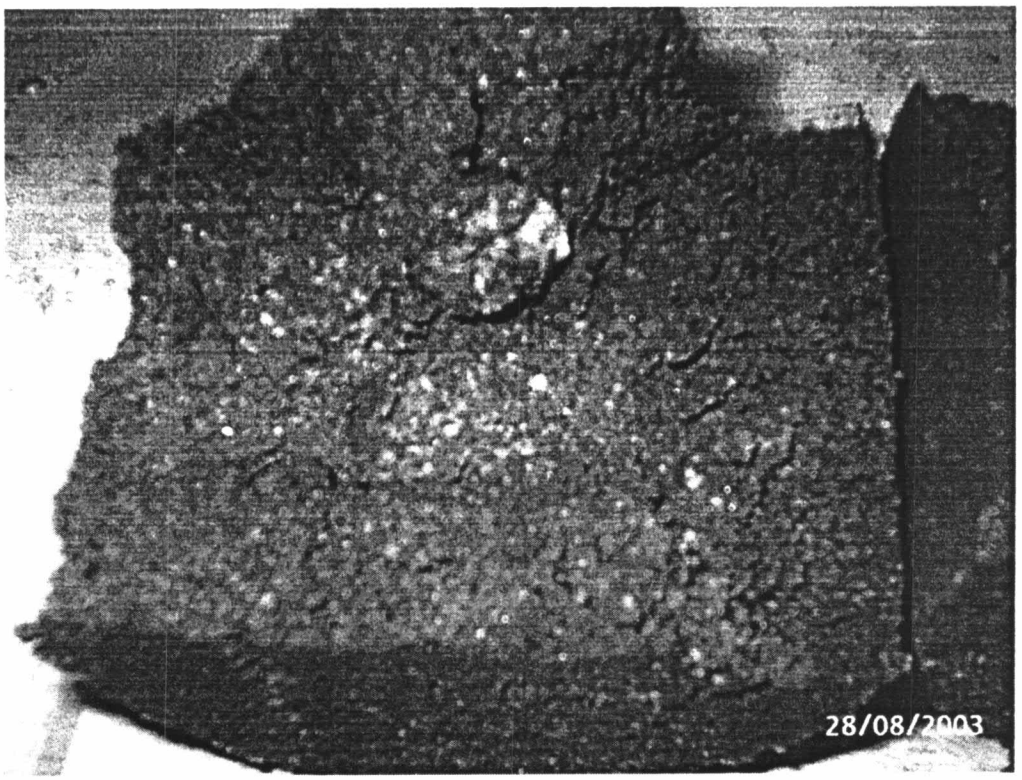
FIGURED OF HYDRAULIC FRACTURE FORM



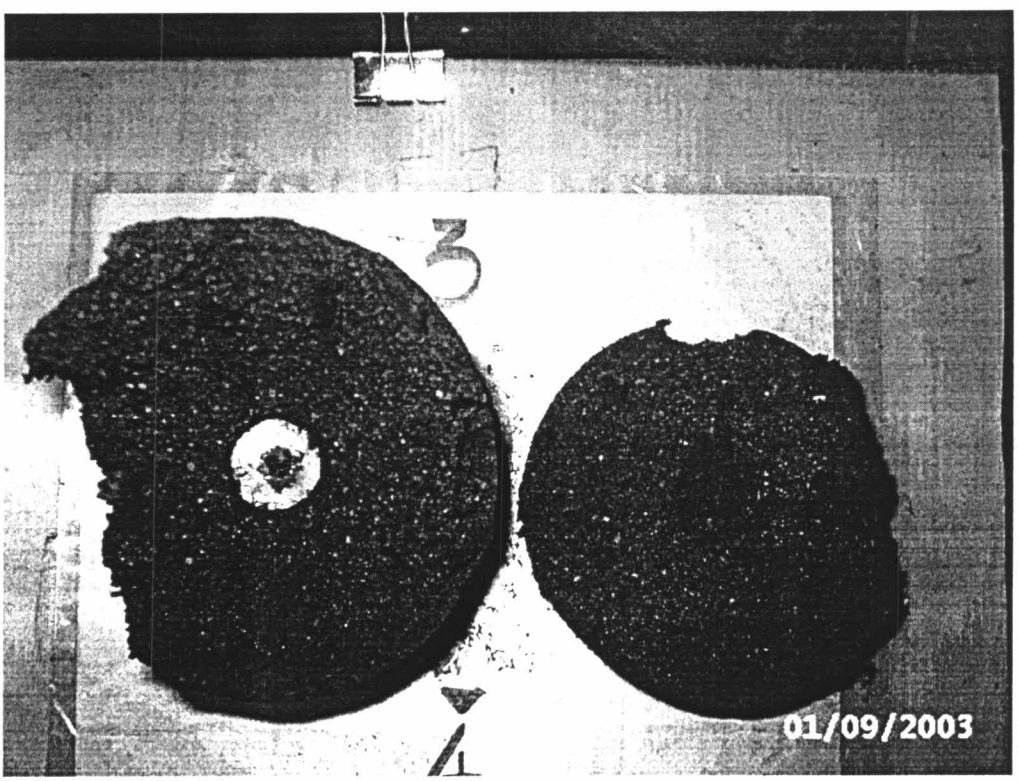
SHF01 5% of Bentonite Content – Overburden pressure = 100 kPa



SHF02 5% of Bentonite Content – Overburden pressure = 200 kPa

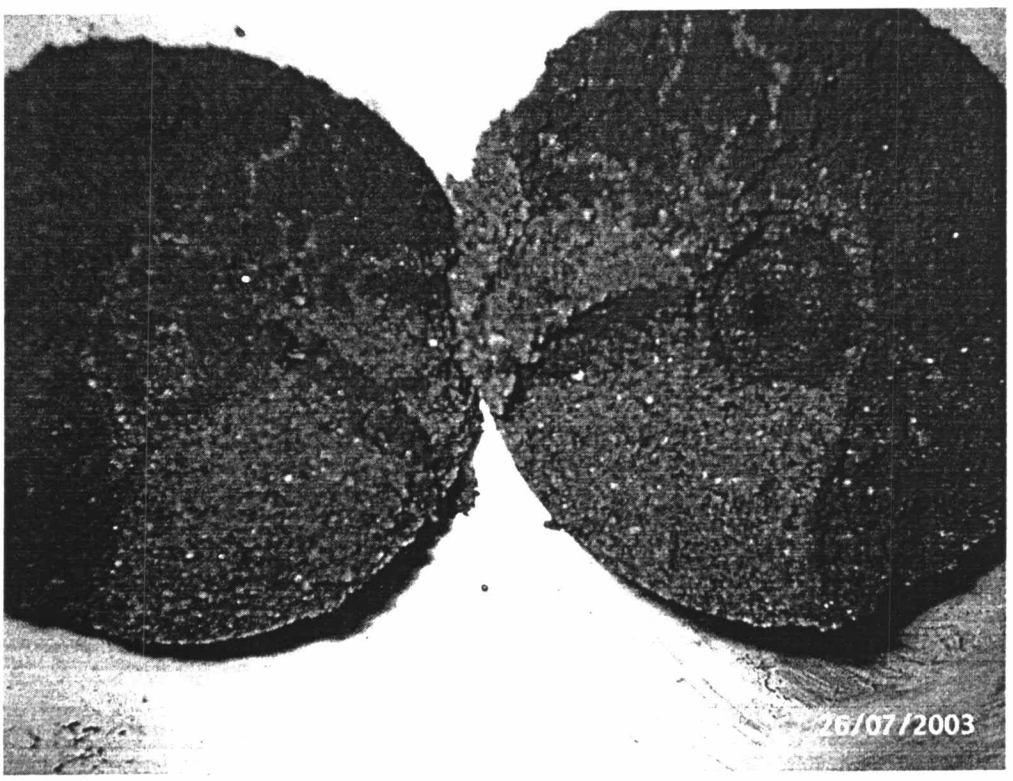


SHF03 5% of Bentonite Content – Overburden pressure = 300 kPa

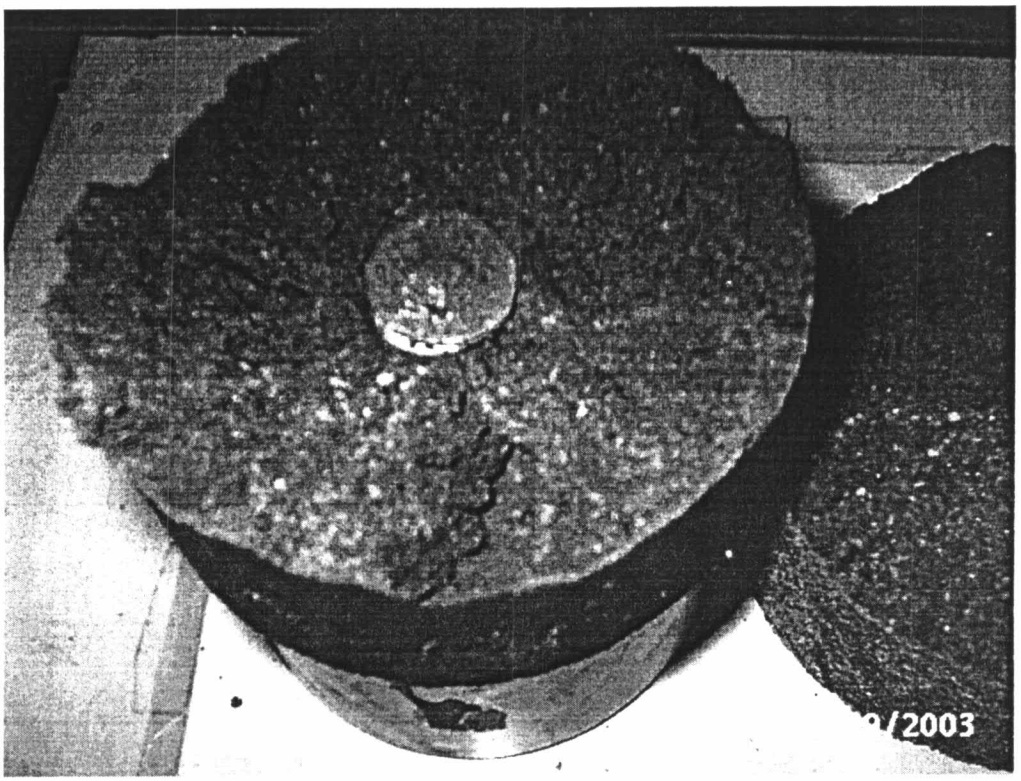


SHF04 10% of Bentonite Content – Overburden pressure = 100 kPa

SHF0510% of Bentonite Content – Overburden pressure = 200 kPa

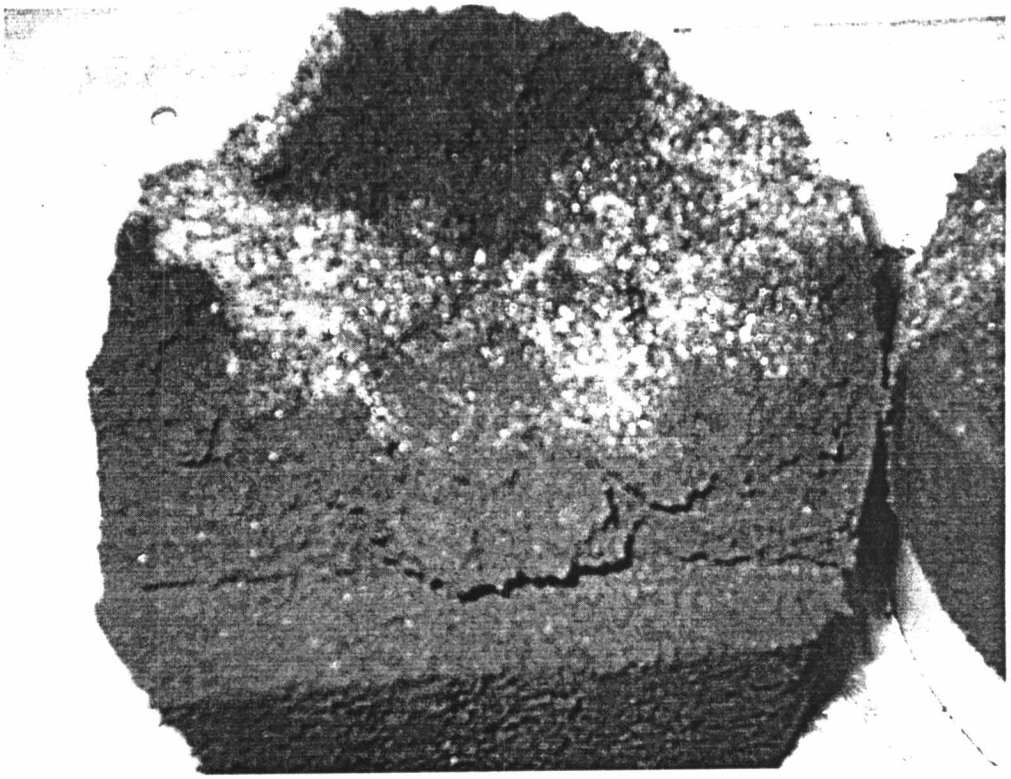


SHF06 10% of Bentonite Content – Overburden pressure = 300 kPa

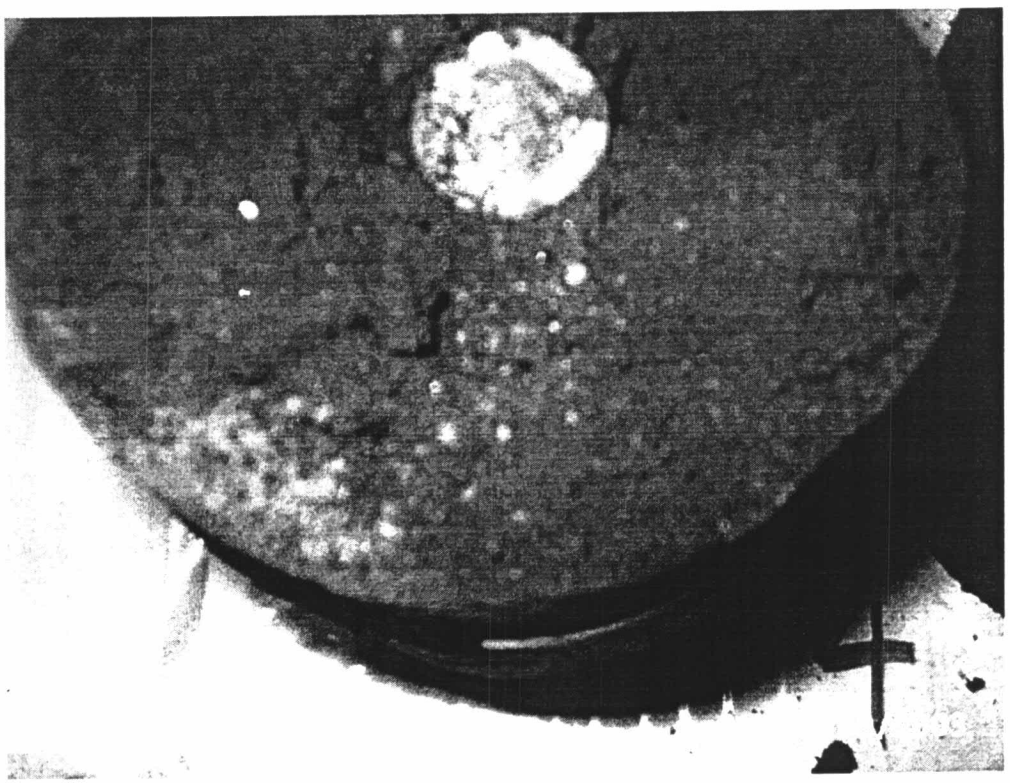


SHF07 15% of Bentonite Content – Overburden pressure = 100 kPa

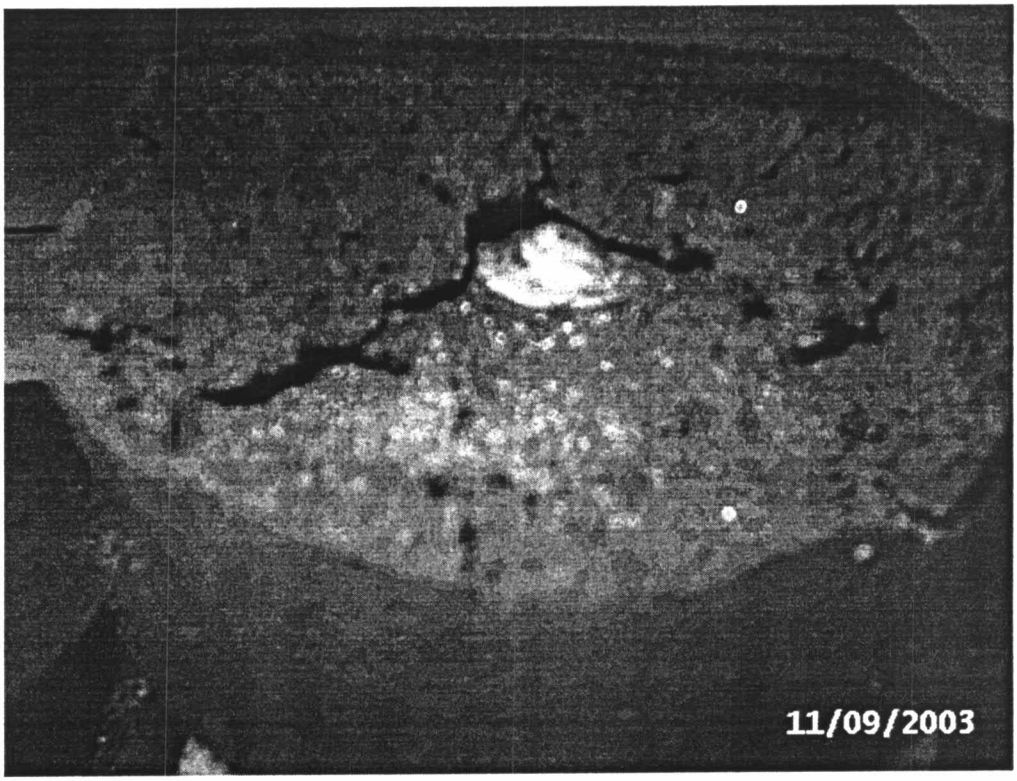
SHF08 15% of Bentonite Content – Overburden pressure = 200 kPa



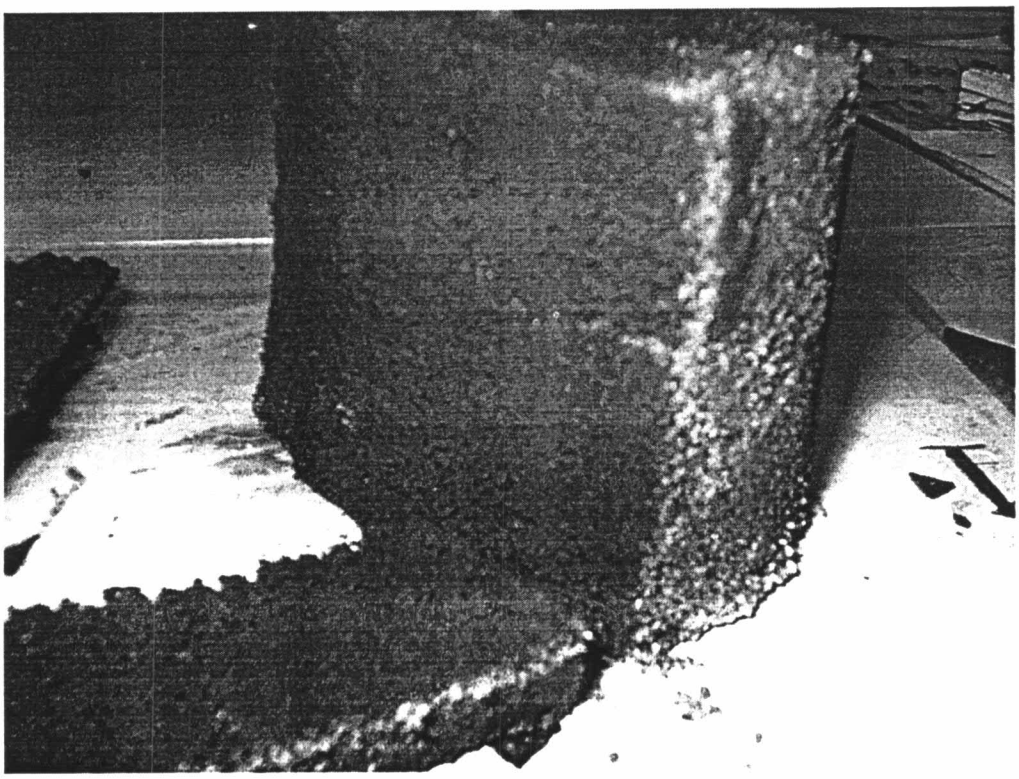
SHF09 15% of Bentonite Content – Overburden pressure = 300 kPa



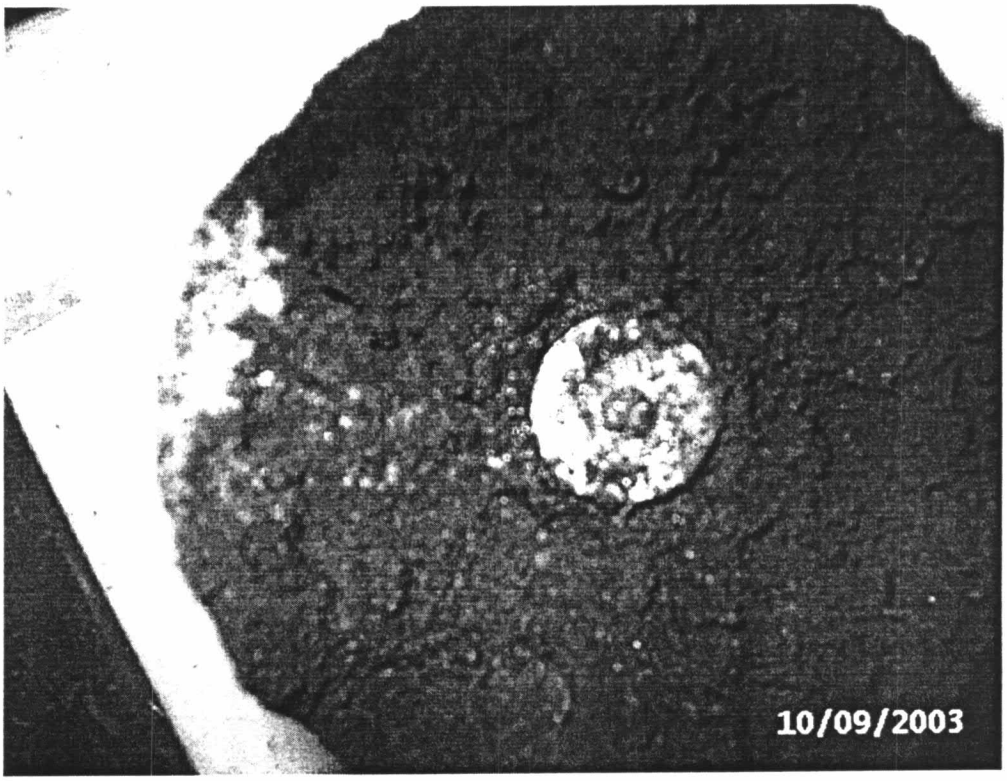
SHF10 20% of Bentonite Content – Overburden pressure = 100 kPa



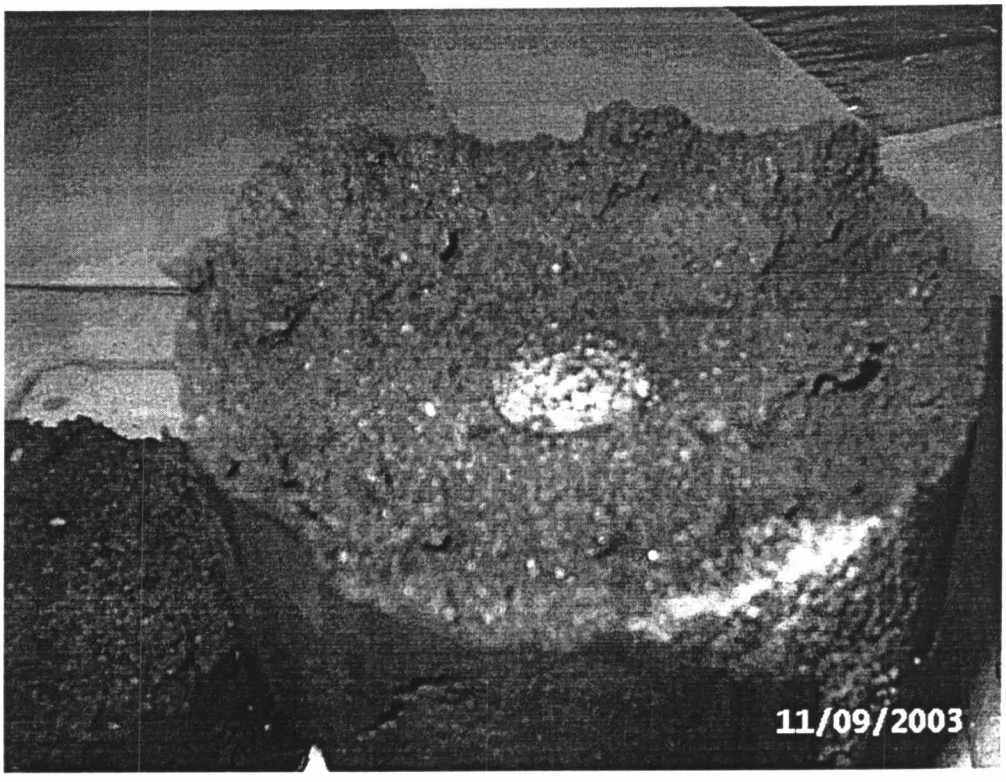
SHF11 20% of Bentonite Content – Overburden pressure = 200 kPa



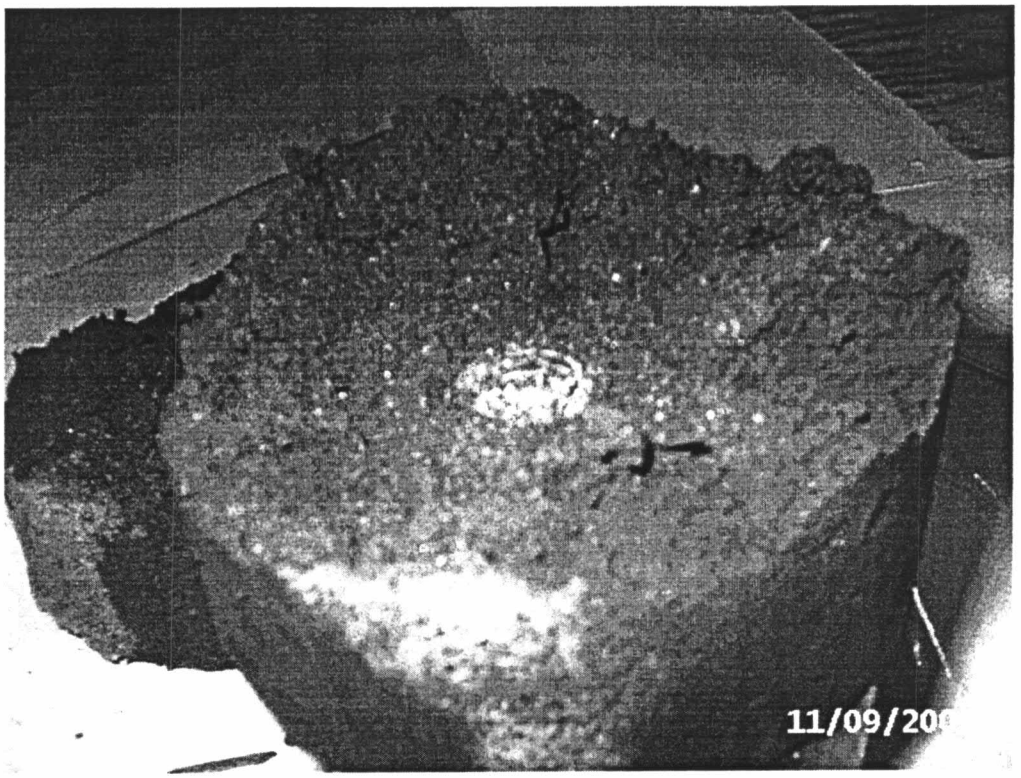
SHF12 20% of Bentonite Content – Overburden pressure = 300 kPa



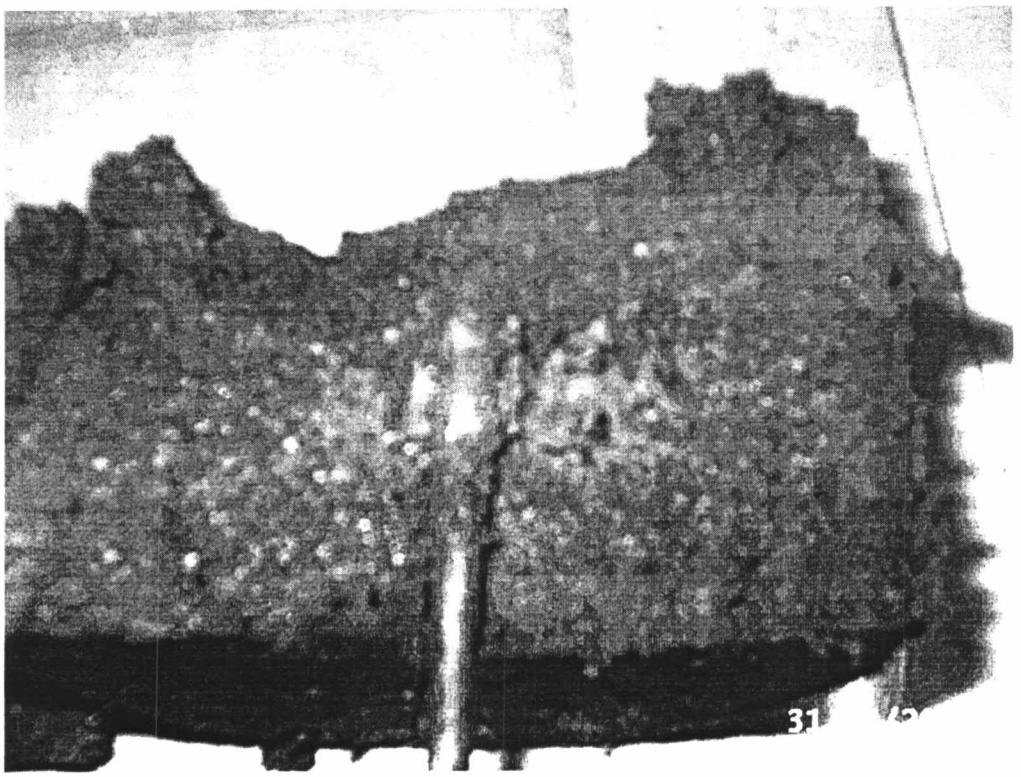
SHF13 25% of Bentonite Content – Overburden pressure = 100 kPa



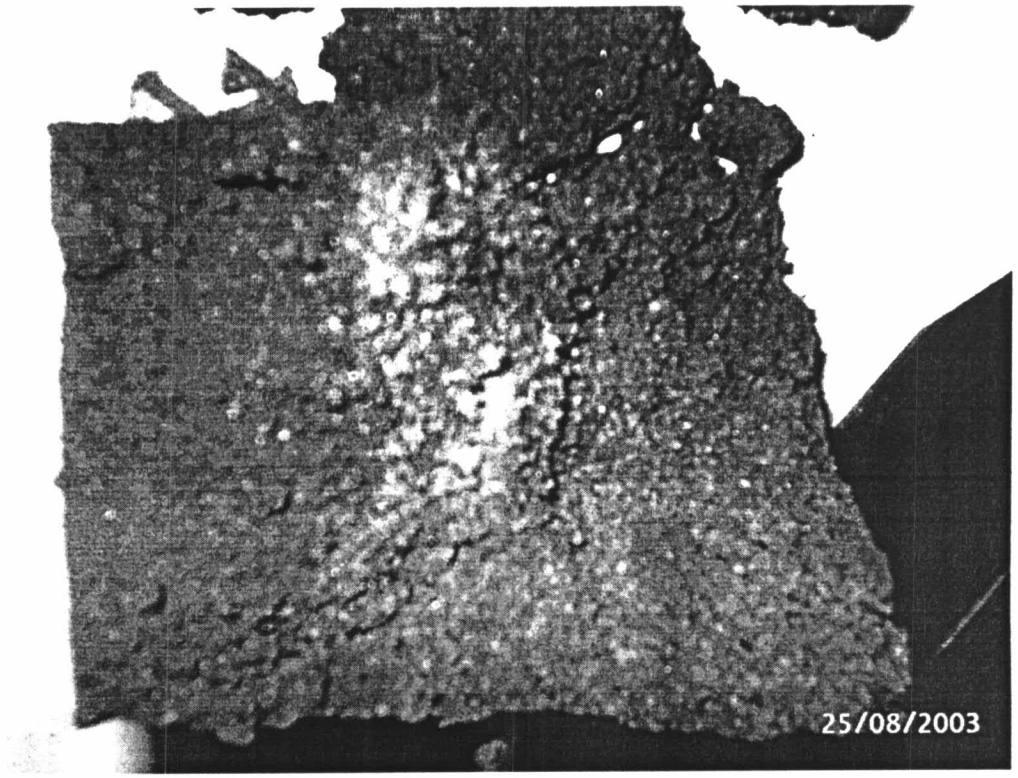
SHF14 25% of Bentonite Content – Overburden pressure = 200 kPa



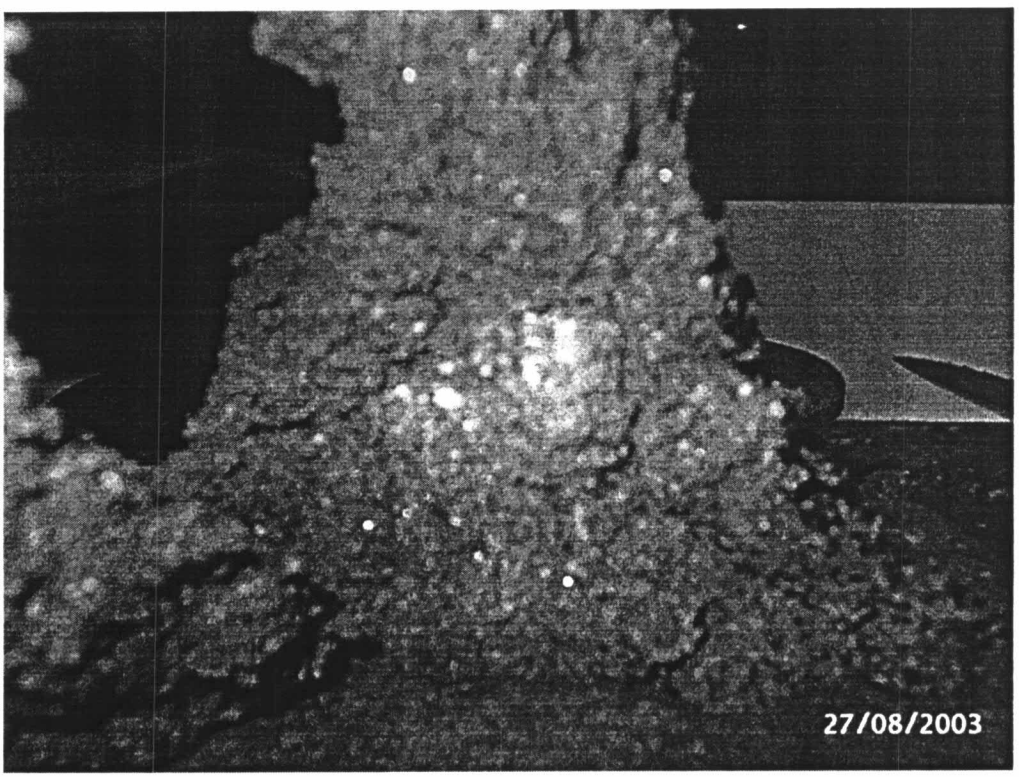
SHF15 25% of Bentonite Content – Overburden pressure = 300 kPa



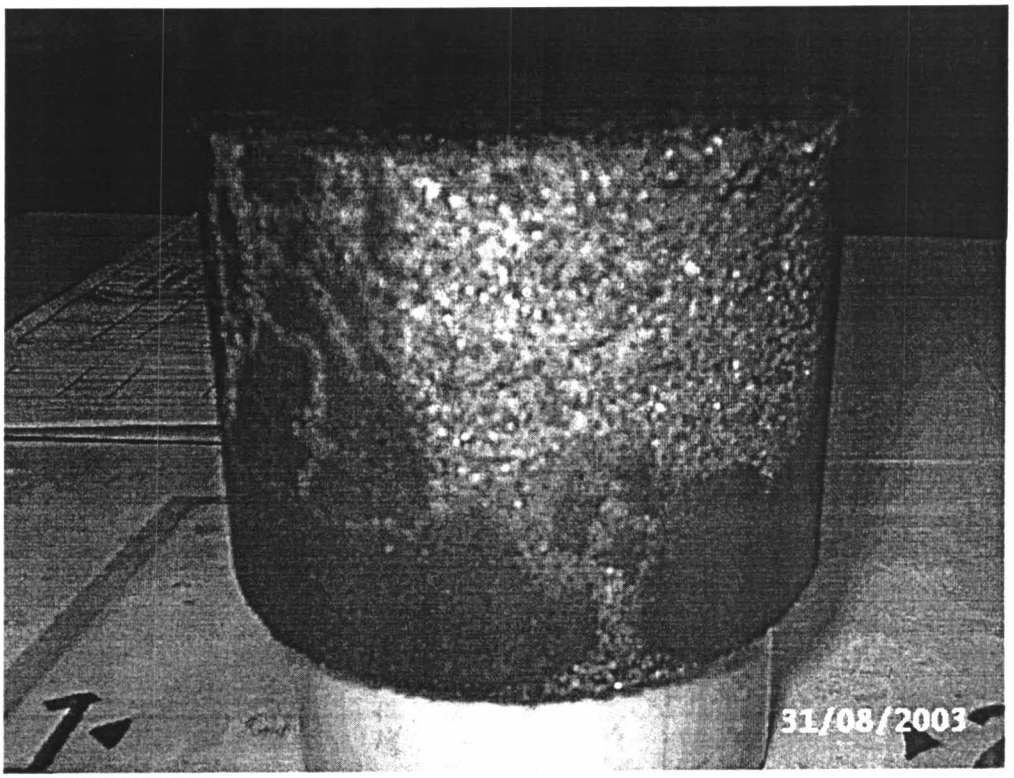
SVF01 5% of Bentonite Content – Overburden pressure = 100 kPa



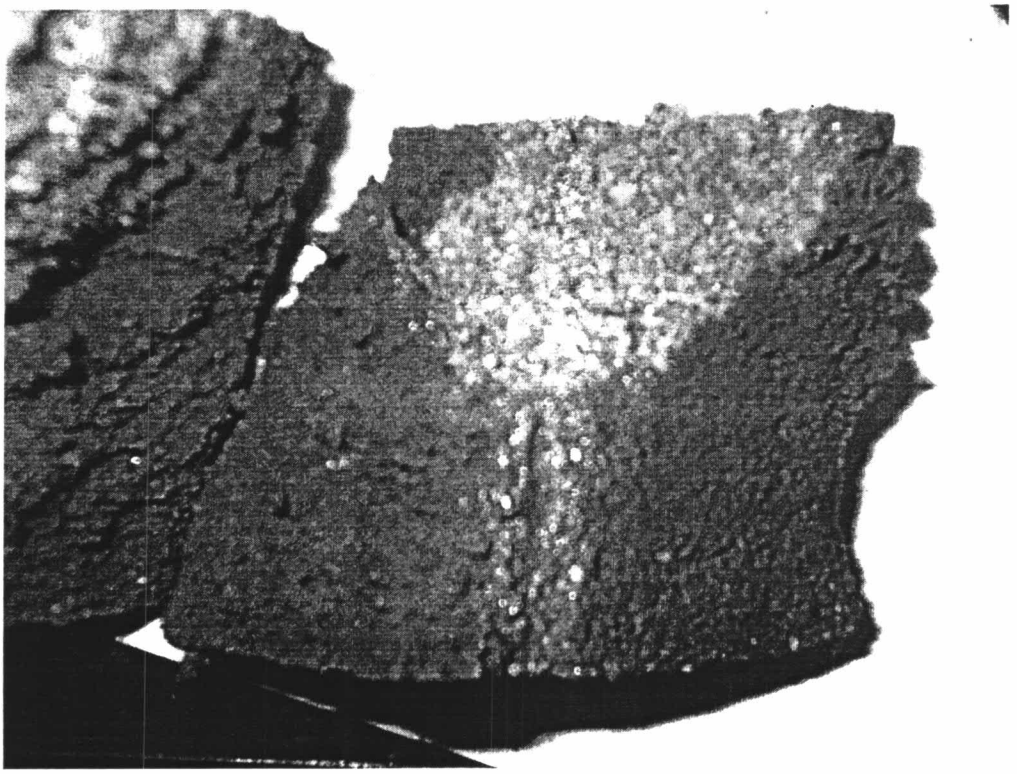
SVF02 5% of Bentonite Content – Overburden pressure = 200 kPa



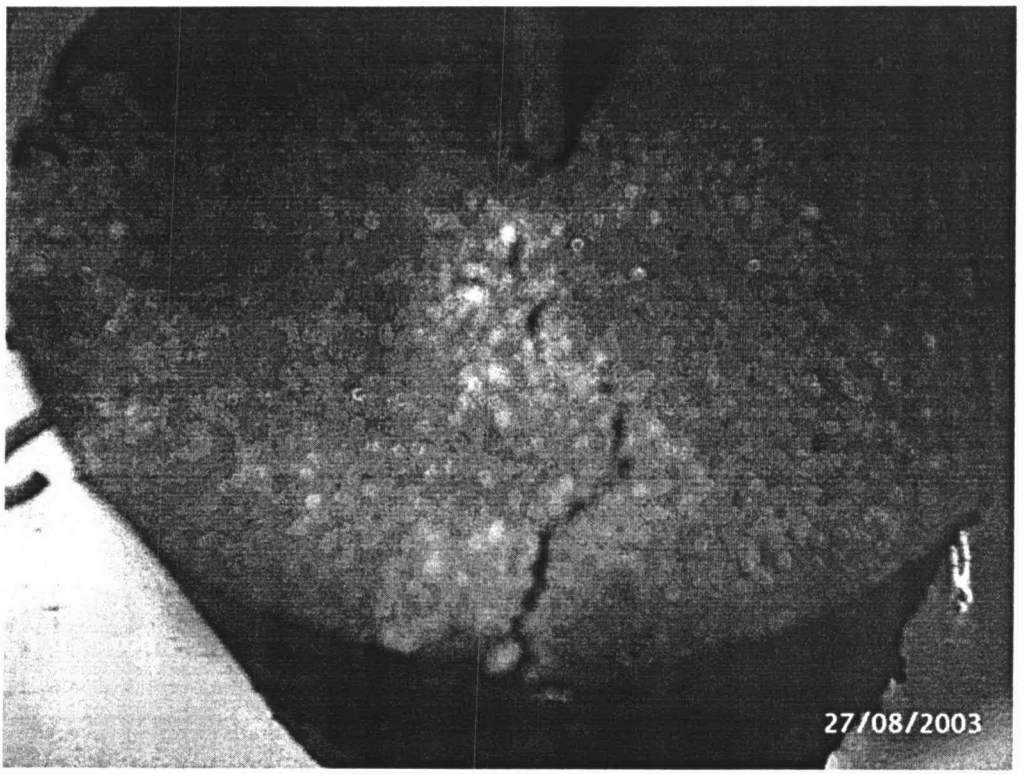
SVF03 5% of Bentonite Content – Overburden pressure = 300 kPa



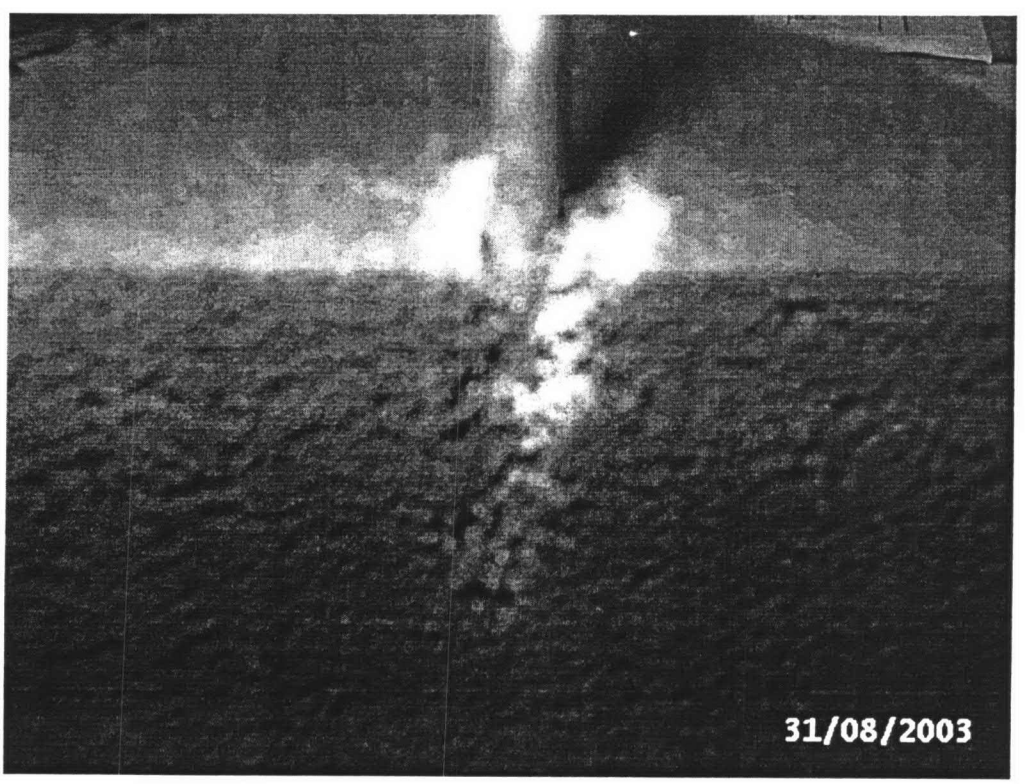
SVF04 10% of Bentonite Content – Overburden pressure = 100 kPa



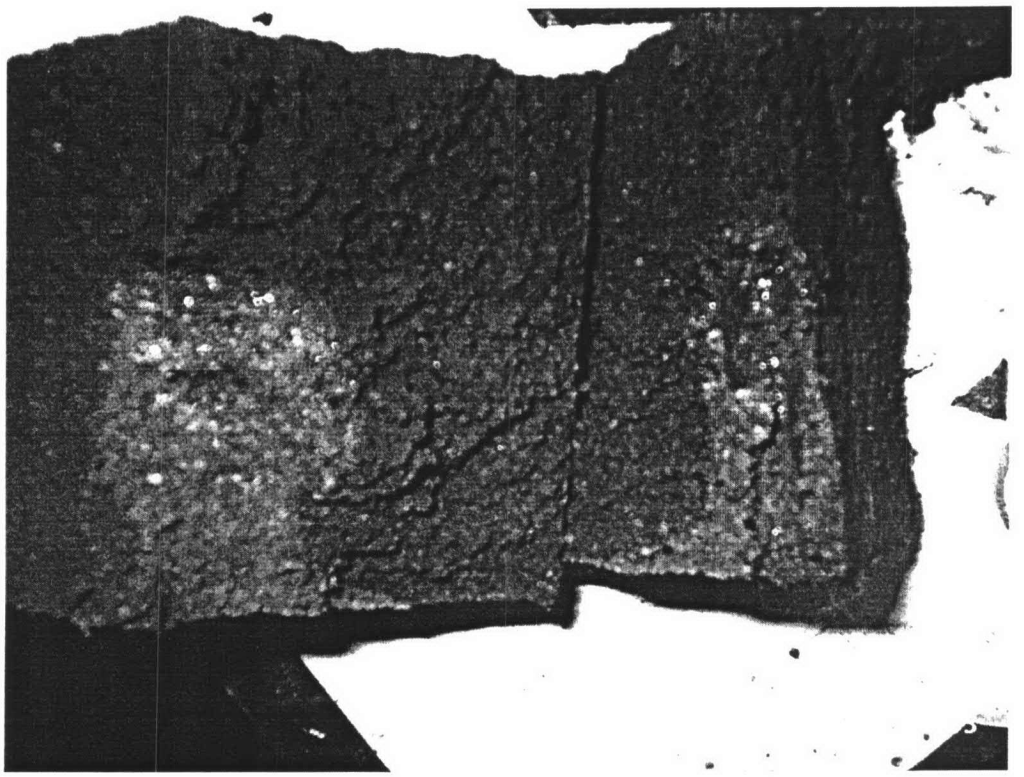
SVF05 10% of Bentonite Content – Overburden pressure = 200 kPa



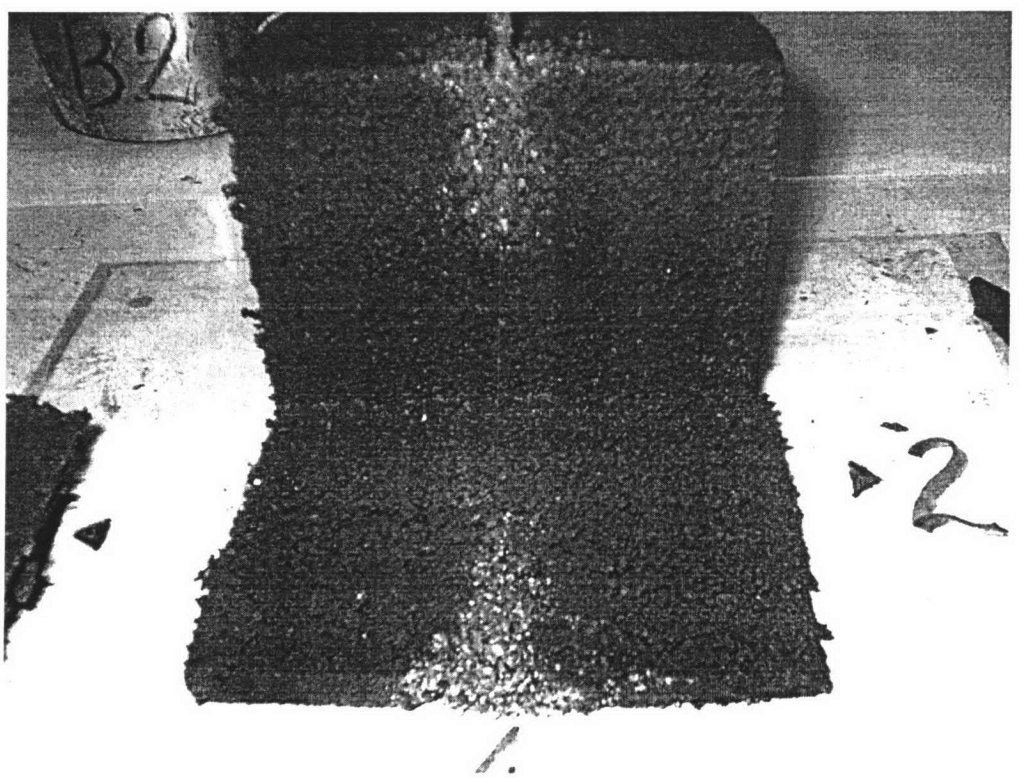
SVF06 10% of Bentonite Content – Overburden pressure = 300 kPa



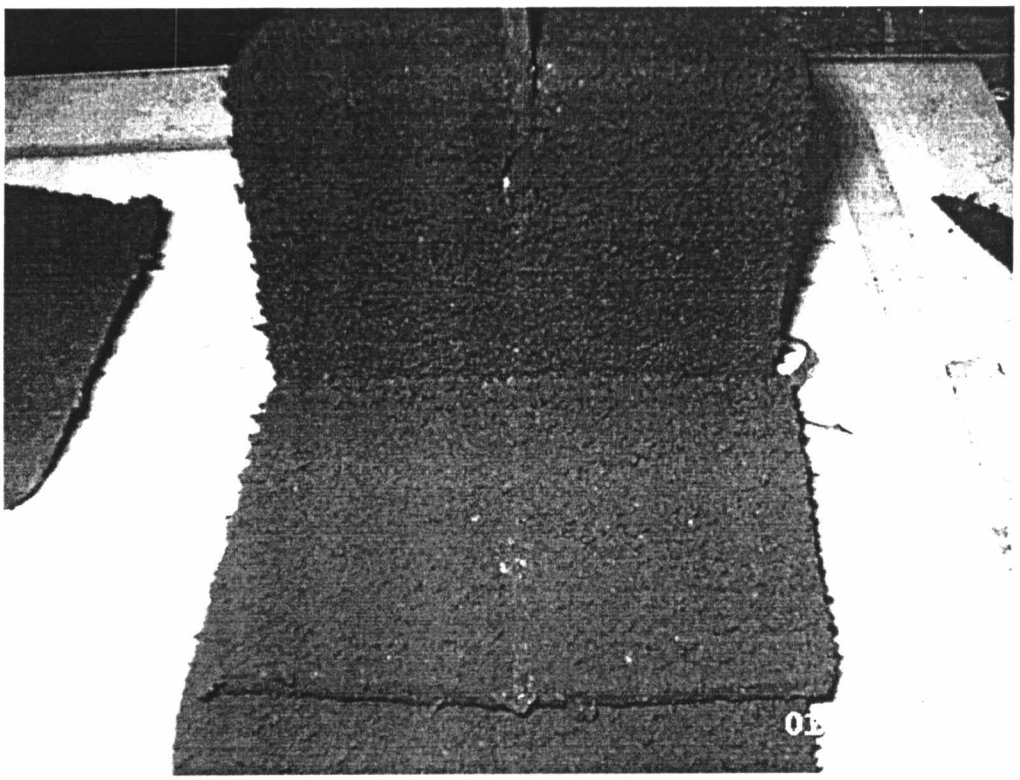
SVF07 15% of Bentonite Content – Overburden pressure = 100 kPa



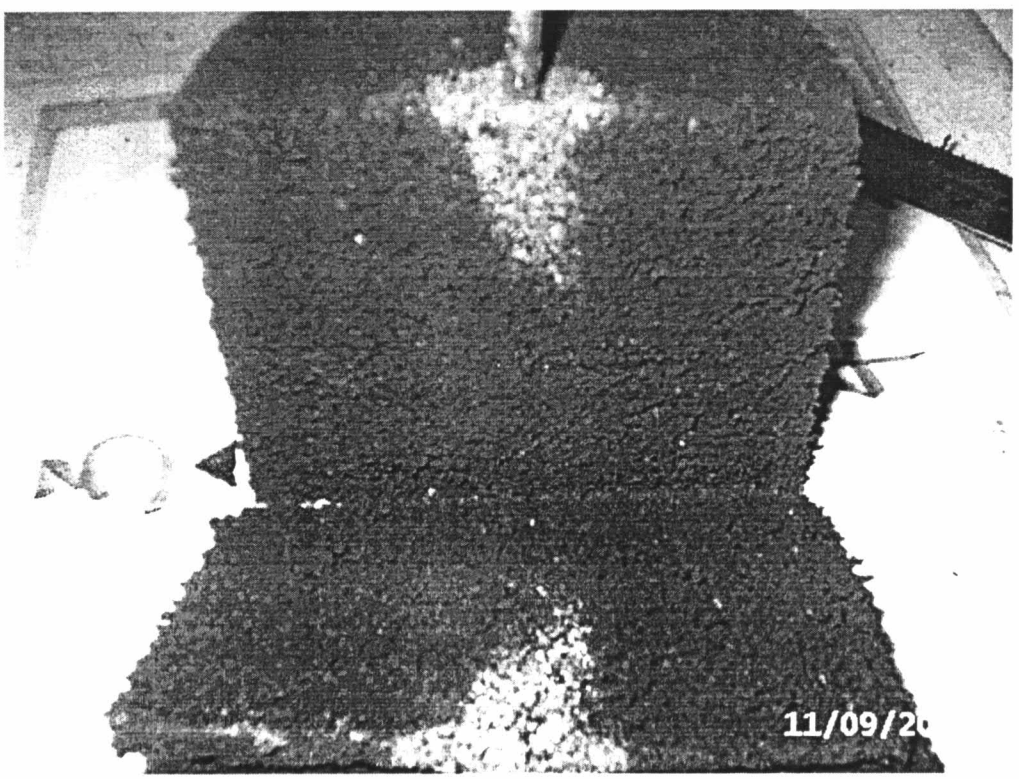
SVF08 15% of Bentonite Content – Overburden pressure = 200 kPa



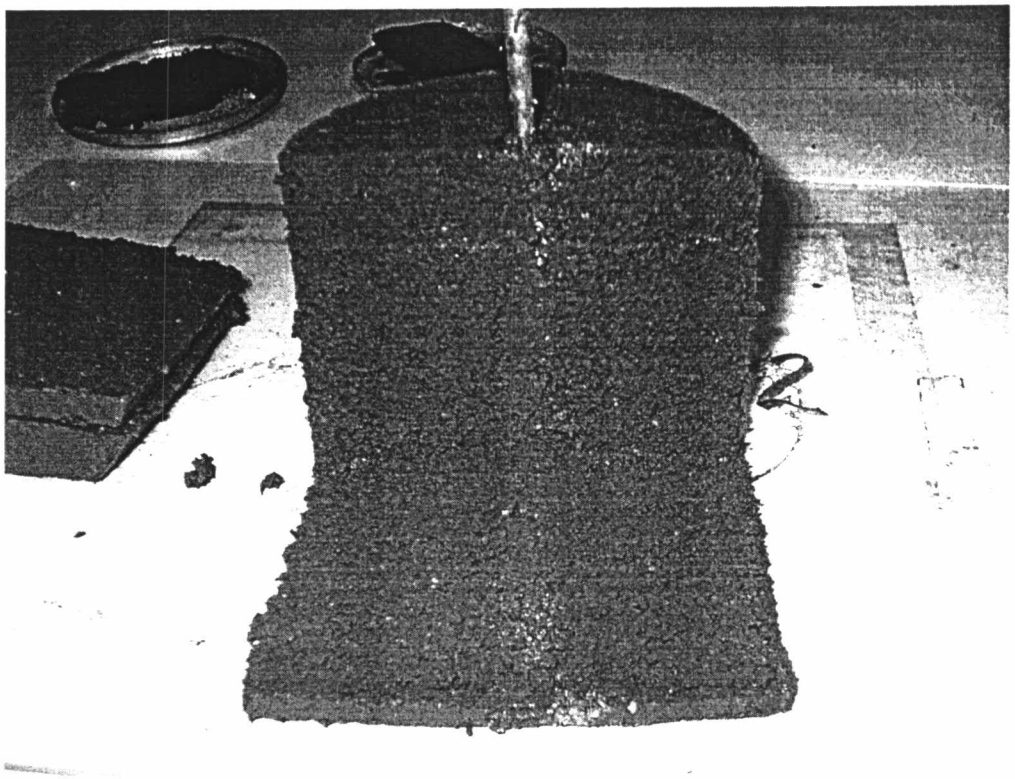
SVF09 15% of Bentonite Content – Overburden pressure = 300 kPa



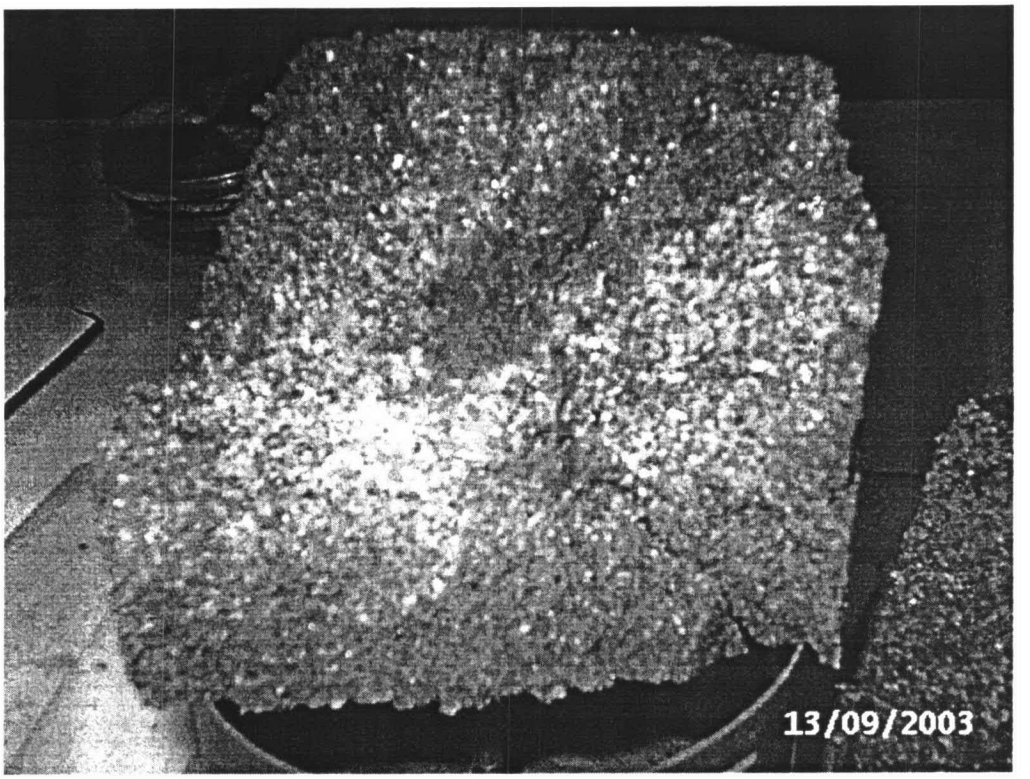
SVF10 20% of Bentonite Content – Overburden pressure = 100 kPa



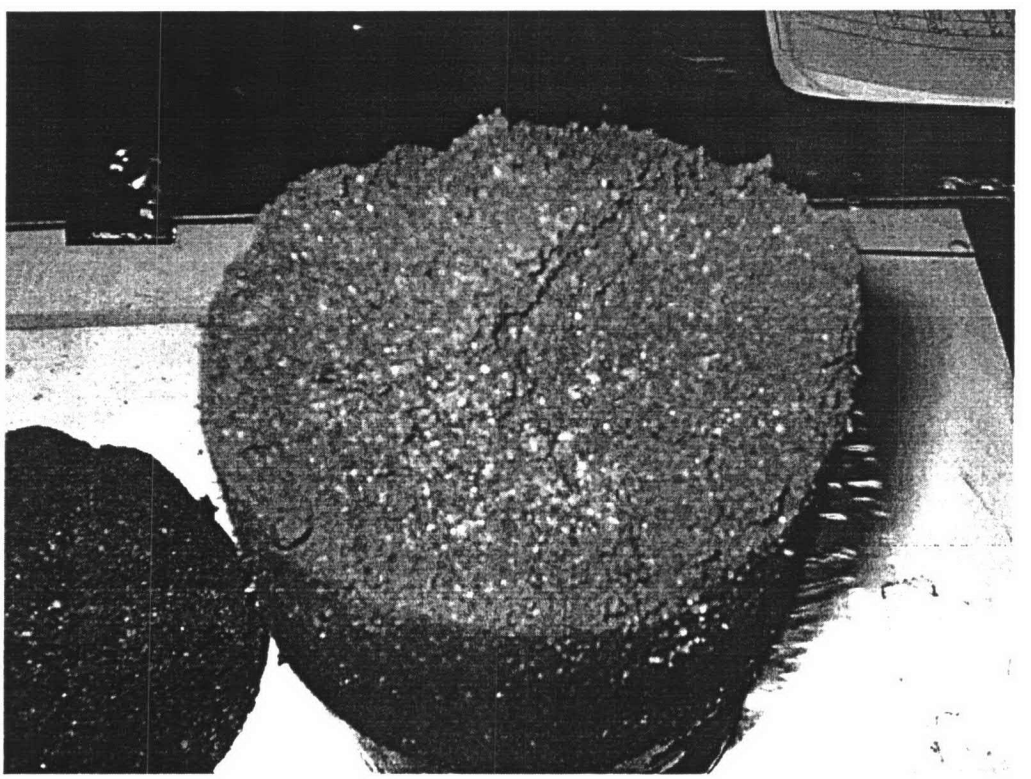
SVF11 20% of Bentonite Content – Overburden pressure = 200 kPa



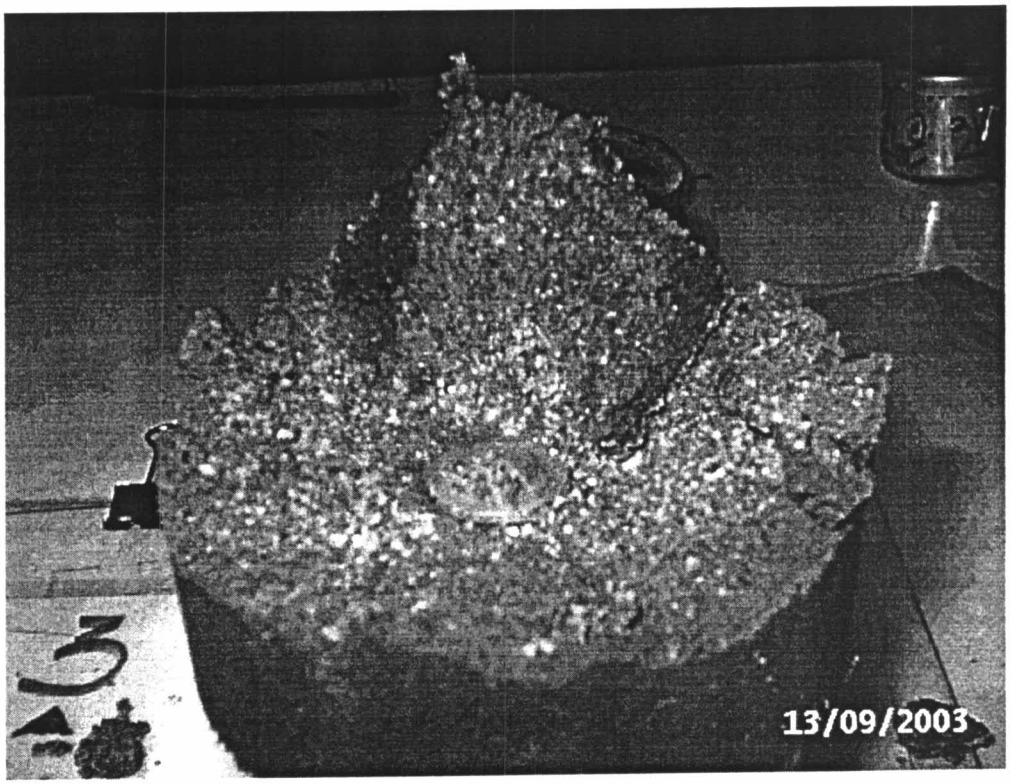
SVF12 20% of Bentonite Content – Overburden pressure = 300 kPa



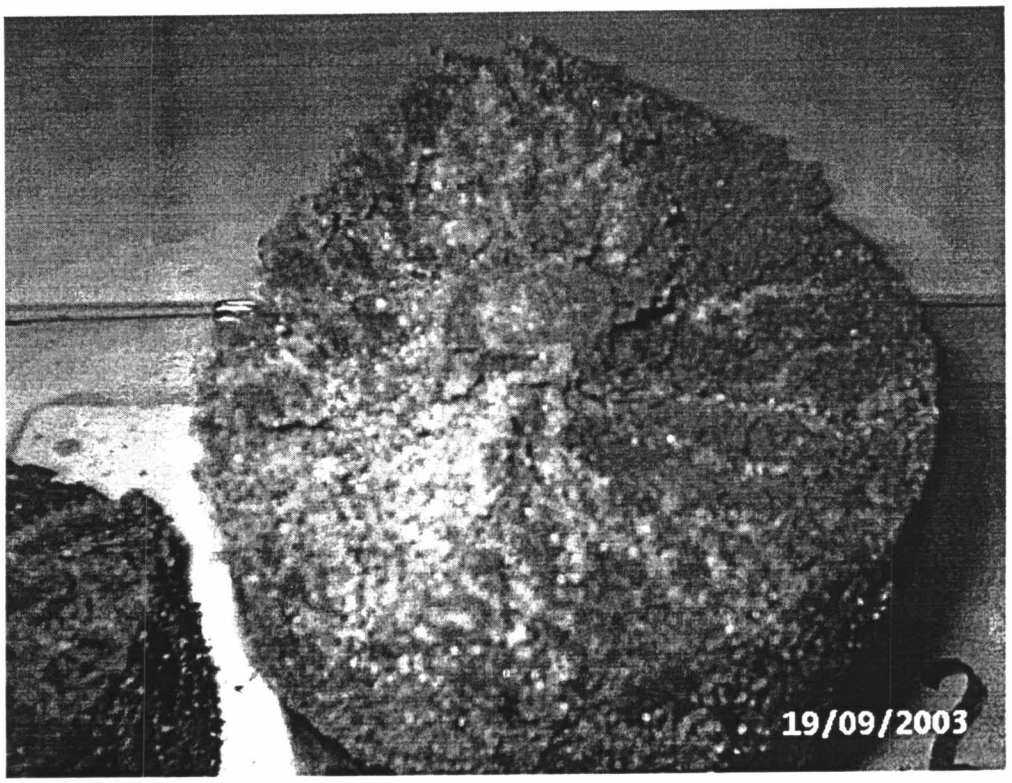
QHF 01 5% of Bentonite Content – Overburden Stress = 100 kPa



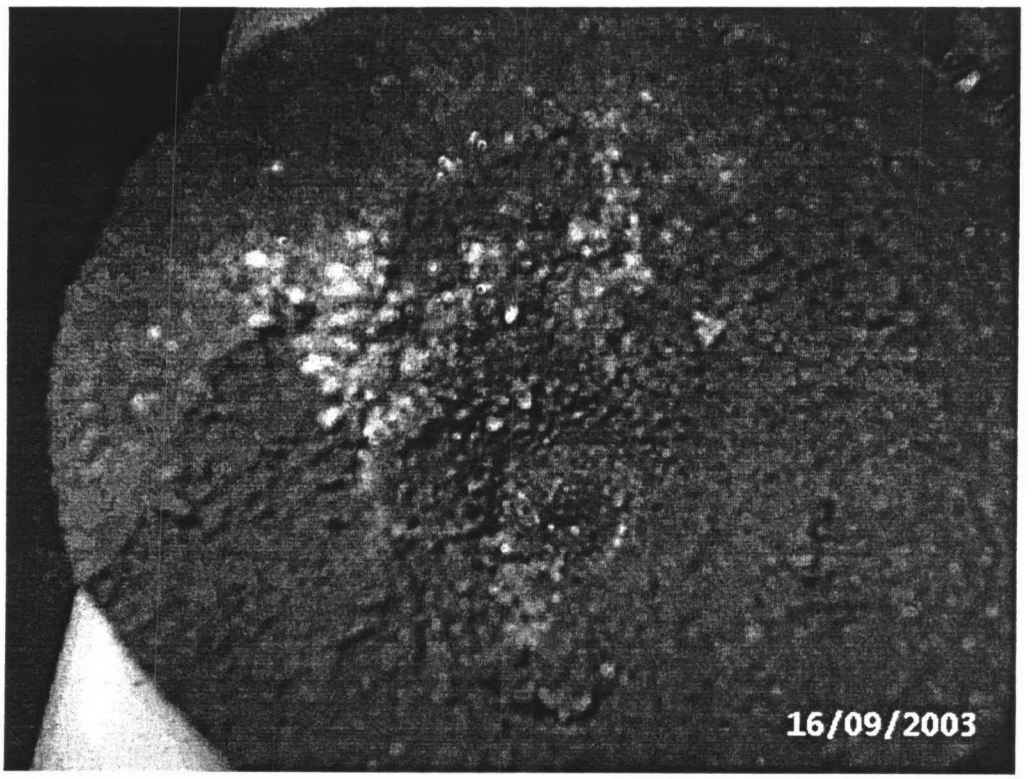
QHF 03 5% of Bentonite Content – Overburden Stress = 300 kPa



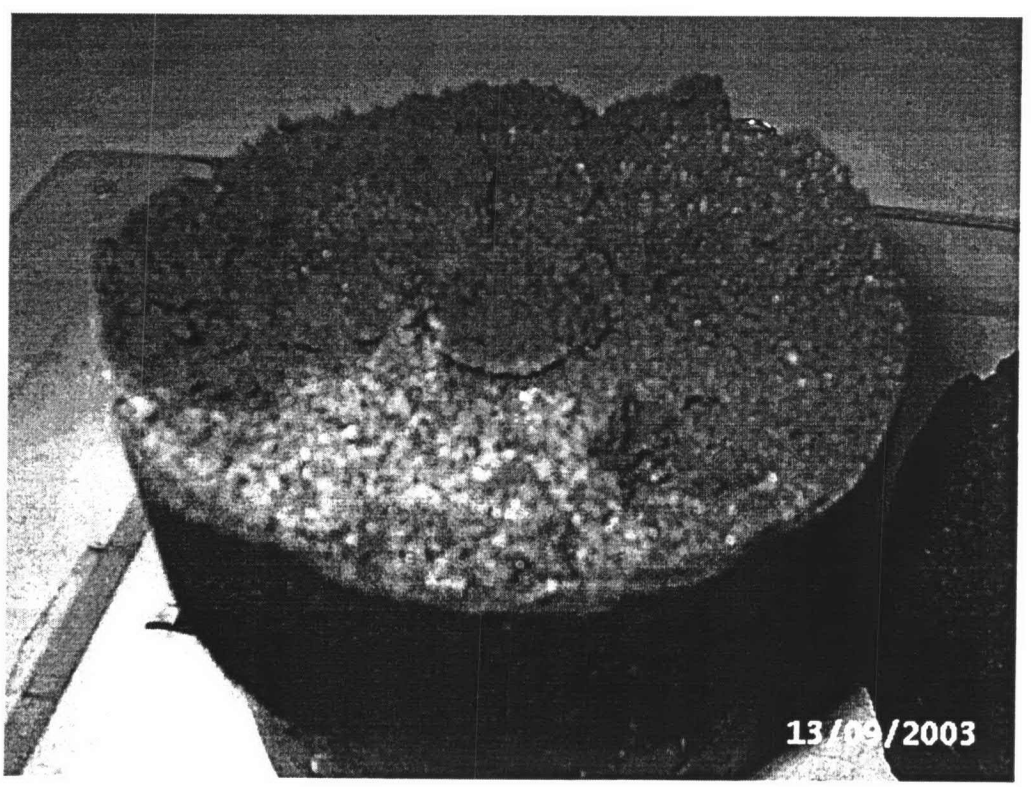
QHF 04 10% of Bentonite Content – Overburden Stress = 100 kPa



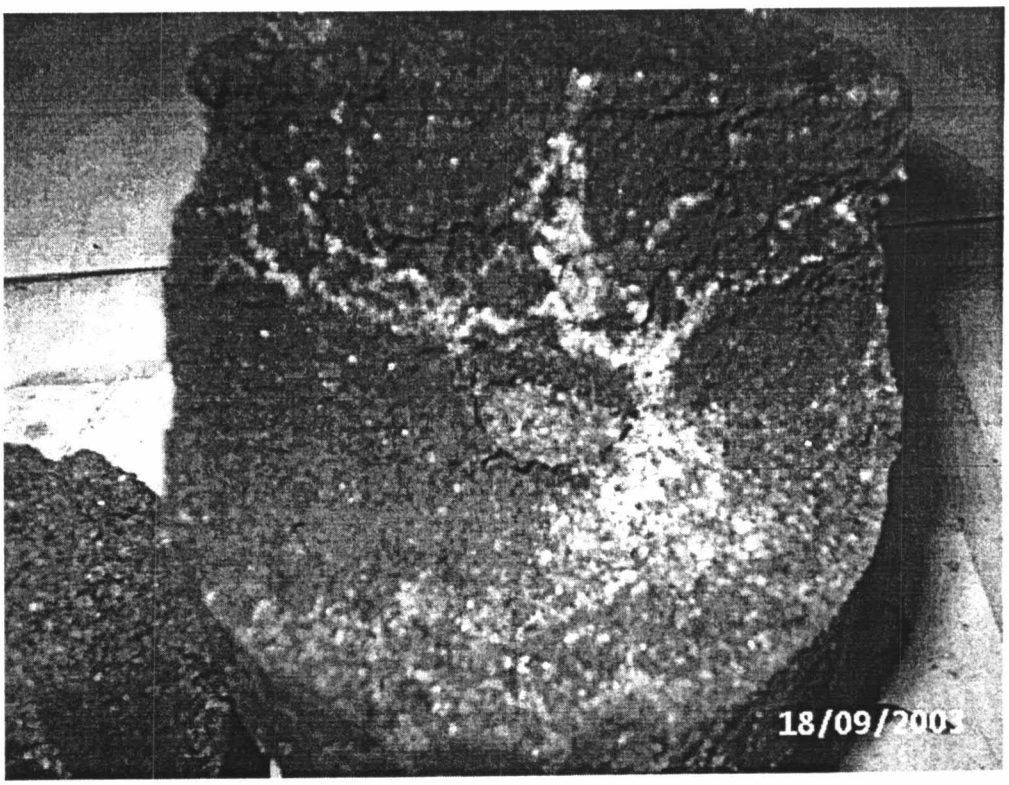
QHF 05 10% of Bentonite Content – Overburden Stress = 200 kPa



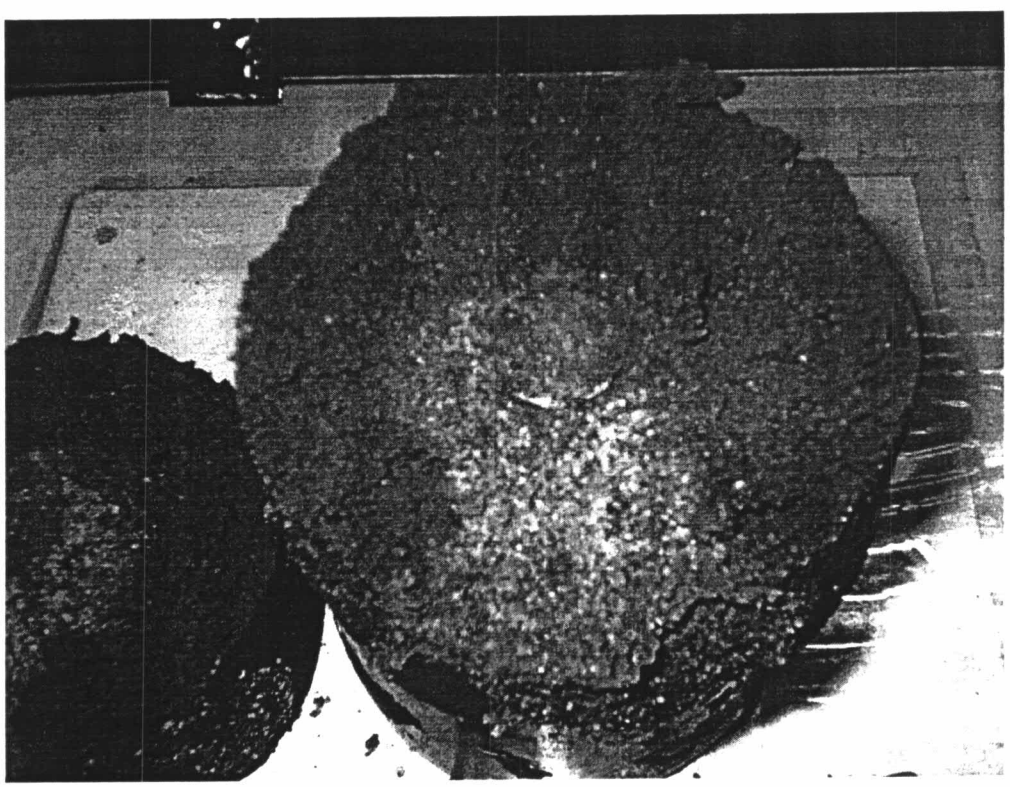
QHF 06 10% of Bentonite Content – Overburden Stress = 300 kPa



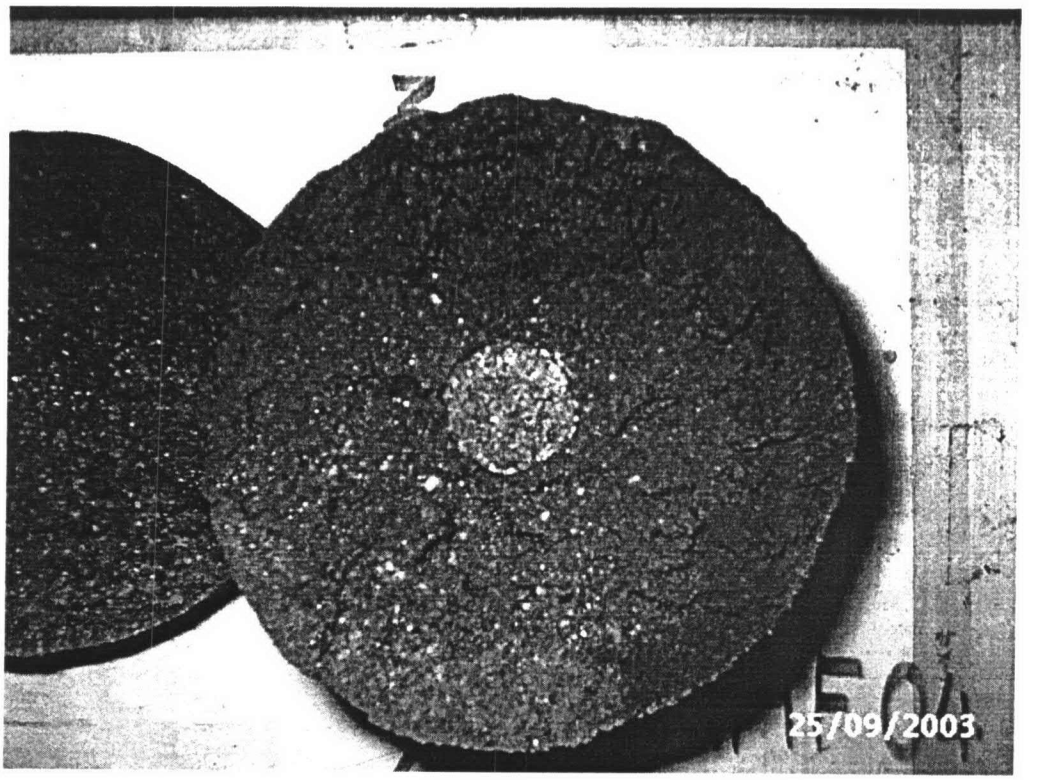
QHF 07 15% of Bentonite Content – Overburden Stress = 100 kPa



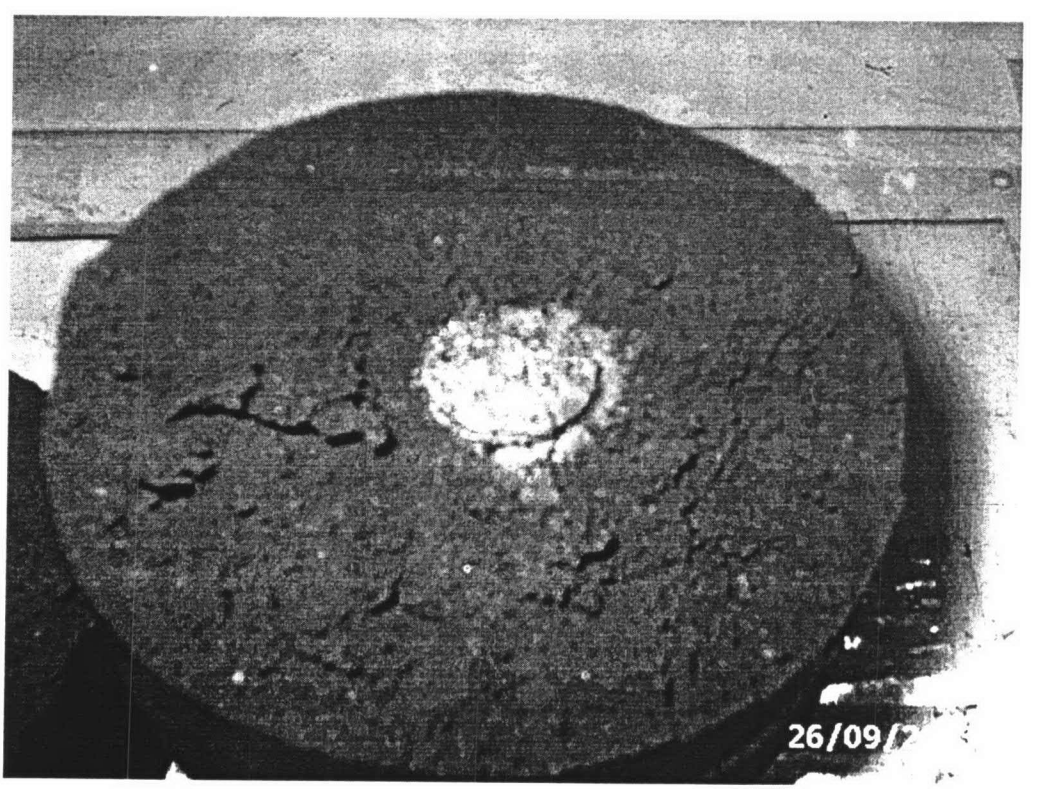
QHF 08 15% of Bentonite Content – Overburden Stress = 200 kPa



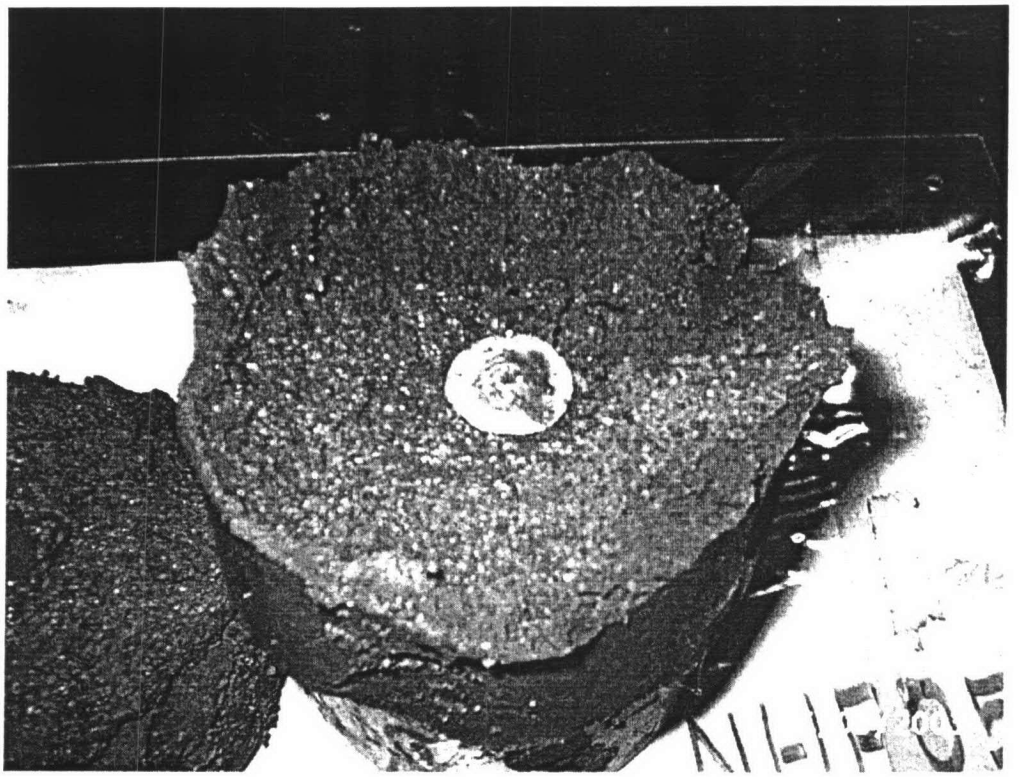
QHF 09 15% of Bentonite Content – Overburden Stress = 300 kPa



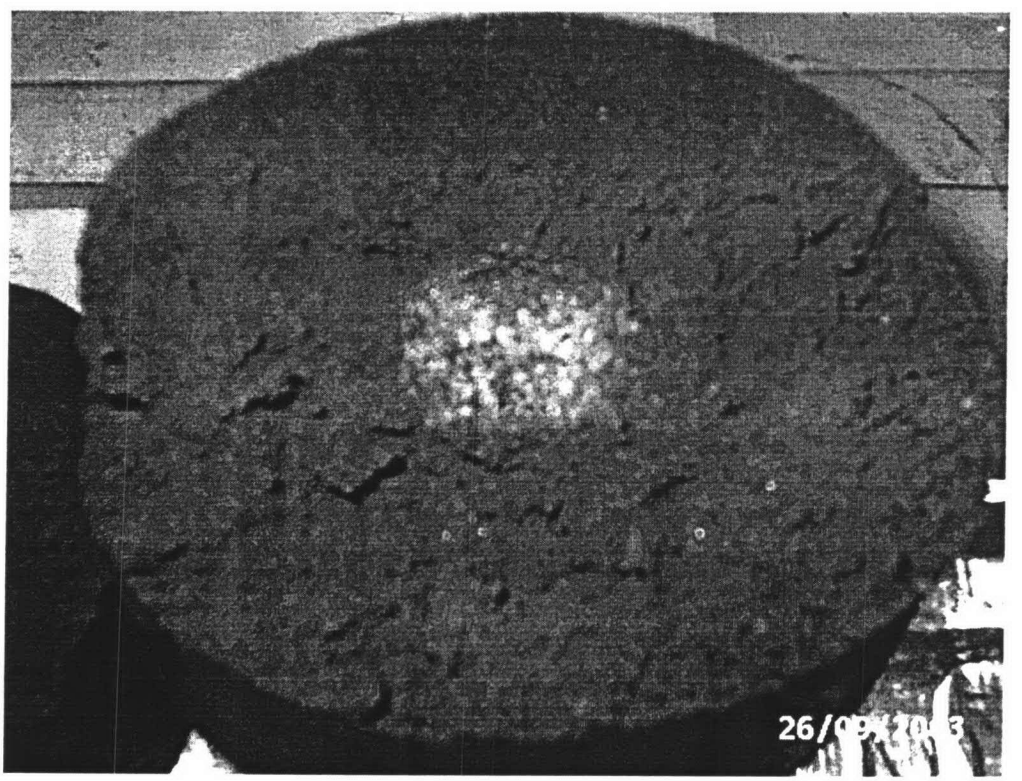
QHF 10 20% of Bentonite Content – Overburden Stress = 100 kPa



QHF 11 20% of Bentonite Content – Overburden Stress = 200 kPa

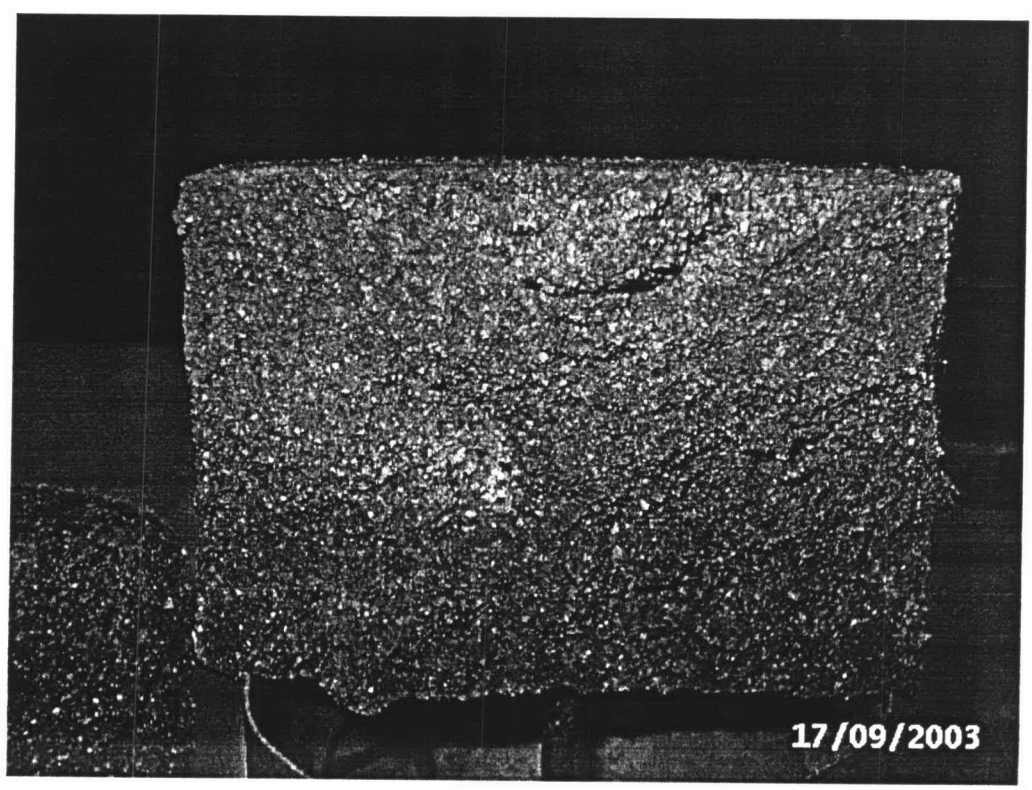


QHF 13 25% of Bentonite Content – Overburden Stress = 100 kPa



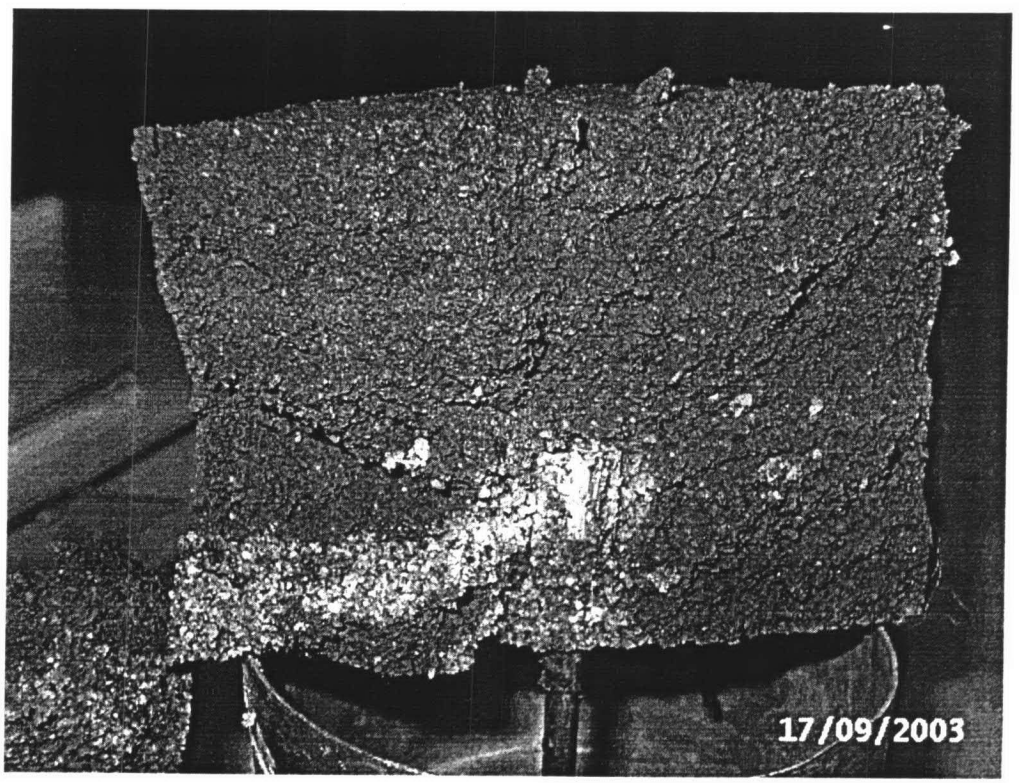
QHF 14 25% of Bentonite Content – Overburden Stress = 200 kPa

QVF 02 5% of Bentonite Content – Overburden Stress = 200 kPa

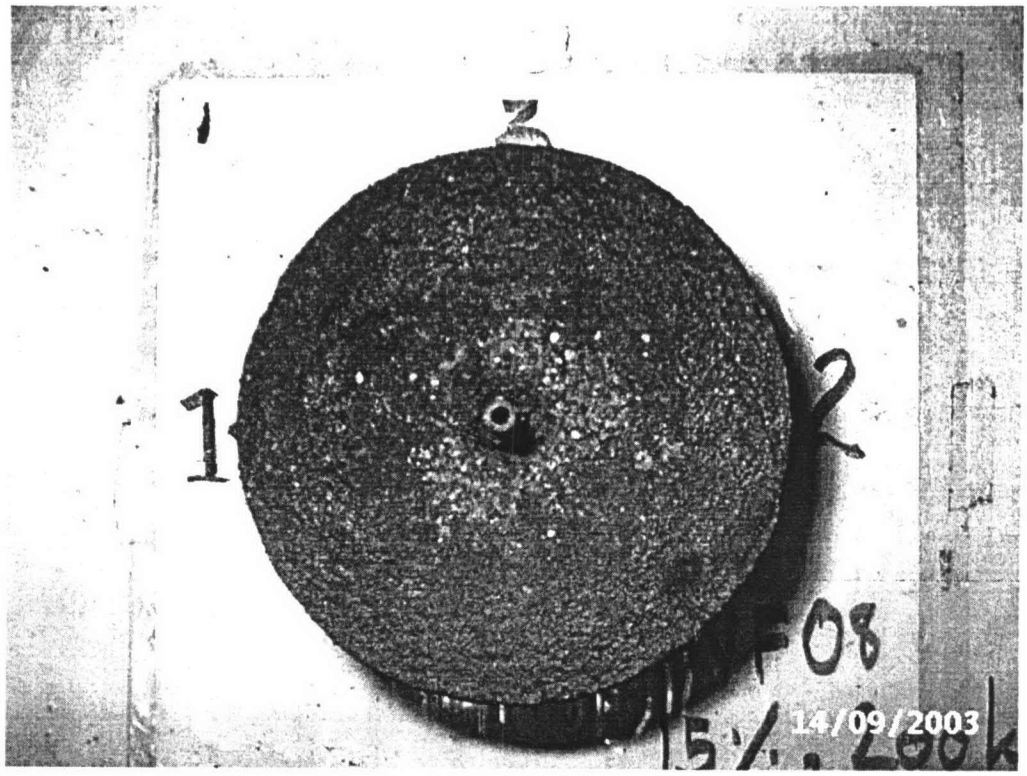


QVF 03 5% of Bentonite Content – Overburden Stress = 300 kPa

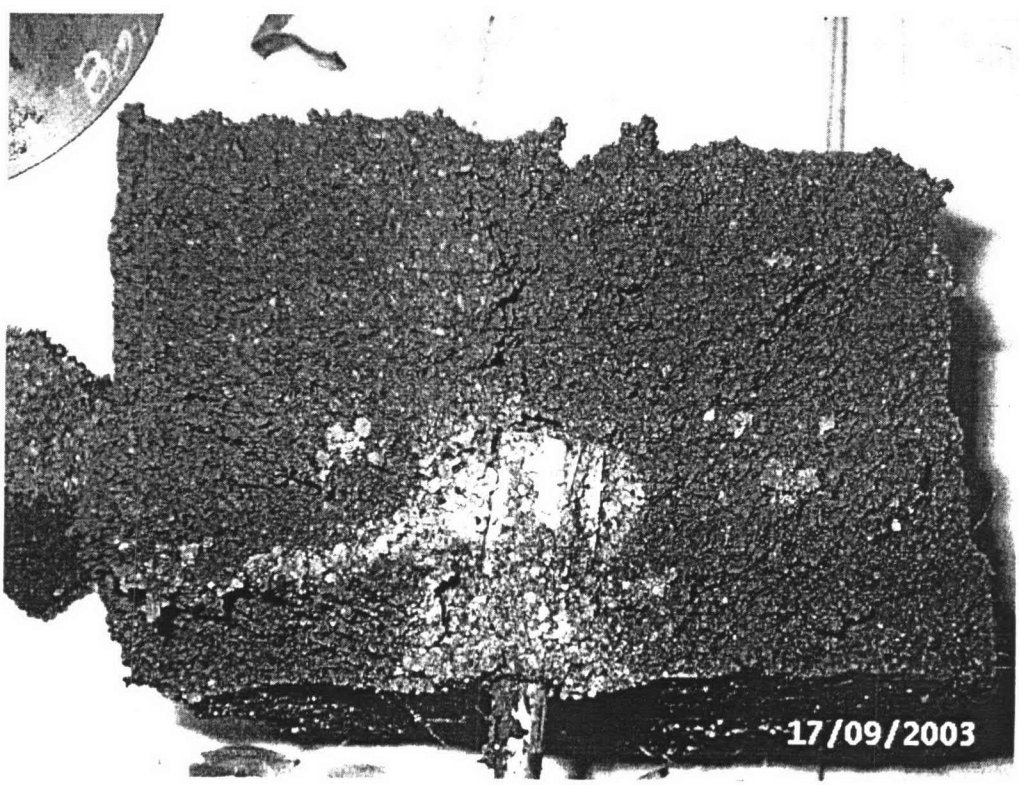
QVF 05 10% of Bentonite Content – Overburden Stress = 200 kPa



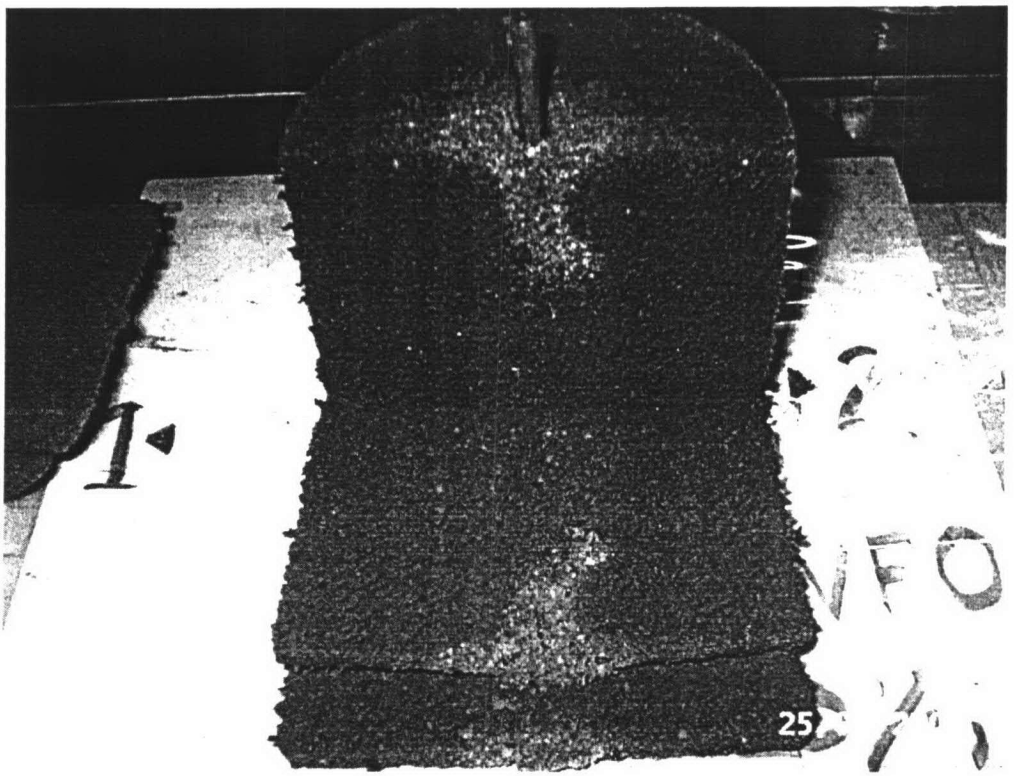
QVF 06 10% of Bentonite Content – Overburden Stress = 300 kPa



QVF 08 15% of Bentonite Content – Overburden Stress = 200 kPa



QVF 09 15% of Bentonite Content – Overburden Stress = 300 kPa



QVF 10 20% of Bentonite Content – Overburden Stress = 100 kPa

VITA

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