

Research Report
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LABORATORY EVALUATION OF EDGE DRAINS

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KENTUCKY TRANSPORTATION CENTER
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INTRODUCTION

This report documents laboratory test results performed on four brands of highway edge drains. The four brands included in this study are Hydraway (by Monsanto), Akwadrain (by International Construction Equipment, Inc.), Advantage (by Advanced Drainage Systems), and PDS 40 (by Pro Drain Systems).

LABORATORY TEST

The following tests were performed and are not ASTM standard test procedures.

FABRIC PERMEABILITY

The fabrics were removed from their cores and cut into 4-inch squares. The fabric was then clamped over the end of a plastic funnel that was attached to a 4000-ml graduated cylinder (Figure 1). A falling-head permeability test was used. The cylinder was filled with water and the time required for the water to fall from one elevation (h_1) to a second elevation (h_2) was recorded. The following equation was used to calculate the coefficient of permeability.

$$K=(aL/At) \ln (h_1/h_2)$$

where :a=area of plastic cylinder (cm²);
:A=area of fabric sample (cm²);
:L=thickness of fabric sample (cm);
:t=elapsed time of test (sec);
:ln=natural logarithm;
:h₁=first elevation (cm);
:h₂=second elevation (cm);

FABRIC PUNCTURE TEST

The fabric was removed from the core and clamped over a hollow cylinder having an inside diameter 2.0 inches. The fabric was then punctured with a steel ram having a cross-sectional area of approximately 0.25 square inch (Figure 2). Tests were performed with the materials dry and the maximum loads were recorded.

SLURRY FILTRATION TEST

A falling-head permeability test was performed to determine the possibility of the fabric clogging. The same procedure was used as in the fabric permeability test except the clear water was replaced with a slurry solution. The solution consisted of 20 grams of minus 200 size particles per 4000-ml of water. The slurry solution was placed in the cylinder and allowed to flow through the fabric. Permeabilities were not calculated from this test. Rate of flow and time to clogging were recorded.

CORE COMPRESSION TEST

Compression tests were conducted on core material that was 11.5 inches square. The tests were performed at a uniform rate in which the load was increase at a rate of 35.7 pounds per second. Tests continued until the maximum load was reached.

A second series of compression tests were conducted at a machine head speed of 0.5 inch per minute. Tests continued for 18 seconds and the maximum load was recorded.

FLOW THROUGH CORE

A specimen of each material (2 feet X 11.5 inches) was placed in a rectangular acrylic box (2 feet X 11.37 inches X 1.75 inches). The box

was attached to the bottom of a graduated barrel that was fitted with a stopper valve and held in an upright position (Figure 3). The barrel was filled with water and the water was allowed to flow through the core. The time necessary for the barrel to empty was recorded.

SUMMARY OF TEST RESULTS

Results of the fabric permeability test indicate the Akwadrain had the highest average coefficient of permeability (0.070 cm/sec). The coefficient of permeability for the Akwadrain was 19.9 percent greater than Hydraway, 60.6 percent greater than Pro Drain, and 70.6 percent greater than Advantage. Fabric permeabilities are listed in Table 1 and in Figure 4. Flow rates are shown in Figures 5 through 9.

Results of the fabric puncture test indicate Hydraway fabric had the highest average puncture strength (479.9 psi). Puncture strength of the Hydraway was 42.1 percent greater than Pro Drain, 46.7 percent greater than Akwadrain, and 47.0 percent greater than Advantage. Puncture test data are contained in Table 2 and in Figures 10 through 14.

Results of the slurry filtration test indicate the Hydraway fabric permitted flow for more time prior to (90 seconds). The Pro Drain clogged in 79 seconds and the Advantage clogged in approximately 48 seconds. The Hydraway fabric discharged 716.7 ml of slurry solution before clogging in 90 seconds. The Hydraway fabric discharged 18.8 percent more than Advantage and 41.0 percent more than Pro Drain fabric in 90 seconds. The Akwadrain discharged 155.0 ml in 37.5 seconds. Data indicated there are variations in permeabilities of the fabrics due to the wide scatter in test data for each fabric. Slurry filtration test data are contained in Table 3 and in Figures 15 through 19.

Compression tests conducted at a compression rate of 35.7 pounds per second indicate the Akwadrain had the highest compressive strength of

54.72 psi. The compressive strength of the Akwadrain was 5.1 percent higher than Pro Drain, 6.0 percent higher than Hydraway, and 62.3 percent higher than Advantage. Compression test data are contained in Table 4 and Figures 20 through 24.

Compression test performed at a head rate of .028 in./sec. indicate the Hydraway had the highest compressive strength of 64.91 psi. The compressive strength the Hydraway was 1.5 percent greater than Pro Drain, 10.8 percent greater than Akwadrain, and 72.3 percent greater than Advantage. Compression test data are contained in Table 5.

The results of flow through the core indicate that the Pro Drain core emptied the 60.1 gallon container of water in 17.4 seconds. The Pro Drain emptied the barrel 30.1 percent faster than Hydraway, 34.6 percent faster than Advantage, and 60.4 percent faster than Akwadrain. Flow data are contained in Table 6, and Figure 25.

CONCLUSIONS

Test results indicate that the Akwadrain fabric had the highest coefficient of permeability. The Hydraway fabric was 19.86 percent less permeable. The Pro Drain and Advantage fabrics were less than half as permeable as Akwadrain.

Puncture tests indicated the Hydraway had over 40 percent greater capacity for resisting puncture than the other three fabrics.

The slurry filtration tests indicated that the Hydraway fabric was less susceptible to clogging and discharged a larger volume of water.

Compression tests conducted on the cores indicated the Hydraway had the highest compressive strength. Pro Drain and Akwadrain had compressive strengths of 99.6 and 96.8 percent, respectively, of that of Hydraway. The compressive strength of the Advantage core was 66.8 percent less than Hydraway.

Flow test through the core indicated the Pro Drain core drained a 60.1-gallon container 30 percent more rapidly than Hydraway, 34.6 percent more rapidly than Advantage, and 60.4 percent more rapidly than Akwadrain.

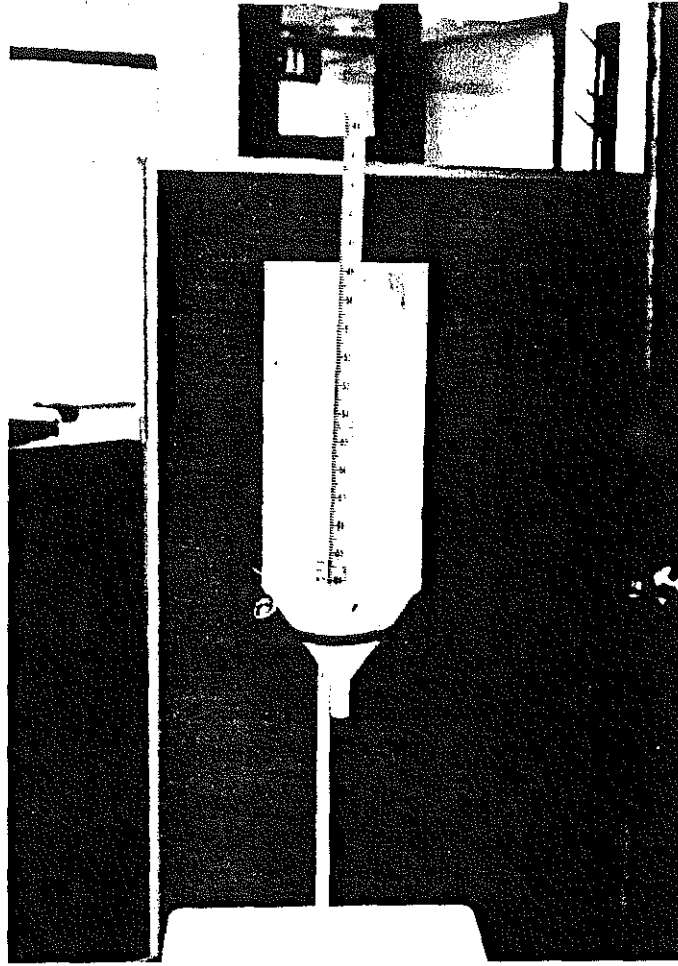


Figure 1. Permeability Testing Apparatus

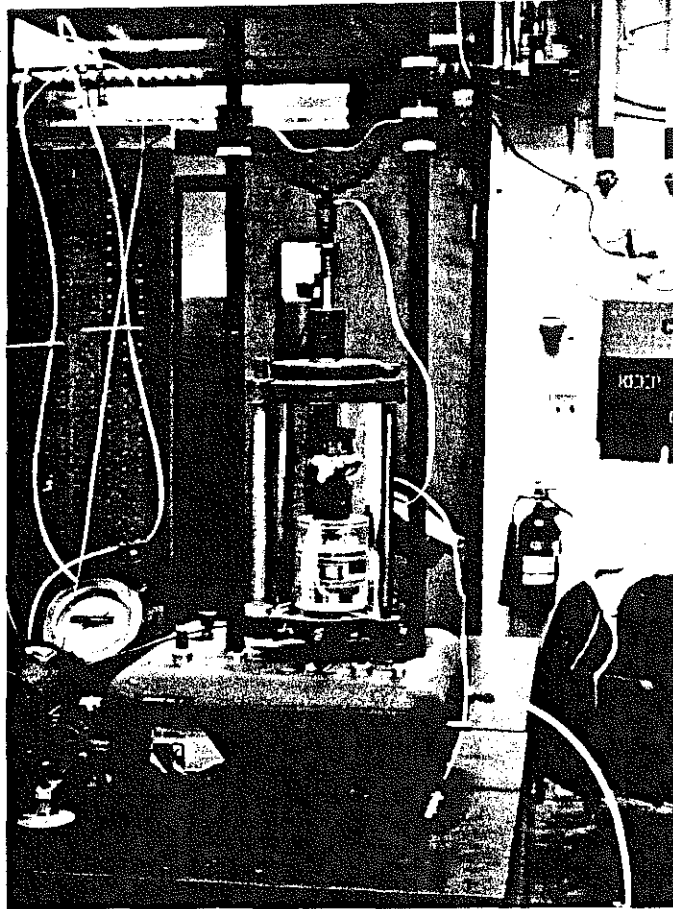


Figure 2. Puncture Test Apparatus

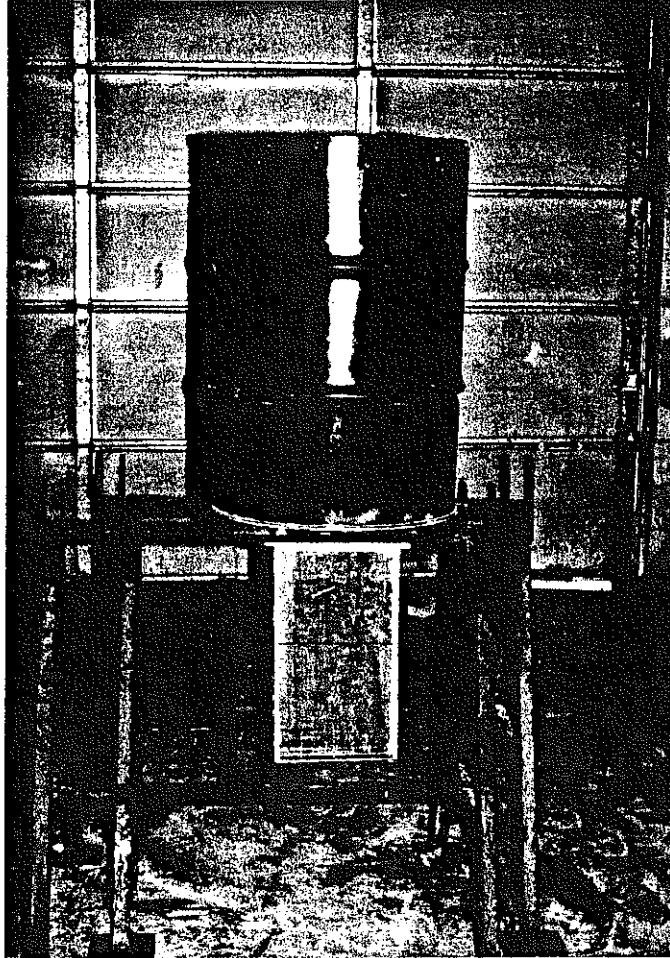


Figure 3. Apparatus Used for Testing Flow of Cores.

TABLE 1. FABRIC PERMEABILITY

(Coefficient of Permeability)
(cm/sec)

| | HYDRAWAY | PRODRAIN | AKWADRAIN | ADVANTAGE |
|-----------|----------|----------|-----------|-----------|
| Sample #1 | .0549736 | .0234919 | .0658833 | .0217297 |
| Sample #2 | .0599422 | .0171176 | .0941191 | .0191247 |
| Sample #3 | .0490436 | .0285037 | .0677065 | .0209439 |
| Sample #4 | .0606204 | .0287634 | .0525572 | |
| | | .0402718 | | |
| Average: | .0561450 | .0276295 | .0700665 | .0205994 |

TABLE 2. PUNCTURE STRENGTH OF FABRIC (psi)

| | HYDRAWAY | PRODRAIN | AKWADRAIN | ADVANTAGE |
|-----------|----------|----------|-----------|-----------|
| Sample #1 | 512.00 | 273.60 | 255.88 | 276.40 |
| Sample #2 | 517.60 | 302.40 | 251.60 | 253.20 |
| Sample #3 | 410.00 | 257.60 | 257.60 | 233.20 |
| Average: | 479.88 | 277.88 | 258.40 | 254.28 |

TABLE 3. SLURRY FILTRATION TEST

(Amount Discharged/Time to Clog)
(ml/sec)

| | HYDRAWAY | PRODRAIN | AKWADRAIN | ADVANTAGE |
|-----------|-----------|-------------|--------------|-----------|
| Sample #1 | 613.33/90 | 510.00/90 | 173.33/36 | 539.99/75 |
| Sample #2 | 963.32/90 | 250.00/48 | 210.00/42 | 539.99/75 |
| Sample #3 | 753.33/90 | 460.00/90 | 30.00/24 | 666.66/90 |
| Sample #4 | 536.66/90 | 550.00/90 | 206.66/48 | |
| Average: | 716.66/90 | 442.50/79.5 | 155.00/37.50 | 582.21/80 |

TABLE 4. COMPRESSION STRENGTH OF CORE

(At First Peak)
(psi)

| | HYDRAWAY | PRODRAIN | AKWADRAIN | ADVANTAGE |
|-----------|----------|----------|-----------|-----------|
| Sample #1 | 52.02 | 53.91 | 58.18 | 20.98 |
| Sample #2 | 50.76 | 49.91 | 51.25 | 19.39 |
| Sample #3 | | | | 21.46 |
| Average: | 51.39 | 51.91 | 54.72 | 20.61 |

* Load Increased at 35.7 lbs/sec

TABLE 5. COMPRESSION STRENGTH OF CORE

(At 18 Seconds)
(psi)

| | HYDRAWAY | PRODRAIN | AKWADRAIN | ADVANTAGE |
|-----------|----------|----------|-----------|-----------|
| Sample #1 | 65.28 | 65.84 | 55.49 | 18.62 |
| Sample #2 | 67.64 | 62.00 | 58.35 | 17.97 |
| Sample #3 | 61.81 | | 59.72 | 17.26 |
| Average: | 64.91 | 63.92 | 57.85 | 17.95 |

* Machine Head Rate of .5 in./min

TABLE 6. FLOW THROUGH THE CORE

(Time to Empty)
(sec)

| | HYDRAWAY | PRODRAIN | AKWADRAIN | ADVANTAGE |
|-----------|----------|----------|-----------|-----------|
| Sample #1 | 25.2 | 17.4 | 44.4 | 25.8 |
| Sample #2 | 24.6 | 17.4 | 43.8 | 26.4 |
| Sample #3 | 24.9 | 17.4 | 43.8 | 27.6 |
| Average: | 24.9 | 17.4 | 44.0 | 26.6 |

PERMEABILITY

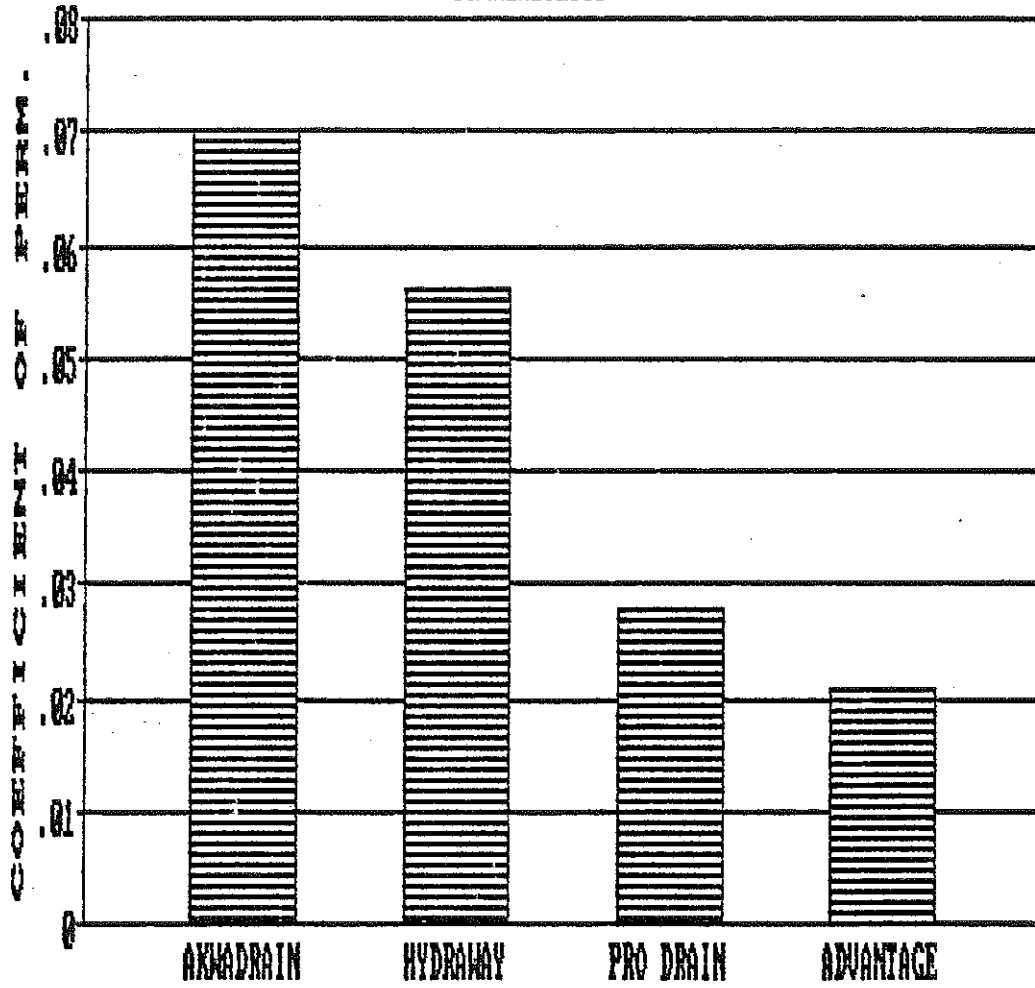


Figure 4. Average Coefficient of Pemeability.

FALLING HEAD PERMEABILITY

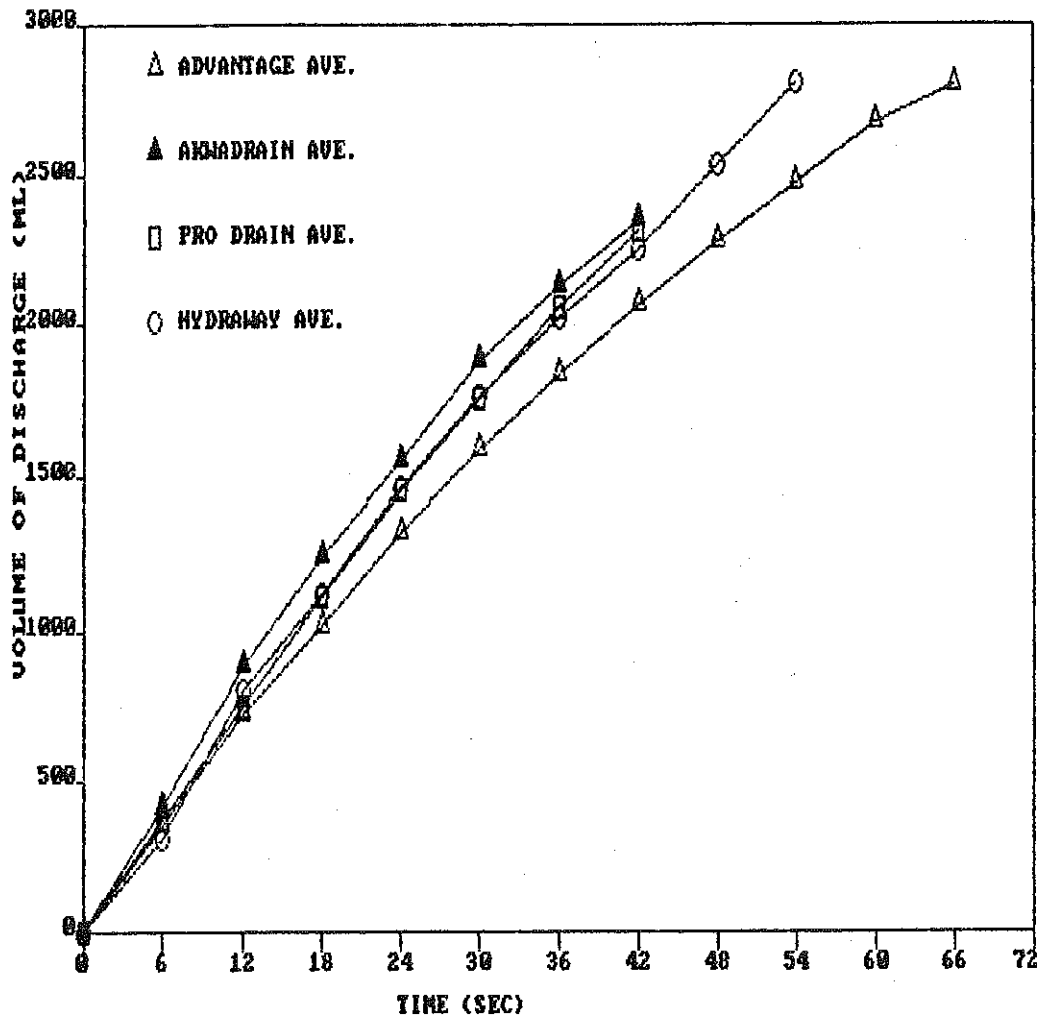


Figure 5. Fabric Permeability.

FALLING HEAD PERMEABILITY

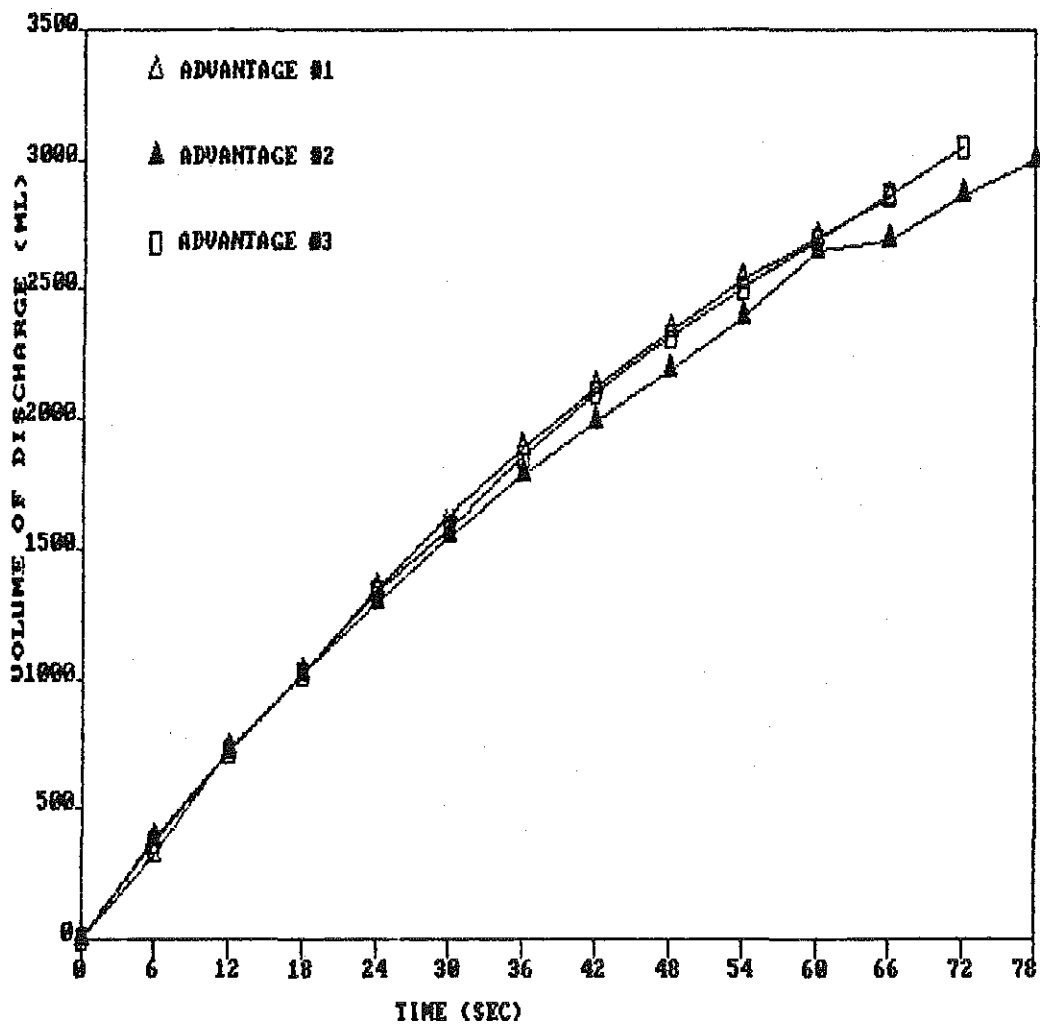


Figure 6. Fabric Permeability.

FALLING HEAD PERMEABILITY

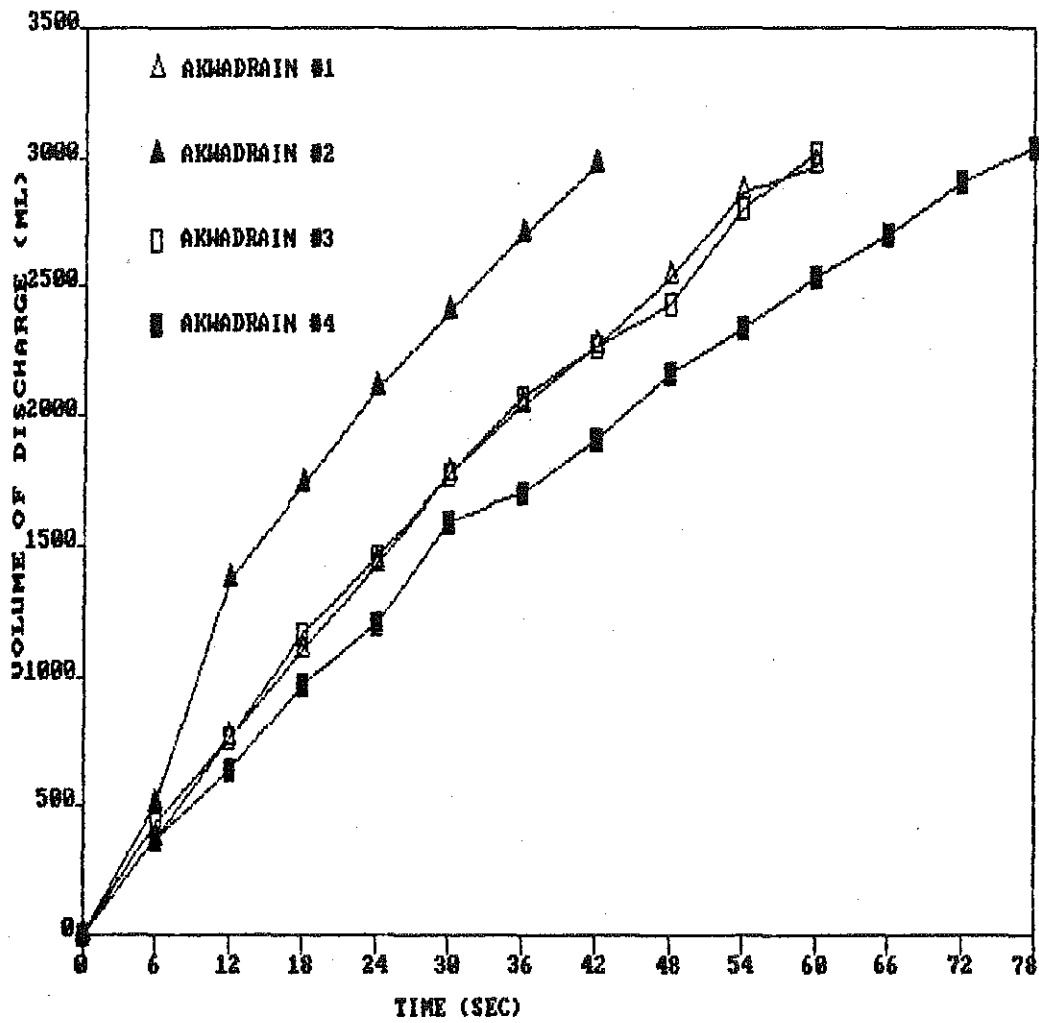


Figure 7. Fabric Permeability.

FALLING HEAD PERMEABILITY

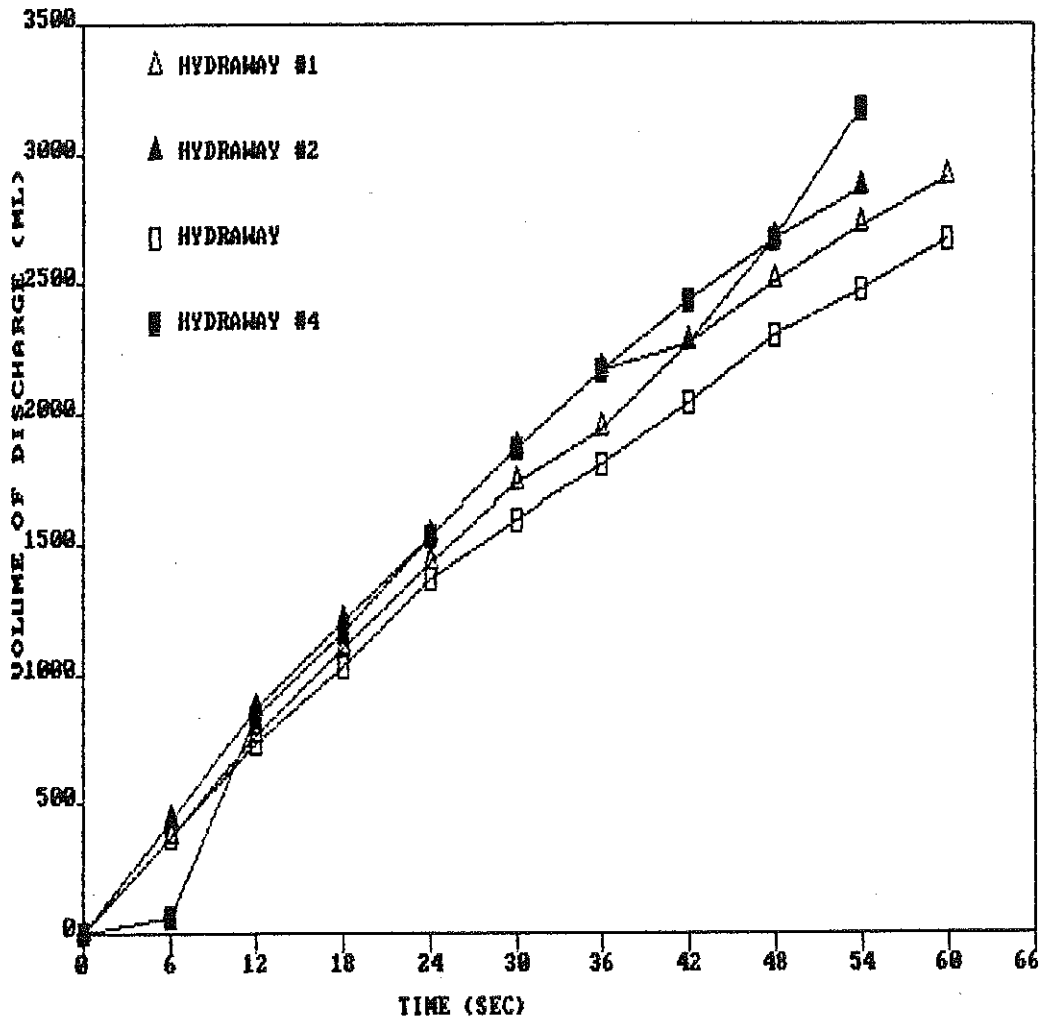


Figure 8. Fabric Permeability.

FALLING HEAD PERMEABILITY

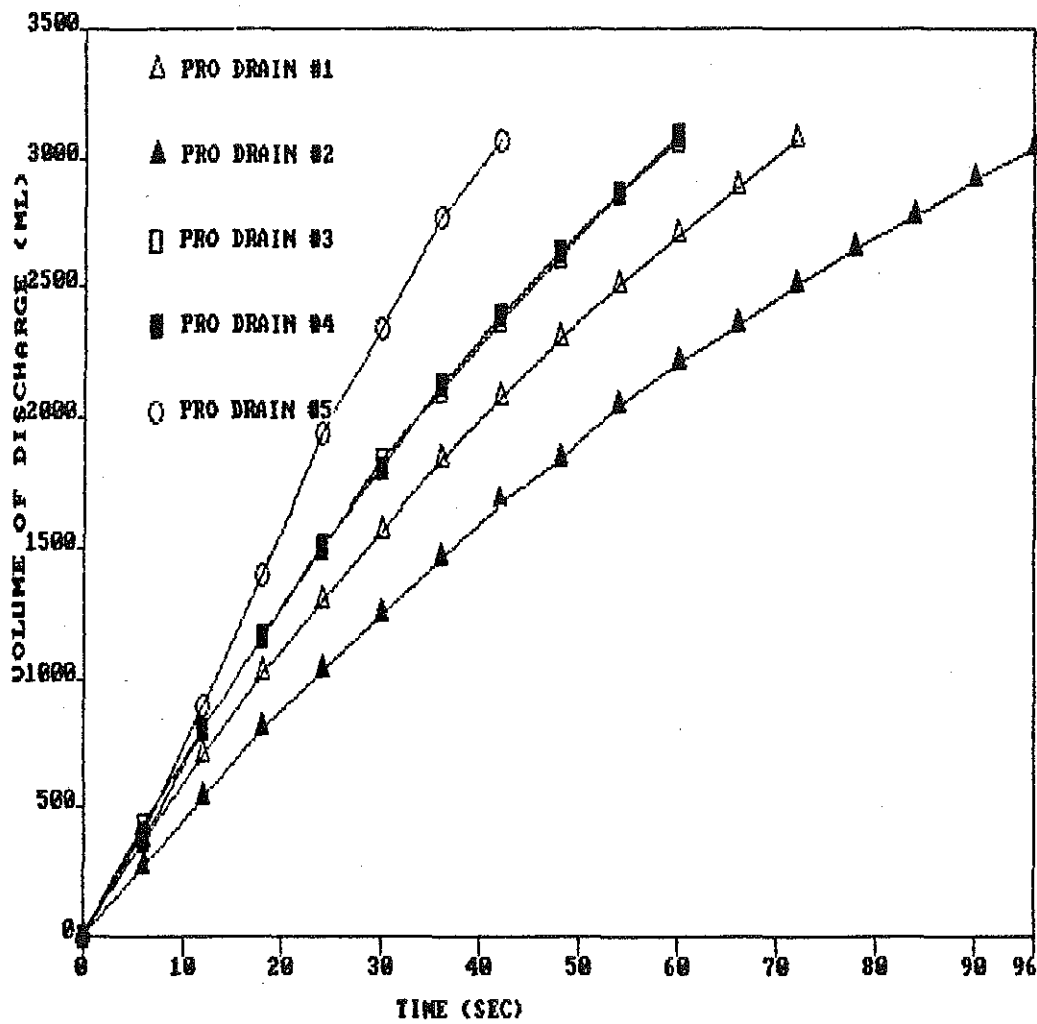


Figure 9. Fabric Permeability.

PUNCTURE TEST

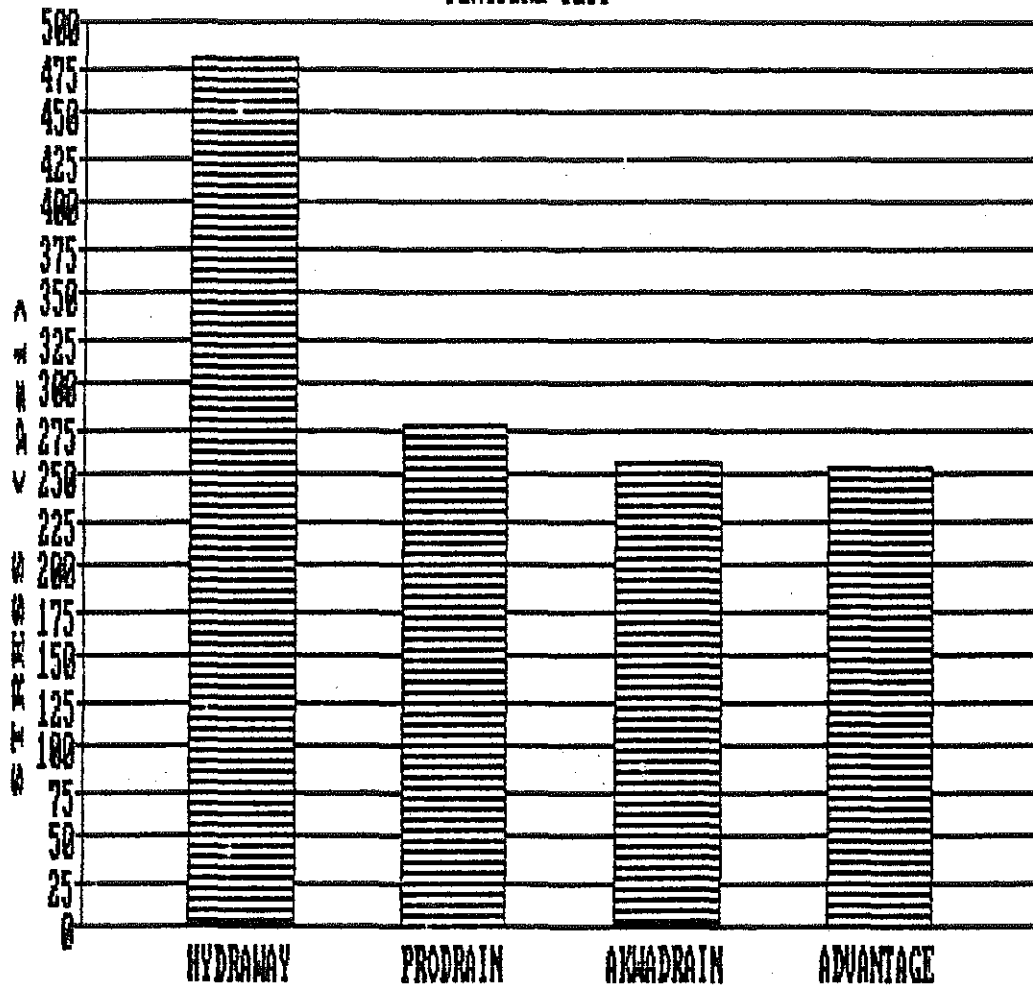


Figure 10. Average Puncture Strength.

PUNCTURE TEST (PRORAIN)

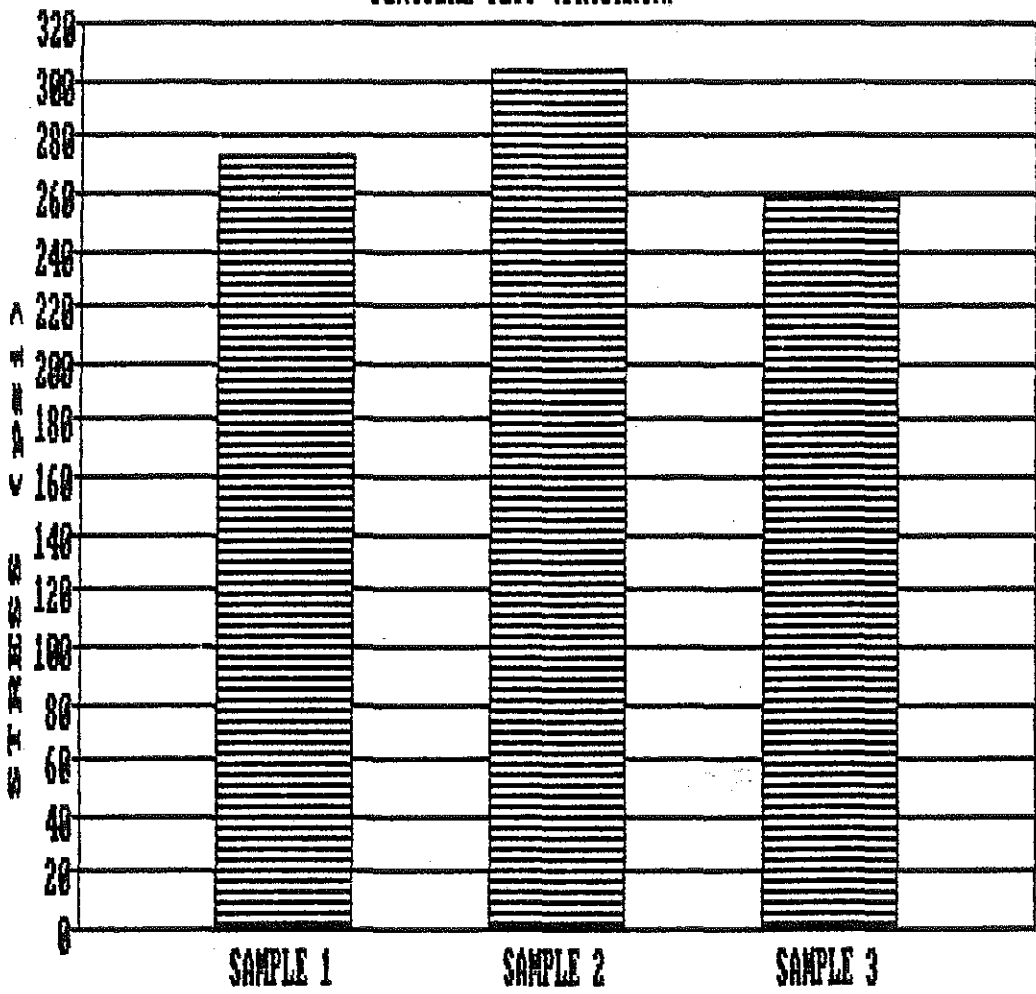


Figure 11. Pro Drain Puncture Test.

PUNCTURE TEST (ADVANTAGE)

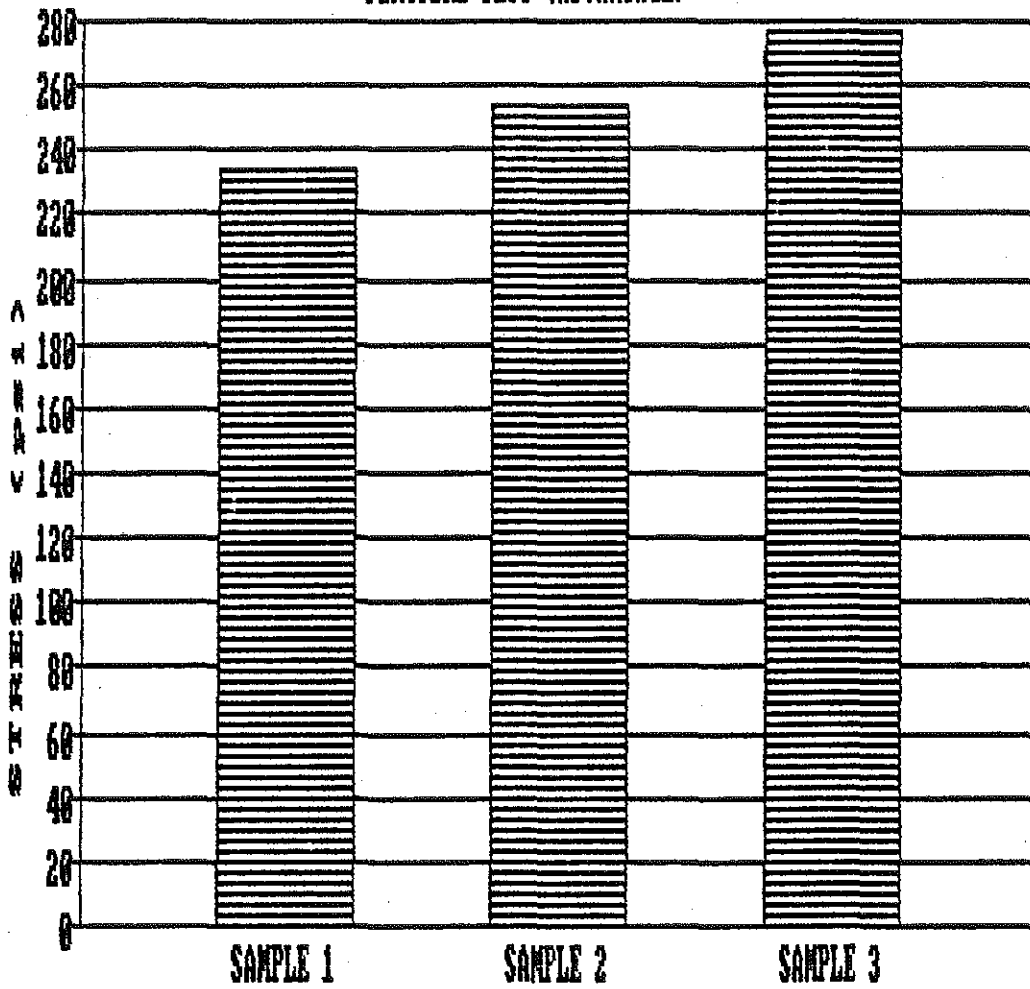


Figure 12. Avantage Puncture Test.

PUNCTURE TEST (HYDRAWAY)

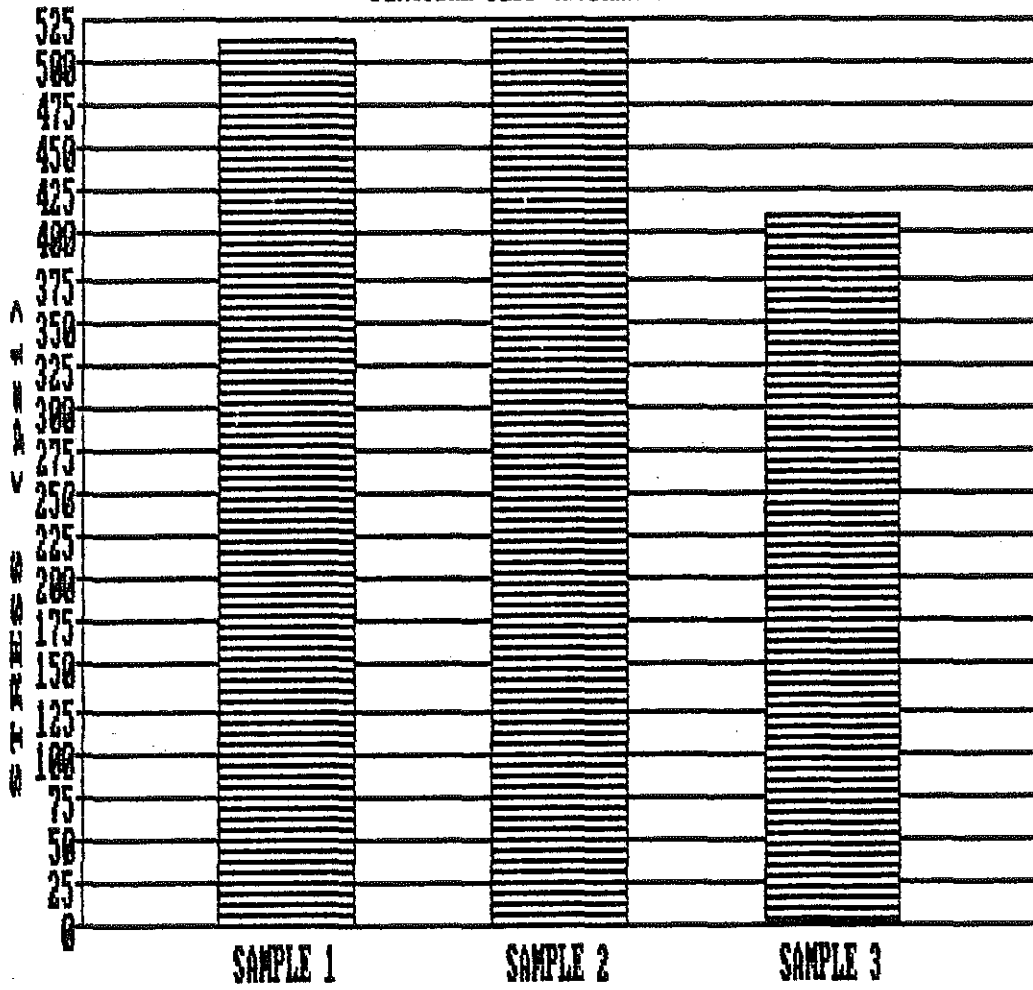


Figure 13. Hydroway Puncture Test.

EDGE DRAINS

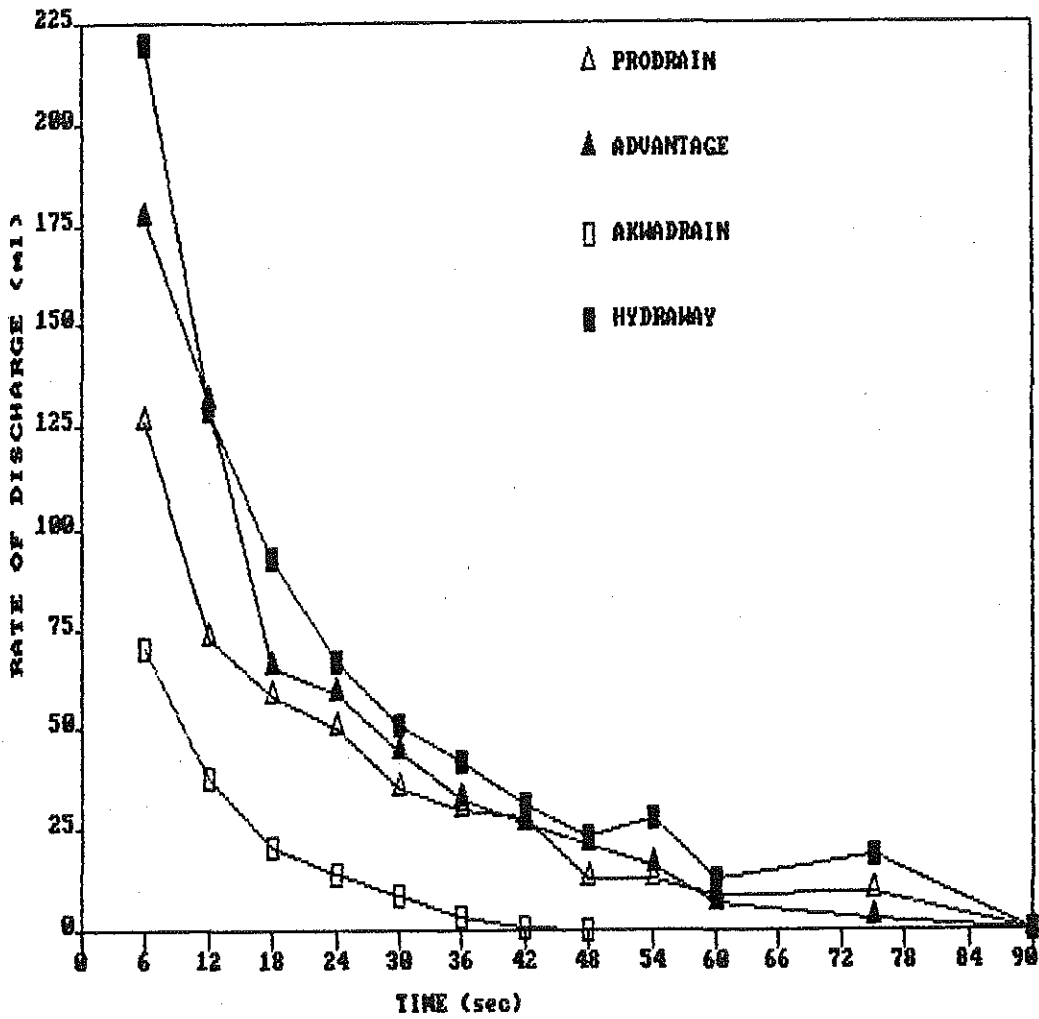


Figure 15. Average Slurry Filtration Test.

HYDRAWAY

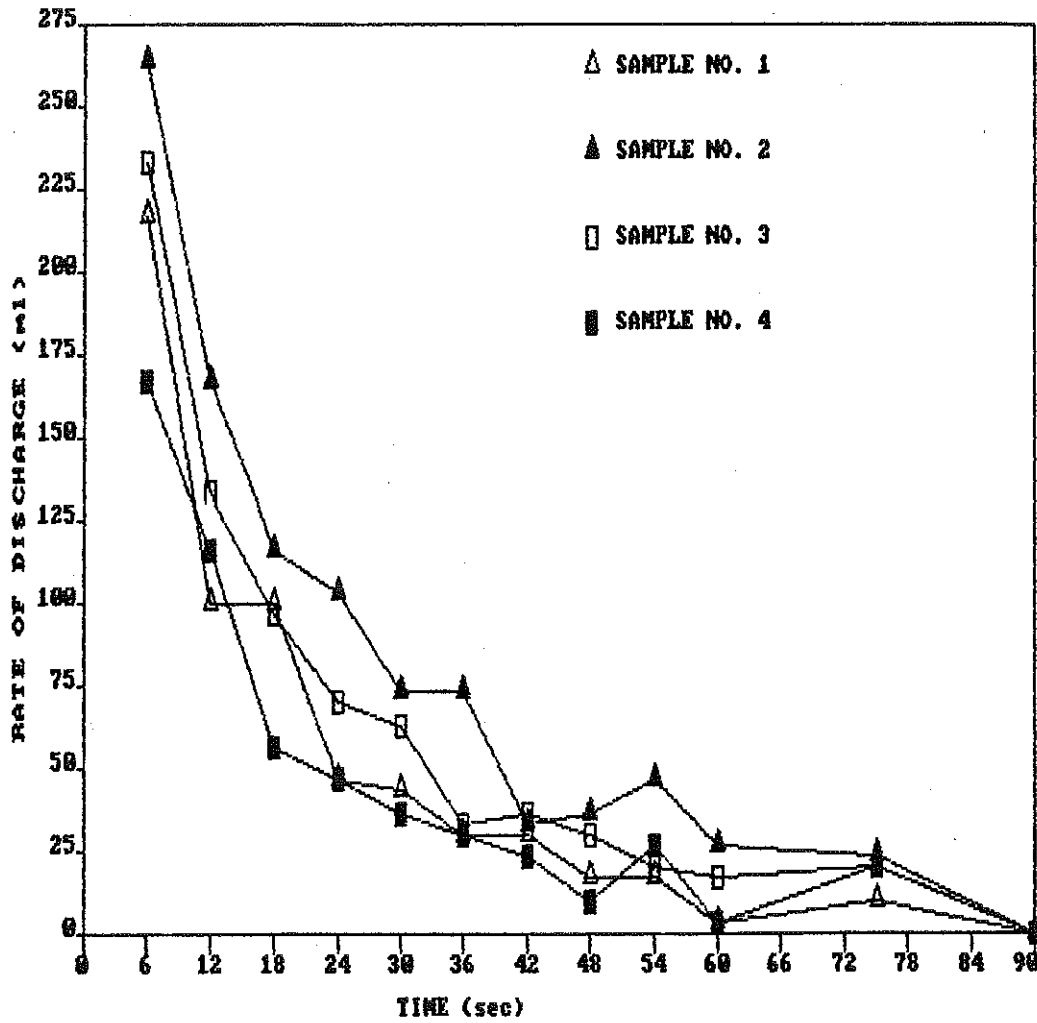


Figure 16. Hydraway Slurry Filtration Test.

AKWADRAIN

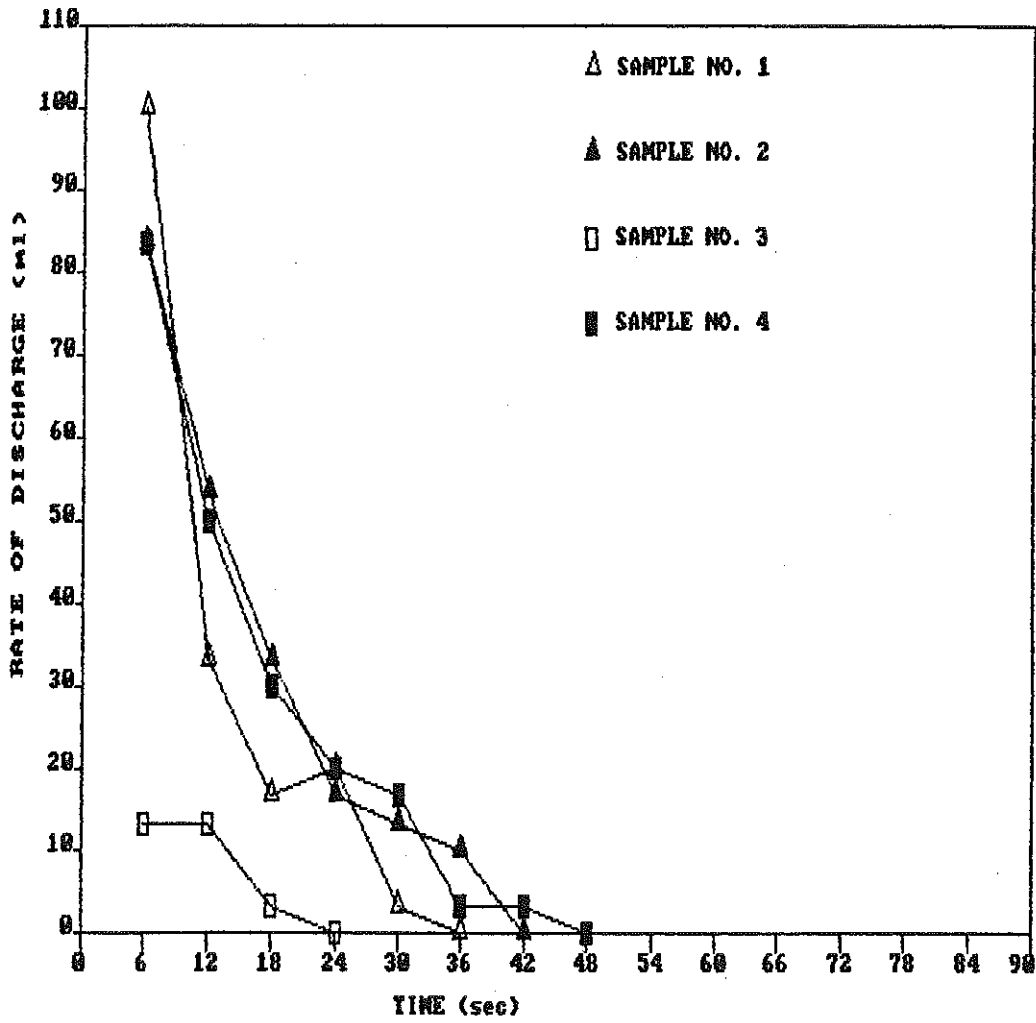


Figure 17. Akwadrain Slurry Filtration Test.

ADS ADVANTAGE

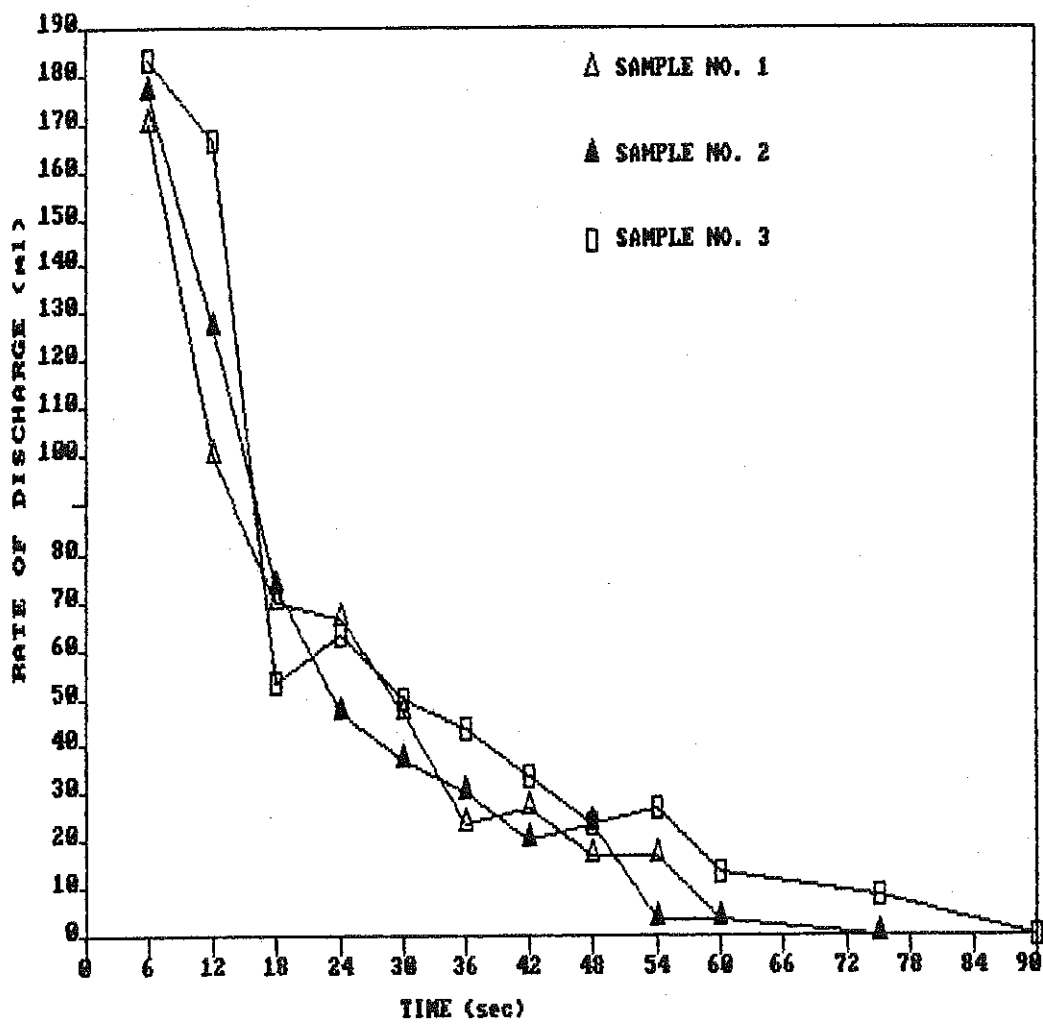


Figure 18. Advantage Slurry Filtration Test.

PRODRAIN

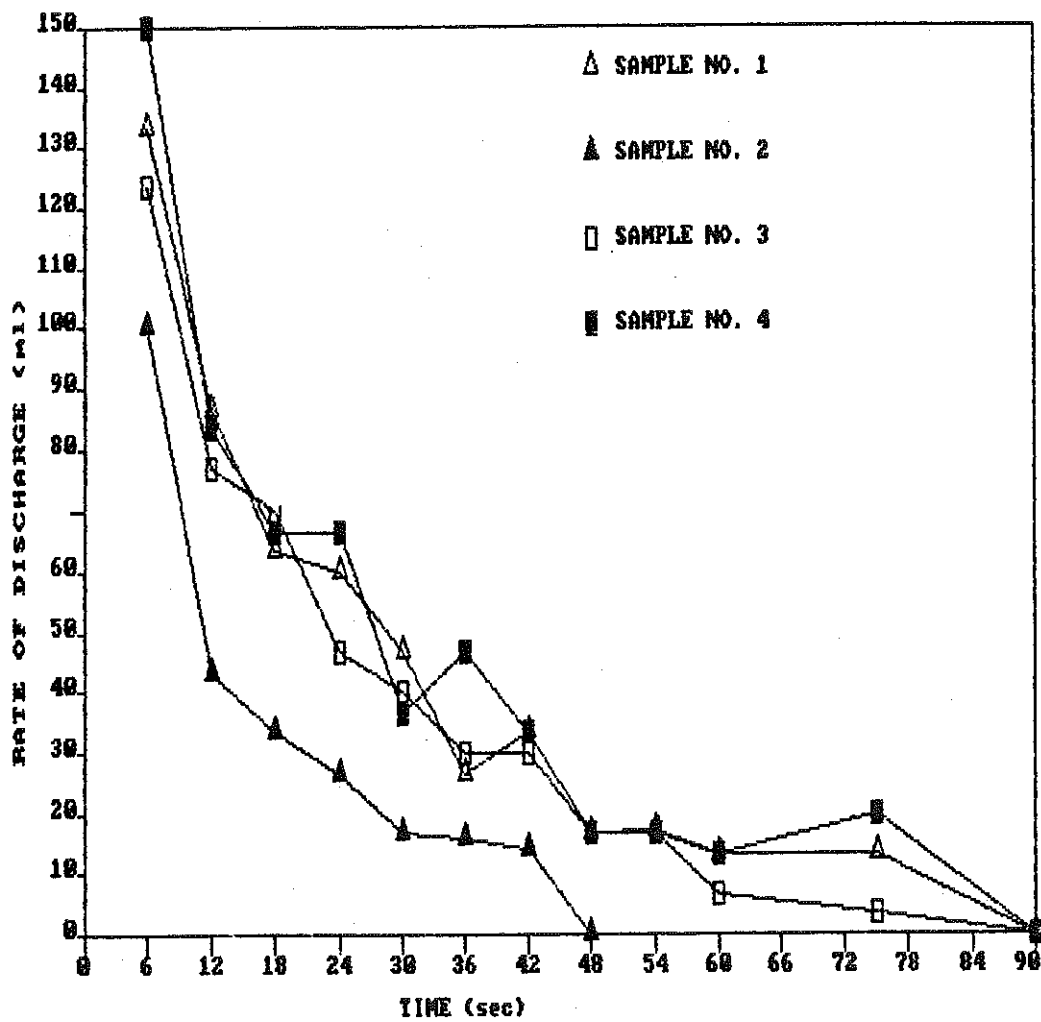


Figure 19. Pro Drain Slurry Filtration Test.

COMPRESSION TEST (PRODRAIN)

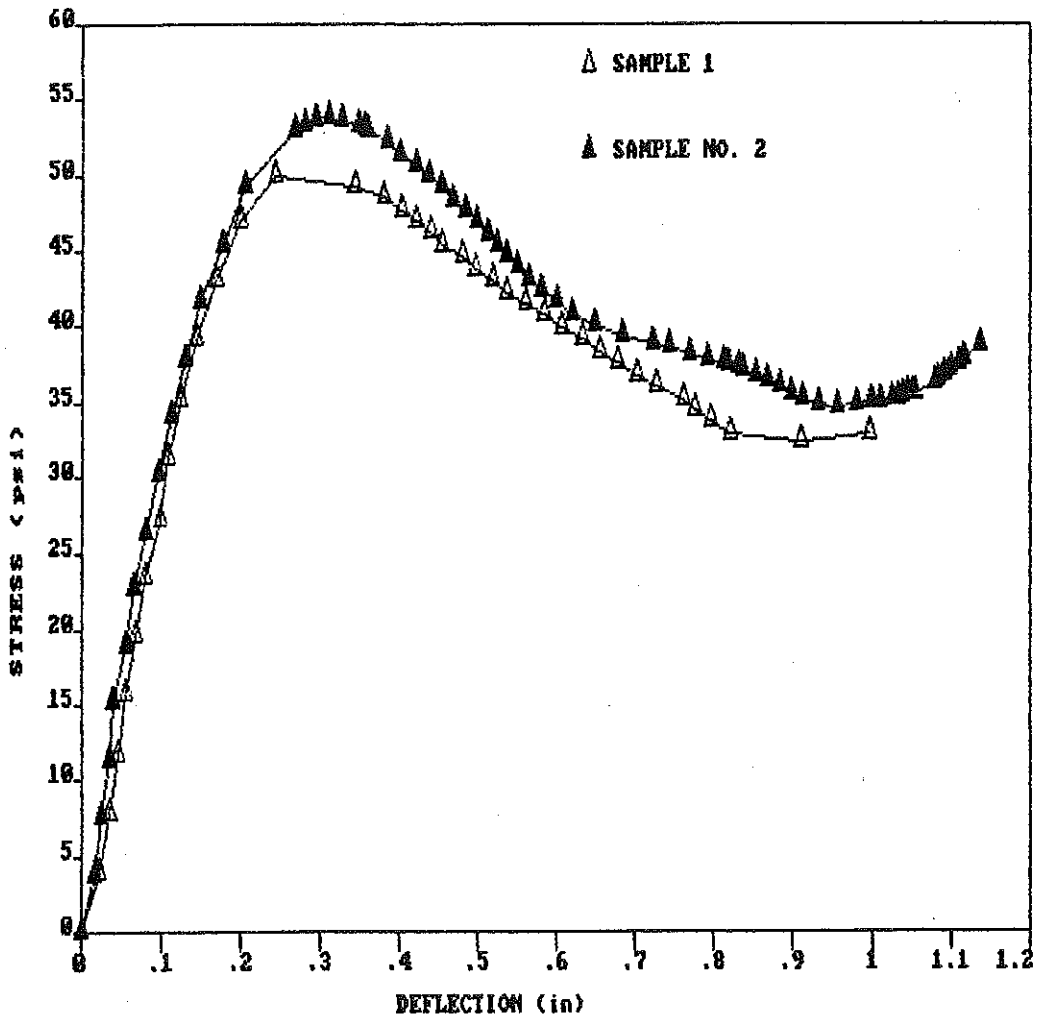


Figure 23. Pro Drain Core Compression Test.

CORE FLOW RATE

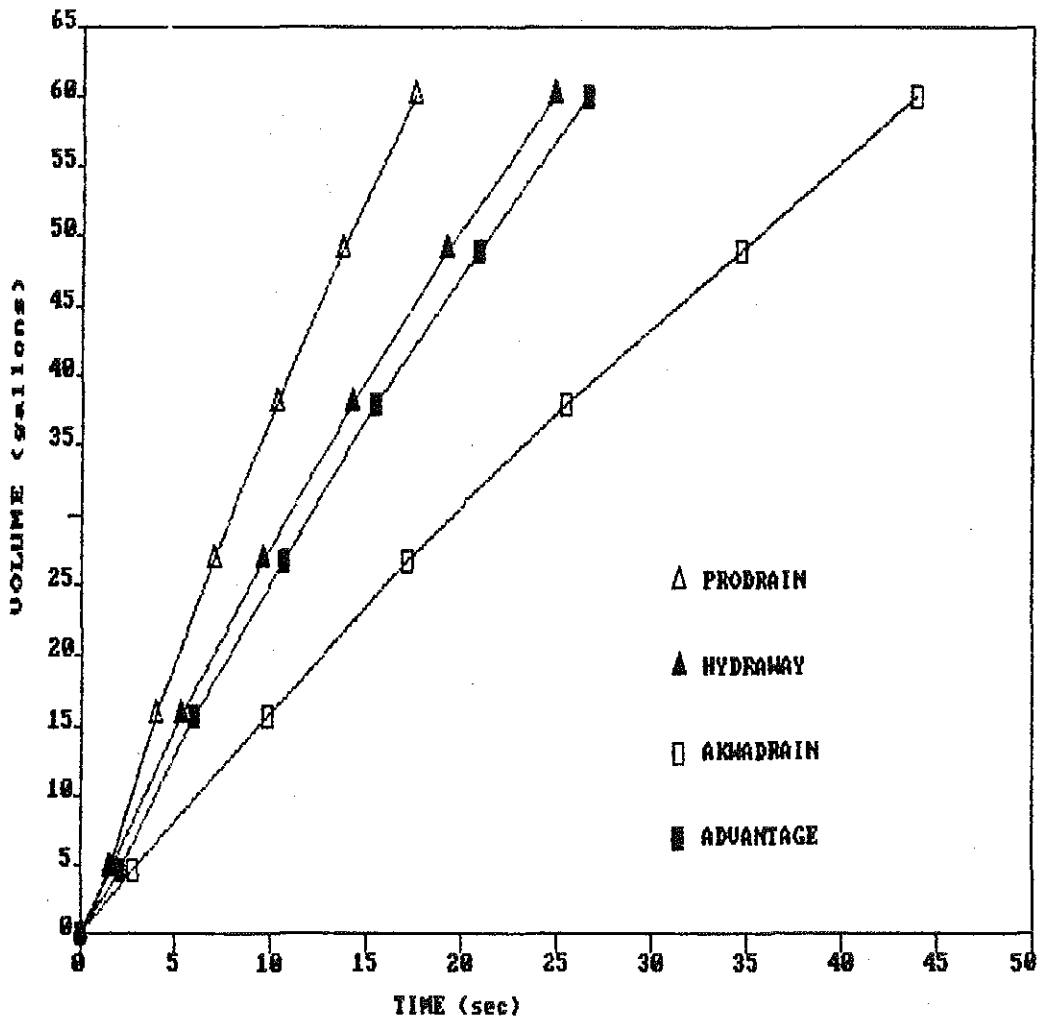


Figure 25. Average Core Flow Rates.