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DEPRESSED CURB OPENING INLETS
- SUPERCRITICAL FLOW -
EXPERIMENTAL DATA

Prepared for
U. S. Department of Commerce
Bureau of Public Roads
Hydraulic Research Division

by

S. S. Karaki
and
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Colorado State University Research Foundation
Civil Engineering Section
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DEPRESSED CURB OPENING INLETS
SUPERCRITICAL FLOW

INTRODUCTION

A study of efficiency of depressed curb opening inlets was undertaken as a cooperative study consisting of two parts: (1) Theoretical study by Dr. W. J. Bauer, Chicago, Illinois; (2) Experimental investigation by Colorado State University, Fort Collins, Colorado. A hydrodynamic study of non-depressed curb opening inlets was conducted at Stanford University (5).

There have been a number of other empirical studies made of curb opening inlet efficiencies (1)(2)(4) but no definitive criteria are yet available for highway engineers to use for designing curb opening inlets on varying roadway grades and cross slopes. This report gives the laboratory data for depressed curb opening inlets with uniform approach flow at supercritical velocities and is intended to supply part of the needed design information. No correlation or conclusion has been attempted; the report by Dr. Bauer is expected to present the results and conclusions of the total study.

NOMENCLATURE

It would be well to explain the variables used in the study before discussing the laboratory equipment or testing program, so that the reasons for constructing certain features of the flume and the dimensions used will be better understood. This can best be done with the aid of a definition sketch as shown in Fig. 1.

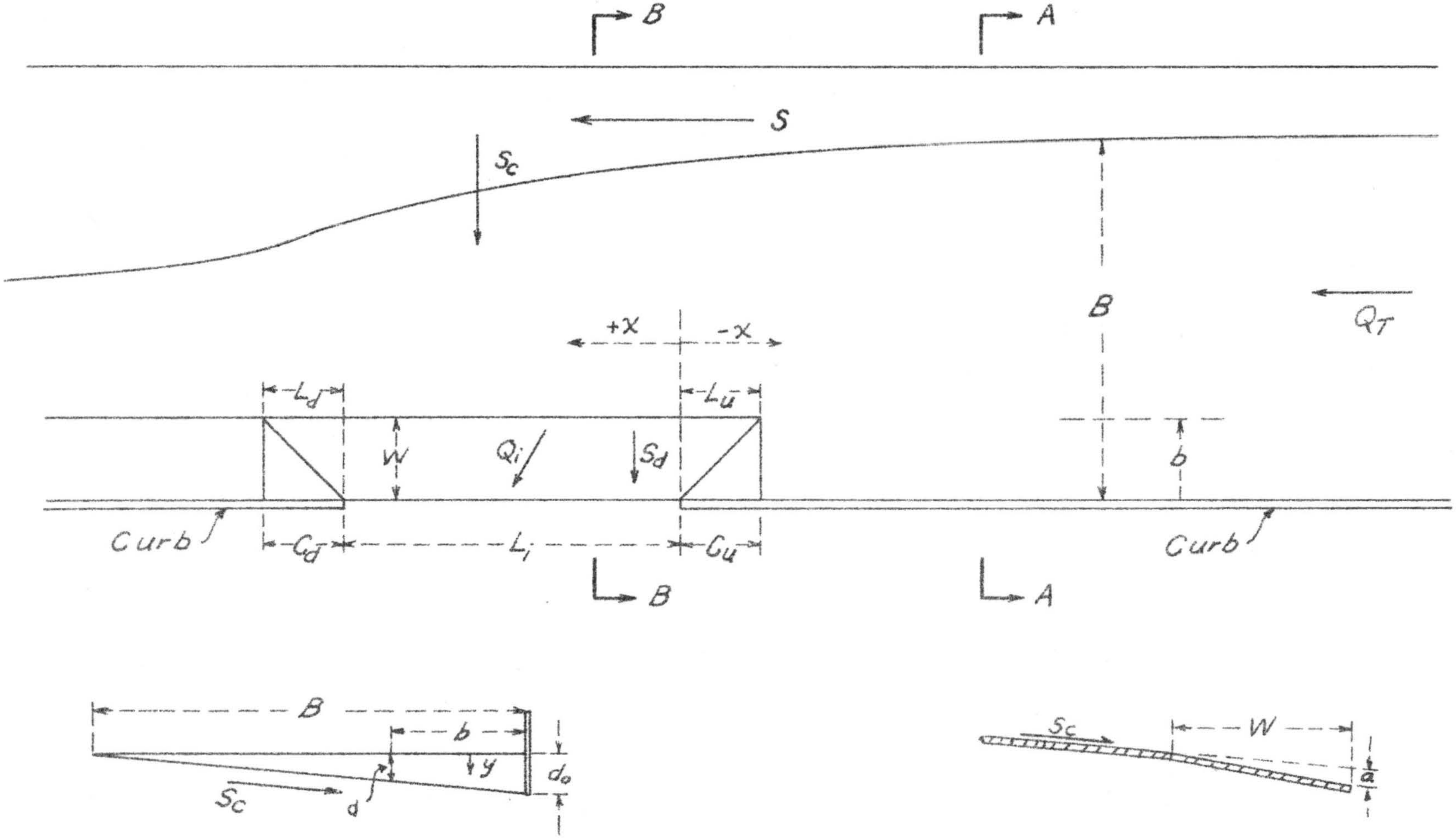
B = width of flow spread on the pavement upstream of the curb opening in ft.

b = lateral distance from the curb face in feet.

d = depth of flow in the flow section in feet.

d_o = depth of flow at the curb face in feet.

L_i = length of curb opening in feet.



Section A-A

Section B-B

Fig. 1 Definition Sketch

Nomenclature - continued

Q_i = inlet discharge in c.f.s.

Q_T = total discharge on the highway pavement measured through the master orifice in c.f.s.

S = longitudinal pavement slope.

S_c = pavement cross slope.

v = velocity at a point in the flow in f.p.s.

$\bar{v}$ = average velocity in a vertical section in f.p.s.

x = distance of a cross section normal to the curb face measured from the beginning of the curb opening; negative values upstream, positive values downstream, in ft.

The use of nomenclature describing transition geometry between the normal section and the depressed section warrants further explanation. For this study of depressed curb opening inlets, it was visualized that transition geometry may have some effect on inlet efficiency. L_u is the length of transition, from the normal cross slope, S_c , to full depression slope, S_d , at the upstream end of the curb opening. The dimension L_d is the length of transition from the depression slope to normal cross slope at the downstream end of the curb opening. There could also be an optimum position to begin and terminate the curb opening with respect to the beginning or end of the transition respectively, which could yield maximum inlet discharge for a given curb opening length L_i . These dimensions are termed C_u and C_d .

The depression width, W , is the lateral extent of local depression measured horizontally, normal to the vertical plane of the curb face. For reasons of traffic safety a maximum width of $W = 2$ ft was used in this study. In order to avoid confusion in interpretation of depression slope S_d , the vertical distance a , at the plane of the curb face, which used together with W expresses depression slope.

In addition to the variables discussed, the surface roughness of the flume was described by Manning's roughness coefficient n, using the intergrated form of the Manning equation as developed by Izzard (2):

$$n = \frac{0.56}{Q'} z\, d_o^{8/3} S^{1/2} ,$$

where,

Q' = measured discharge plus a discharge increment to allow for the retarding effect near the curb face. This incremental discharge was estimated from velocity traverse data in the uniform channel section upstream from the transition section.

$z = \dfrac{1}{S_c}$.

Also, a Froude number was used to describe this flow. This Froude number, F_w, was defined as:

$$F_w = \frac{8}{3} \frac{Q'}{d_o^{5/2}} \frac{S_c}{g^{1/2}} \left(\frac{d_w}{d_o}\right)^{1/6} ,$$

in which

d_w = the depth of flow at a distance W from the curb face.

EXPERIMENTAL EQUIPMENT

The laboratory equipment was constructed with prototype dimensions and not as a model. The total width of the flume was 12 feet and the length was 84 feet, of which the first 40-foot section was used to establish uniform flow. The flume was made adjustable both in cross slope, and longitudinal slope. The curb face of the initial 40-foot section was also made adjustable so that the curb could be made vertical for all cross slopes.

In order to establish uniform approach flow in the minimum distance possible, the head box was constructed in four compartments across the flume width, and flow into each compartment was separately controllable to regulate discharge. By this arrangement, the total head at the entrance to the flume was controlled approximately to that necessary for uniform flow conditions. A schematic diagram of the experimental apparatus is shown in Fig. 2.

To obtain maximum benefit from this head box arrangement, guide vanes were extended downstream from the head box for 16 feet in the zone of accelerating flow. The length of 16 feet was established by trial, using longer vanes initially. A distance of 24 feet downstream from the terminal point of the vane was therefore available for further establishment of flow and dissipation of surface disturbances created at the ends of the vanes. Level water surface in a reach upstream from the beginning of the curb opening was considered sufficient criterion for uniform flow.

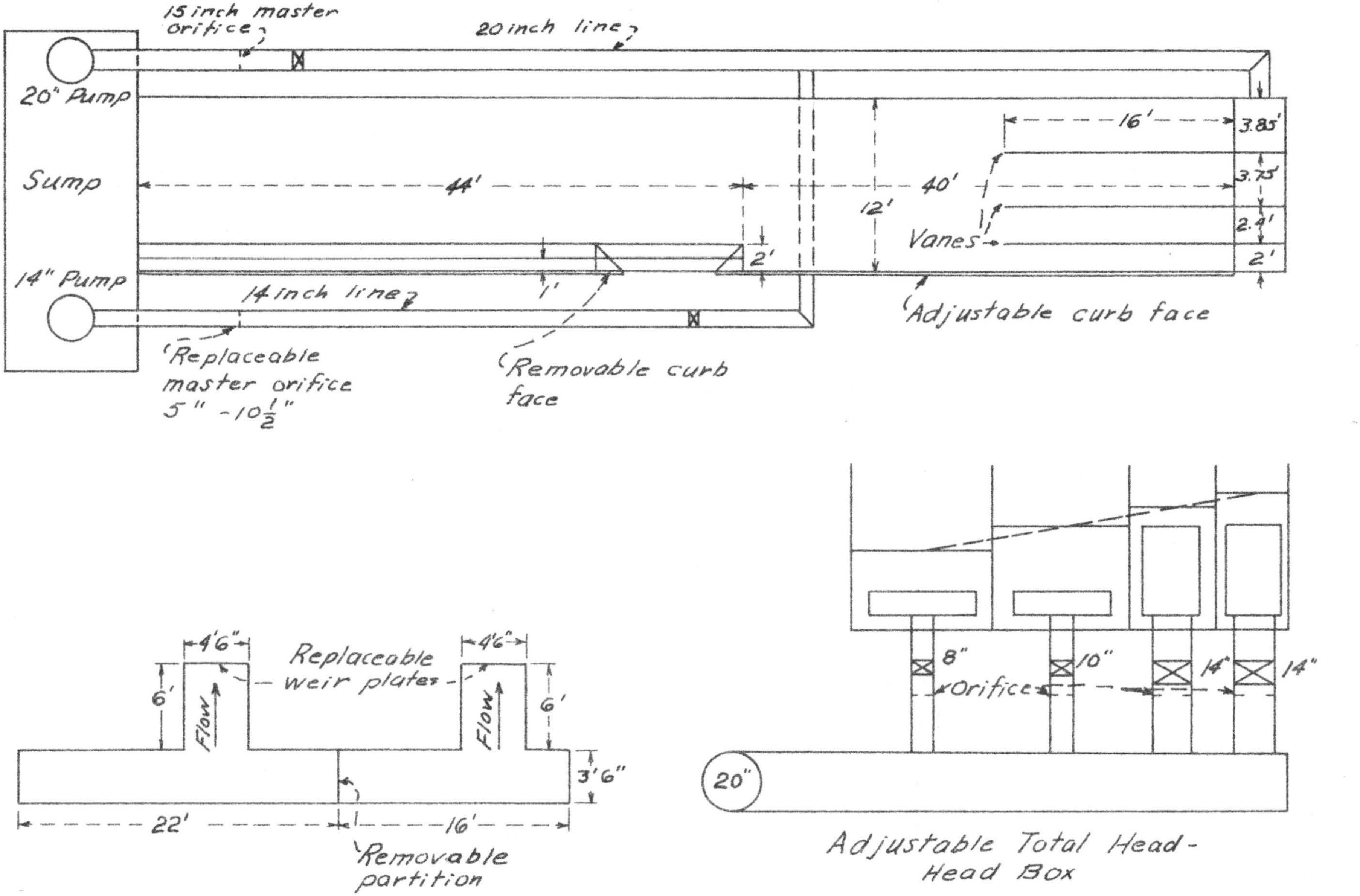
Before any experimental data were taken, a systematic testing procedure was established to reduce the experimental program to a minimum. The program of tests will be described in the next section. The depressed section was constructed so that W could be set at 1 or 2 feet. The depression slopes both for 1 and 2 foot sections were made adjustable with a maximum value of a = 2" for W = 1 foot, and a = 4" for W = 2 feet.

The curb inlet length was made adjustable by fastening removable curbs along the edge of the depressed section. The removable curbs were made in 2.5 and 5 ft sections.

The inlet discharges were measured through two weir boxes located below the flume. Because of the large variation of inlet discharges the weir boxes were made with replaceable weir plates. Triangular 60^0 V-notch weirs were used for discharges to about 2 c.f.s. and suppressed rectangular weirs were used for larger discharges. Each weir was calibrated in place each time it was re-installed.

Instrumentation for the equipment consisted of:

1. Master orifice meters to measure the total flow in the flume.
2. An orifice in each of the risers to the head box to facilitate flow adjustment.



Adjustable Total Head-Head Box

Collection and Measuring System for Inlet Discharge

Fig. 2 Schematic Diagram of Laboratory Flume

3. V-notch weirs and rectangular weirs for measuring inlet discharges.
4. An electrical point gage and a stagnation tube mounted on an instrument carriage; both point gage and stagnation tube were operative from one end of the carriage.

Two pumps were used to supply water to the flume, a 20-inch pump for 5 c.f.s. $< Q_T <$ 16 c.f.s. and a 14" pump for $Q_T <$ 5 c.f.s.

Three master orifices of 5, 10-1/2, and 15-inch diameters were used to measure total discharge Q_T ; each orifice for its appropriate range in discharges. The orifices were calibrated with a calibrated volumetric tank at the start of the experimental program. The orifices in the individual risers to the head box were then calibrated against the master orifice, as were the V-notch and rectangular weirs. The stagnation tube was .040 inches, inside diameter, and constructed so that it could be mounted on the point gage assembly. Mayon tubing was used to connect the stagnation tube to the manometer. The manometer used for measurement of velocity head was adjustable in slope to permit greater accuracy in reading small velocity heads. Photographs of the instrument carriage and point gage assembly are shown in Figs. 3 and 4.

TEST PROGRAM

The laboratory test program was established to achieve a maximum of results with a minimum of runs. This program included: (1) establishing transition geometry, i.e., L_u, C_u , L_d and C_d ; (2) with fixed transition geometry determining depression width W , and depression slope S_d , (a in relation to W); (3) with a selected local depression geometry determining the effects of cross slope, S_c , longitudinal slope, S , and roughness, n , on inlet efficiency.

For comparative reasons, W = 1 ft and W = 2 ft were selected for study. At each value of W , two values of a , 1 inch and 2 inches were tested. Two cross slopes, S_c = 0.015, and 0.06; two longitudinal slopes, S = .04 and

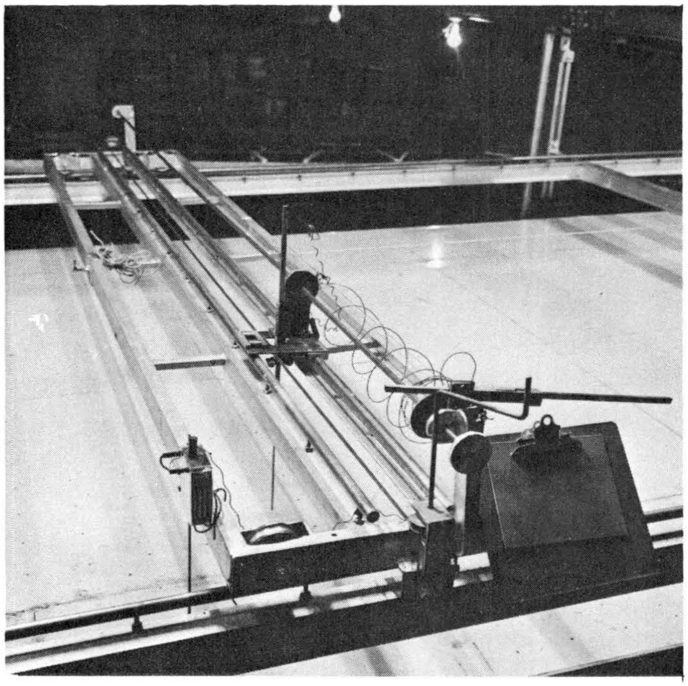


Fig. 3. Instrument carriage used for point gage and stagnation tube.

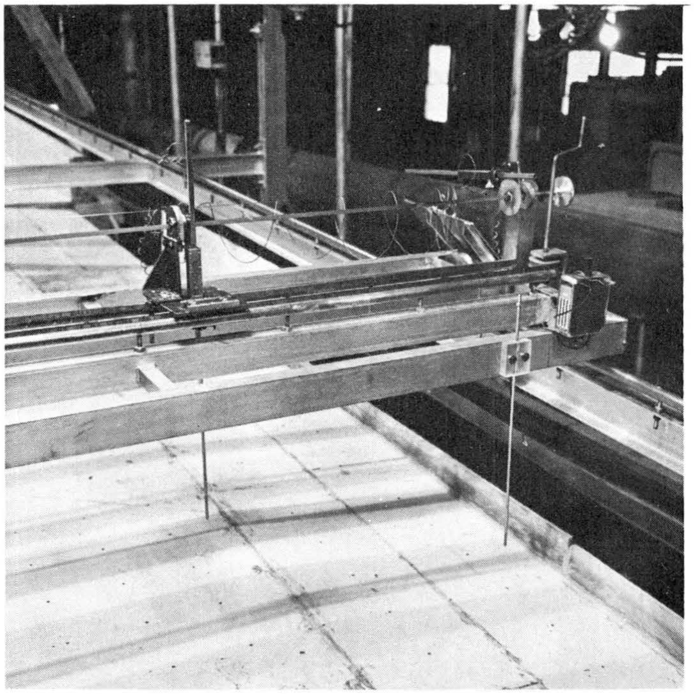


Fig. 4. Electrical contact point gage assembly.

.01; two roughness coefficients, $n \approx .01$ and $\approx .016$ were used. At each setting of flume cross slope, longitudinal slope and roughness, two widths of spread, B = 5 ft, and when discharge capacity permitted, B = 10 ft were used. The complete program of experimental runs are shown in the block diagrams of Figs. 5 and 6.

EXPERIMENTAL PROCEDURE

The orifices, were calibrated prior to start of the tests and the weirs for measuring inlet discharges were calibrated in place each time they were replaced during the test program. Since the width of spread, B , was selected beforehand, the discharge, Q_T , was adjusted to achieve the desired value of B . Because of the requirement of uniform flow, setting a specific value of B usually required considerable trial-and-error effort. In establishing B , the lateral floor profile was first obtained with water discharging in the flume. This profile was plotted and a "best fit" line was drawn through the points. In most instances the "best fit" line was very close to the selected flume cross slope. From this profile the elevation of the floor at B = 5 ft or B = 10 ft was determined and the discharge was adjusted so that the average water surface equalled this elevation. After establishment of flow, velocity traverses were made in the uniform channel section, usually just upstream from the beginning of the upstream transition. The values n , and Q' were then determined from these velocity traverses.

The curb inlet lengths were set, and at each length L_i , the inlet discharge Q_i was measured. Sufficient time, usually about 20 to 25 minutes was allowed before each measurement of Q_i , to be assured of steady flow conditions. Some fluctuation of head over the weirs was experienced at large values of Q_i , particularly with the suppressed rectangular weir. In this case, time averaging measurements of head were taken over an interval of about three to four minutes reading the point gage in the stilling well as rapidly as physically possible. Though this method may be questionable, it was not

Program of Experimental Runs

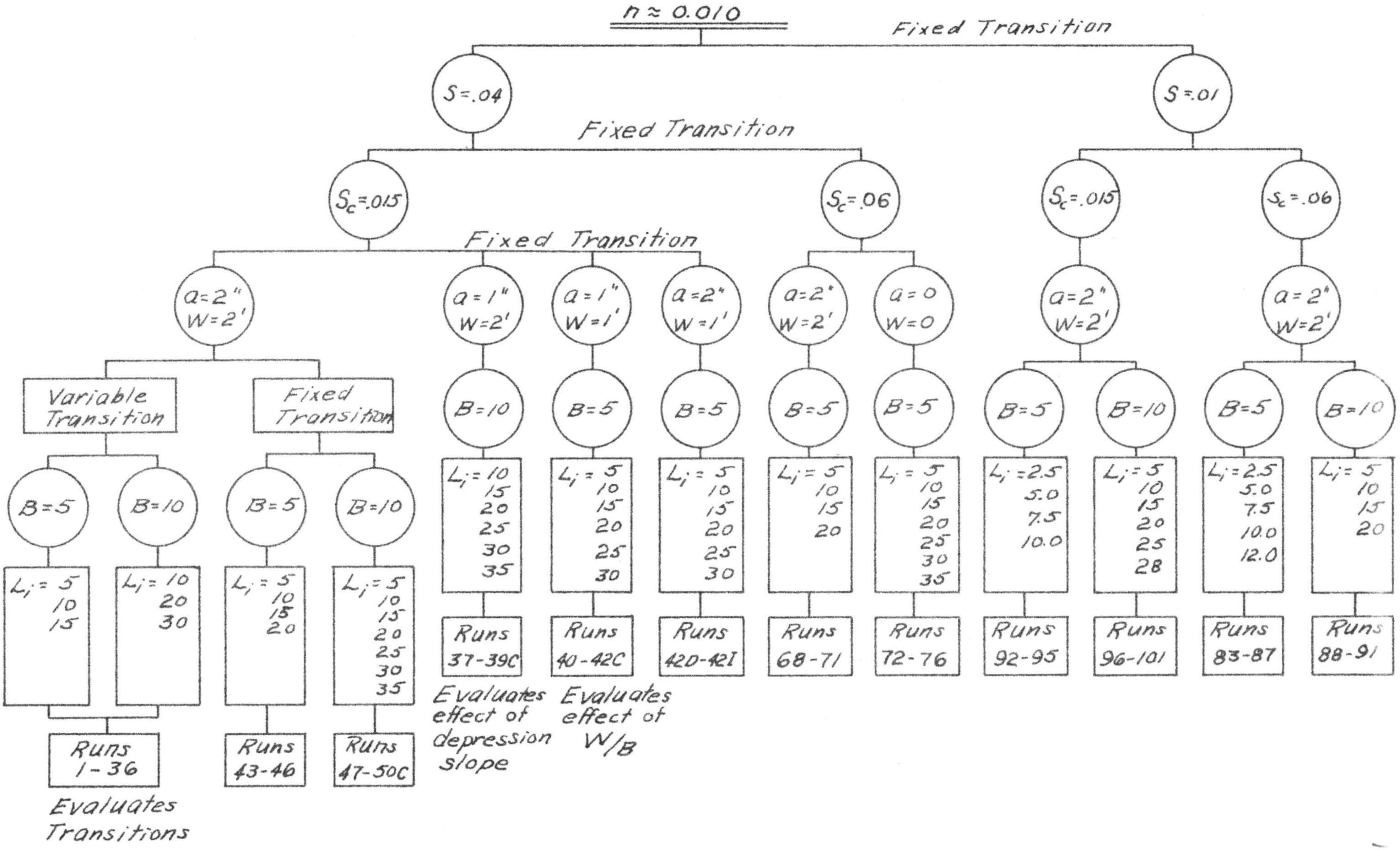


Fig. 5 Block Diagram $n \approx 0.01$

Program of Experimental Runs

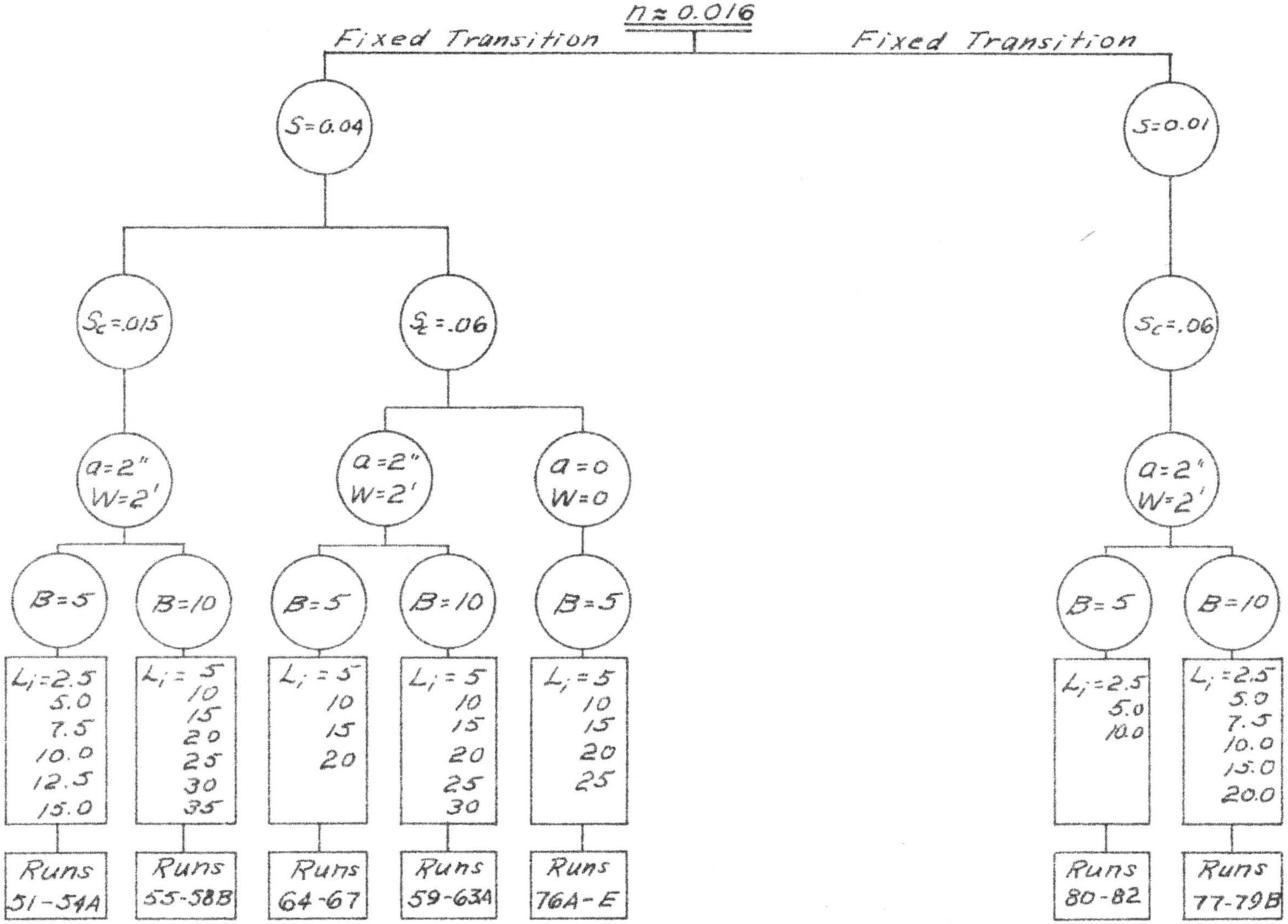


Fig. 6 Block Diagram $n \approx 0.016$

considered economically feasible to purchase and set up an electronic device to automatically give a time-integrated reading of head over the weirs. Each change of inlet length constituted a "run". At each run, both the total and the inlet discharges were read and recorded.

Flume roughness of $n \approx 0.01$ was achieved satisfactorily with the painted flume surface. Originally it was desired that the second roughness coefficient achieve a value near $n \approx 0.02$. However this was not possible without a great deal of time and expense. Therefore, $n \approx 0.016$ was used. Uniformity of roughness over the entire flume surface was a pre-requisite. Because of this, certain commerically available materials such as expanded metal lath, galvanized wire screen, hardware cloth, copper screens, cheesecloth, and burlap were considered. However, because of the large size of the flume none of these materials proved satisfactory. The difficulty with all of the metal screens mentioned above was that they could not be made to lie flat against the flume surface, and where small depths were of concern, the "bulges" created by these materials would prove very difficult to obtain uniformity in roughness. Cheesecloth and burlap were too light and without elaborate fastening methods they would "float" above the flume surface.

The material ultimately used and found satisfactory was fibre glass screen. The screen could be stretched tightly over the flat flume surface with no bulging or high spots. The screen used is normally manufactured for use in window screens. It contained 18 strands to the inch with each fibre approximately 0.015 inch in diameter. Unfortunately a different size of the same material, to give a greater value of n , was not commercially available. Paraffin was used to fasten the fibre glass screen to the flume surface. Nails or staples were not permitted because they would destroy the painted surface and in all likelihood the flume would have to be refinished after the screen was lifted before further runs with smooth surface could be made. Furthermore, breaks in the painted surface would allow water to soak into the plywood causing the plywood to swell and destroy the entire surface. As it developed, the removal of paraffin was difficult and it was necessary to use a motorized floor polisher with a stiff brush to remove all of the paraffin from the flume surface. The flume was then repainted to achieve again a smooth surface with $n \approx 0.01$.

Roughness was not applied to the curb face because of the difficulty of achieving uniformity. The screen could not, without the use of more positive fastening means, be made to lay flat against the curb face.

OBSERVATIONS

The parameters of interest in this study were pre-determined from analysis of data from other laboratory studies. The parameters of significance were visualized as Q_i / Q_T, an expression of inlet efficiency and $L_i/F_w B$, a parameter relating space variables and flow conditions. It is not the purpose of this report to correlate the data other than by the parameters indicated above, nor to formulate design criteria.

Effect of Transition Geometry

The effects of transition geometry are shown in Fig. 7 and the data are given in the summary of experimental data - Table 1. The wide range of inlet efficiencies experienced by the changes show the importance of geometric configuration. Some of the flow conditions created at the transition section both at the upstream and downstream ends of the curb inlet are shown in Figs. 8 to 15. The most efficient upstream transition geometry was found to be $L_u = C_u = 2.0'$ which corresponds to the upper curve in each zone of W/B in Fig. 7. The most efficient downstream condition varied with the width of spread; however, in general when $L_d = C_d = 0$ more discharge was intercepted because of the abrupt face created at the change from the depression slope to the normal cross slope. An abrupt face, for reasons of traffic safety would probably not be satisfactory for use on highways, hence, the transitions selected for this study were $L_u = L_d = C_u = C_d = 2.0'$, and were used throughout the remainder of the study, except for some specialized runs when no local depression at the inlet was used.

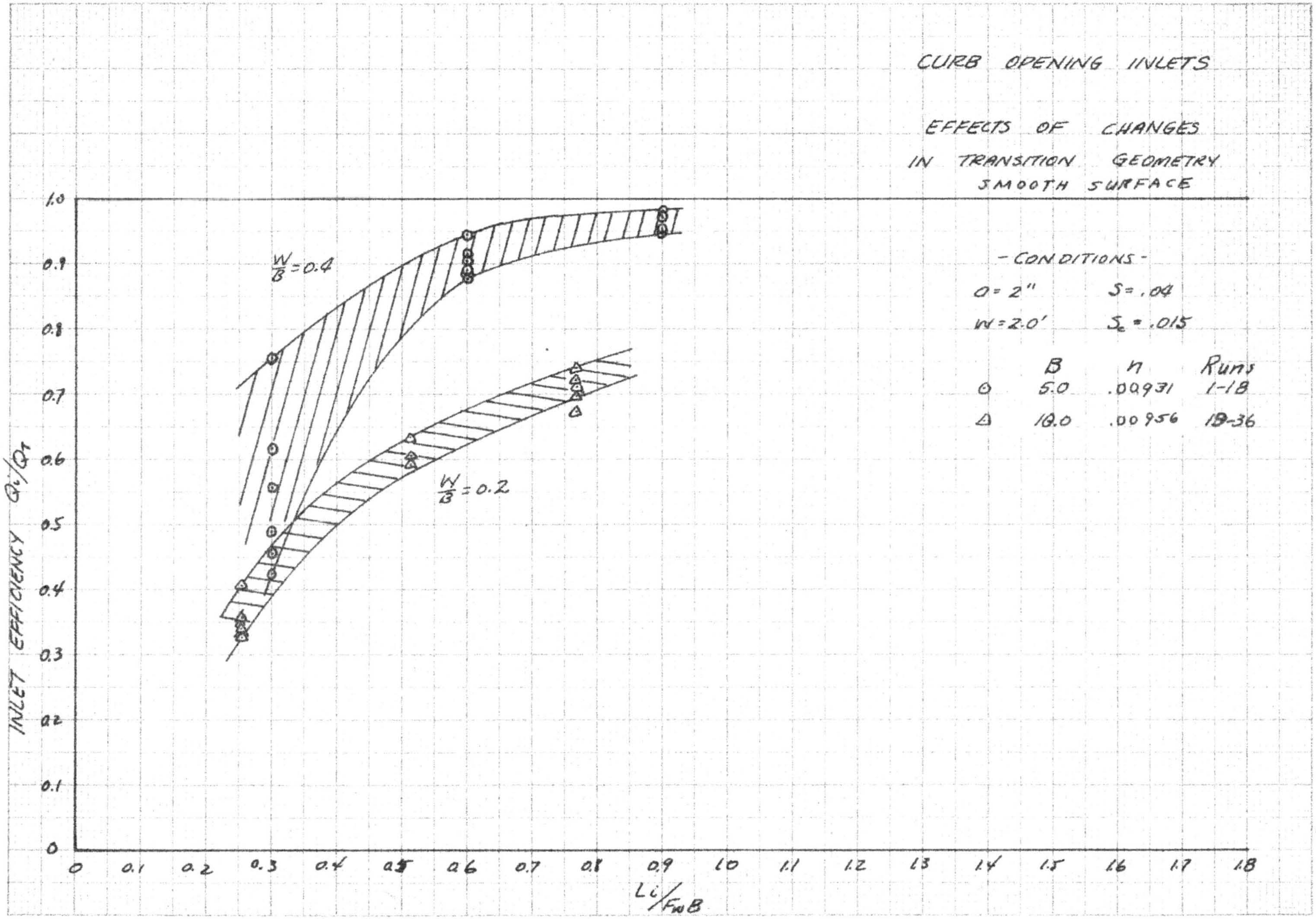

CURB OPENING INLETS
EFFECTS OF CHANGES
IN TRANSITION GEOMETRY
SMOOTH SURFACE
- CONDITIONS -
O = 2"
S = .04
W = 2.0'
S_c = .015
B
n
Runs
○
5.0
.00931
1-18
△
10.0
.00956
19-36
W/B = 0.4
W/B = 0.2
INLET EFFICIENCY Qi/QT
Li/FwB
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2
1.3
1.4
1.5
1.6
1.7
1.8

Fig. 7

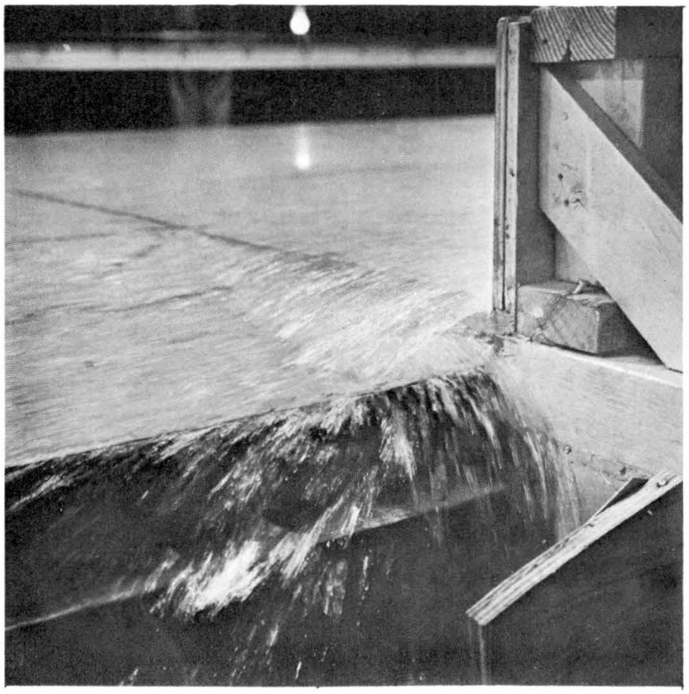


Fig. 8. Run No. 1. $L_u = 0$, $C_u = 0$.

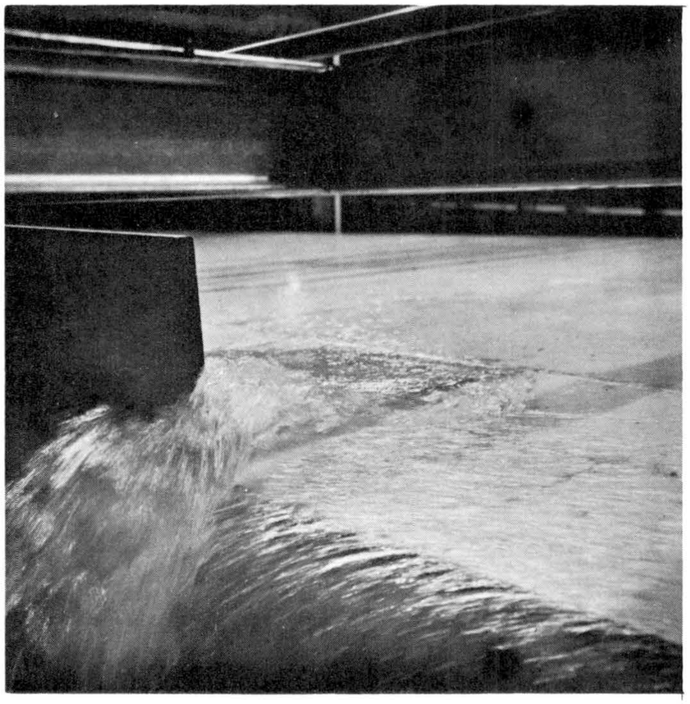


Fig. 9. Run No. 1. $L_d = 0$, $C_d = 0$.

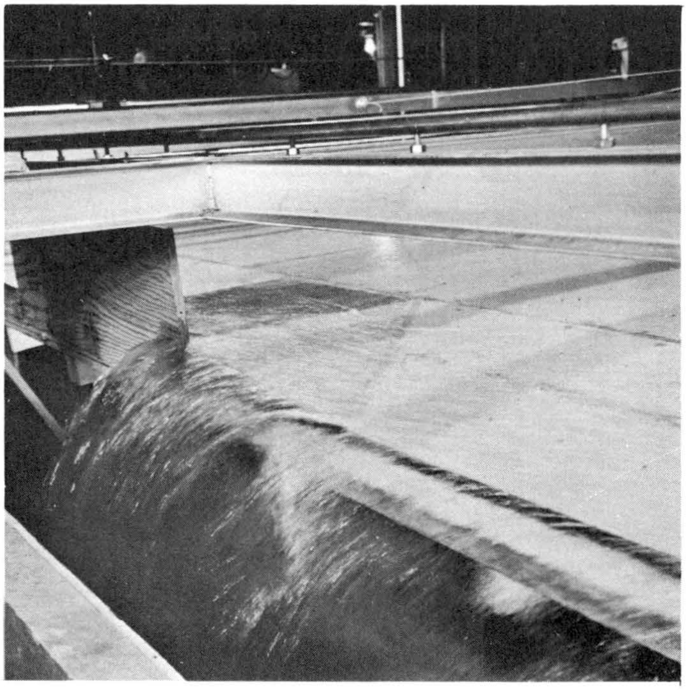


Fig. 10. Run No. 2. $L_d = 2$, $C_d = 0$, $L_u = 0$, $C_u = 0$, $B = 5$.

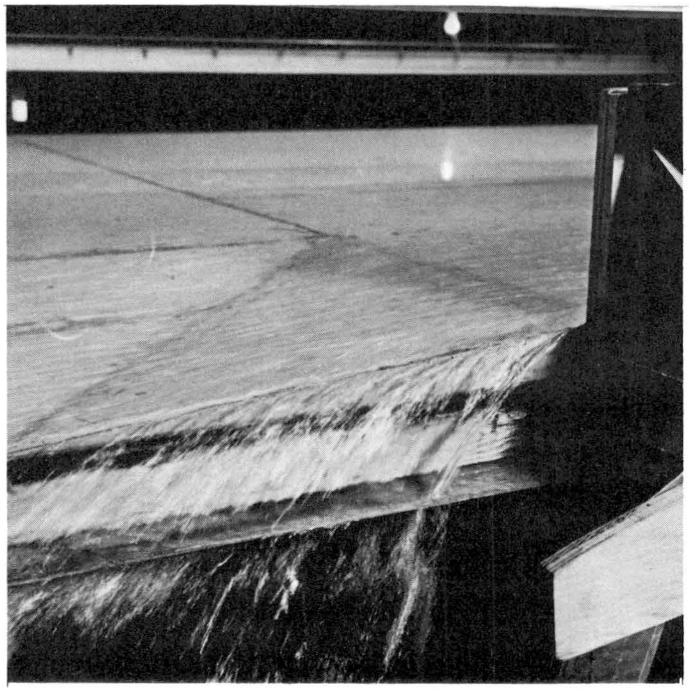


Fig. 11. Run No. 5. $L_u = 2$, $C_u = 0$, $B = 5$.

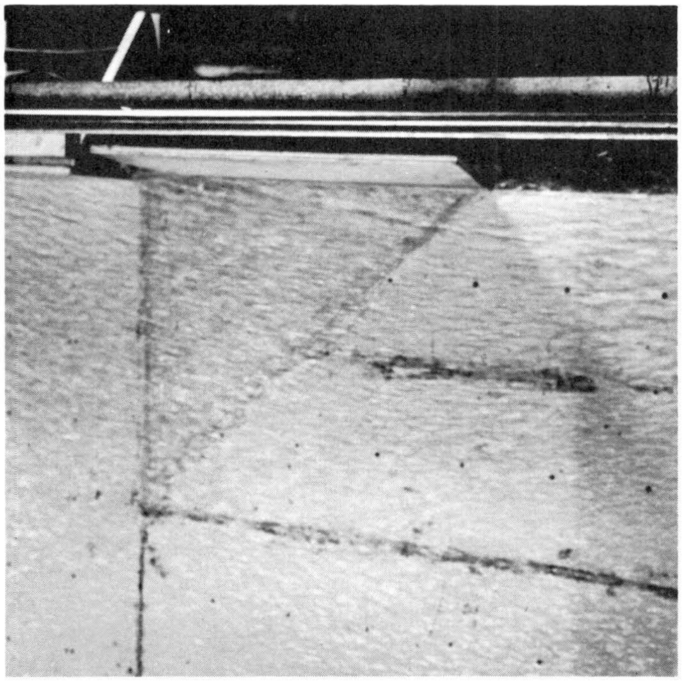


Fig. 12. Run No. 6. $L_u = 2$, $C_u = 2$, $B = 5$.

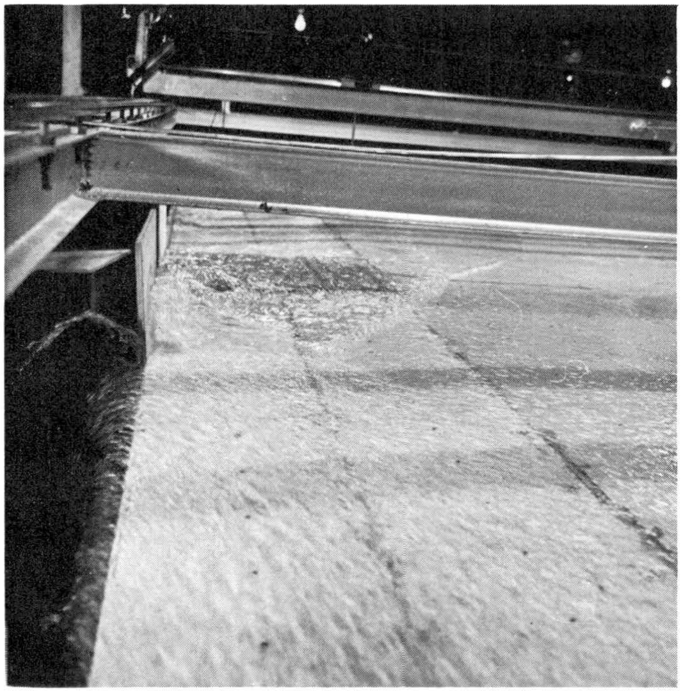


Fig. 13. Run No. 4. $L_d = 0$, $C_d = 2$, $B = 5$.

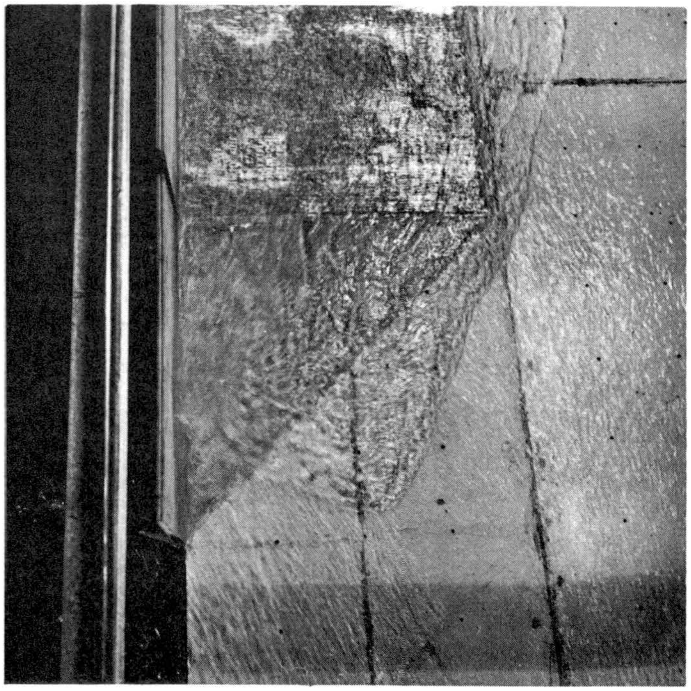


Fig. 14. Run No. 3. $L_d = 2$, $C_d = 2$, $B = 5$.

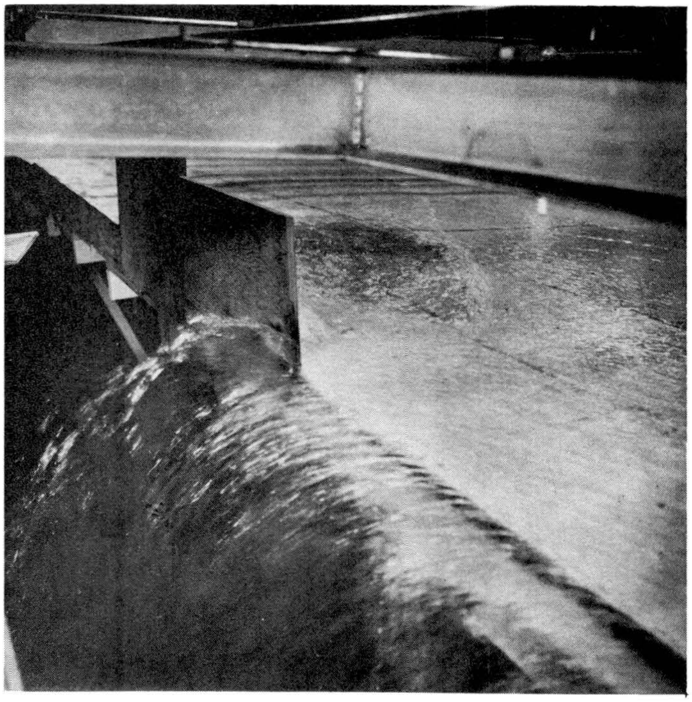


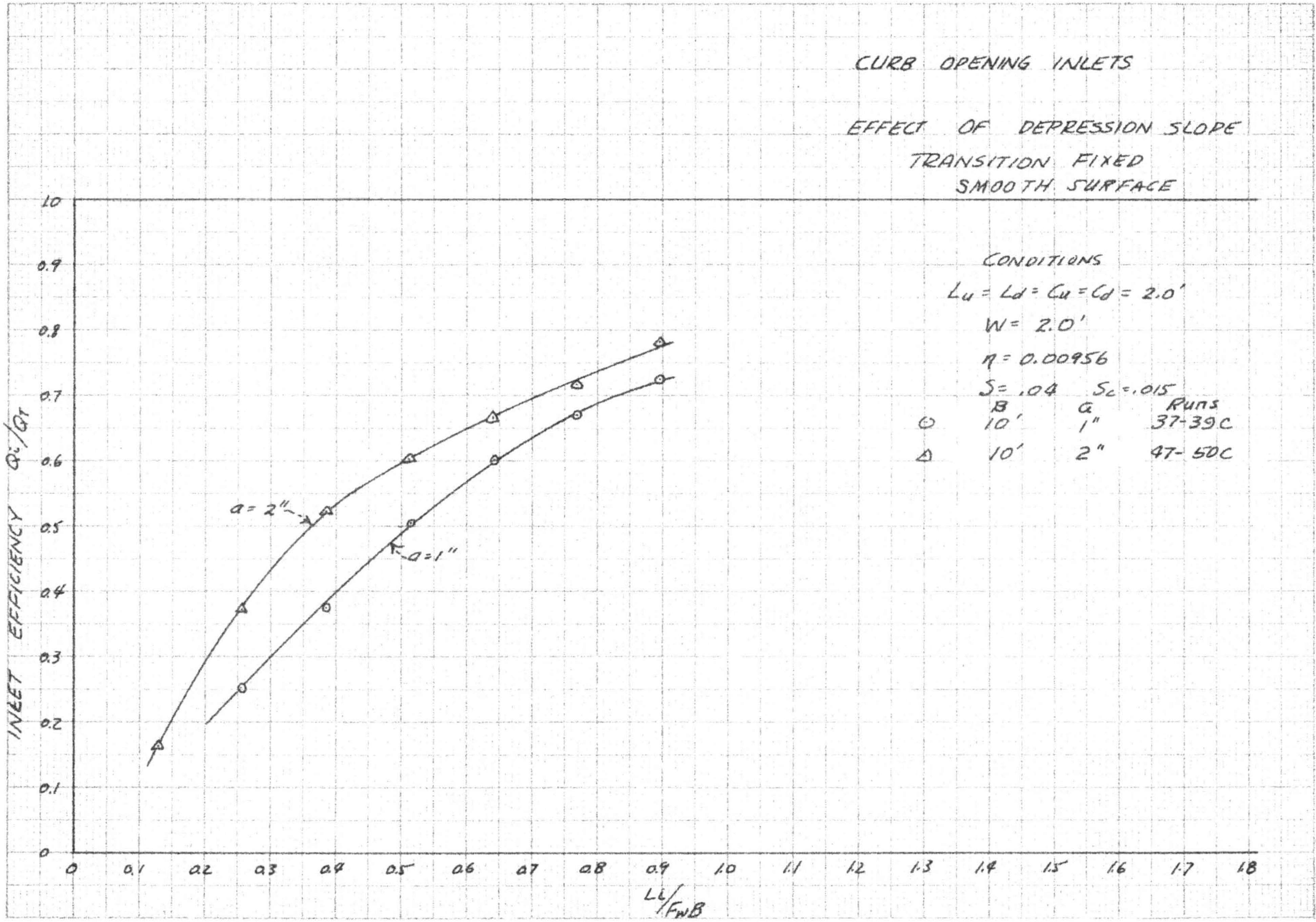
Fig. 15. Run No. 3. $L_d = 2$, $C_d = 2$, $B = 5.0$.

Effect of Depression Slope and Width

Other runs were made to determine the effects of depression slope and width. Although variations in comparative graphs of Q_i/Q_T vs. $L_i/F_W B$ are possible, in this report the effects of depression slopes are shown in Figs. 16 and 17. In Fig. 16 the depression width, W, is 2.0 ft and $B = 10$ ft. This graph shows that the greater depression slope enables interception of greater amounts of flow for the same approach flow condition and inlet length. This observation is also verified in Fig. 17 where $W = 1$ and $B = 5.0$. Fig. 18 shows the effect of depression width with the same depression slope and flow conditions. The 2-foot depression width causes greater interception of flow than the 1-foot width for the same gutter flow conditions. From these runs, the flow width $W = 2$ and depression slope $a = 2.0$ in. was selected for the remainder of the tests. The test data are summarized in Table 1.

Effects of Cross Slope, Roughness and Longitudinal Slope

The effect of cross slope on inlet efficiency is shown in Figs. 19 to 22 for longitudinal slopes of 0.04 or 0.01 and both smooth and rough surfaces. No data were taken for $S_c = .015$ with rough flume surface. Comparative plots of the effect of roughness are shown in Figs. 23 to 25 and those for effect of longitudinal slope in Figs. 20 to 28.



CURB OPENING INLETS

EFFECT OF DEPRESSION SLOPE
TRANSITION FIXED
SMOOTH SURFACE

Fig 16

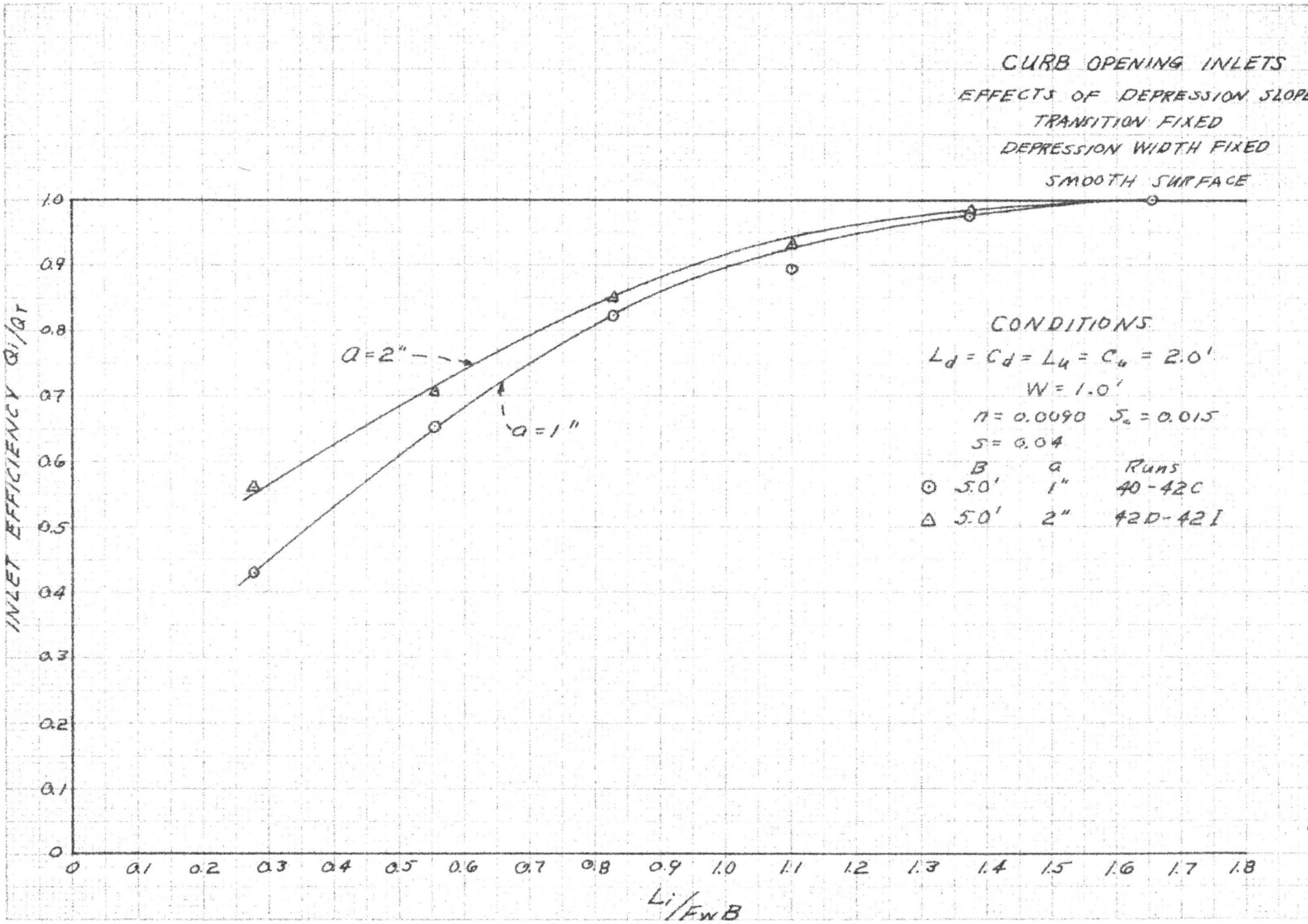

CURB OPENING INLETS
EFFECTS OF DEPRESSION SLOPE
TRANSITION FIXED
DEPRESSION WIDTH FIXED
SMOOTH SURFACE
CONDITIONS
$L_d = C_d = L_u = C_u = 2.0'$
$W = 1.0'$
$n = 0.0090$ $S_o = 0.015$
$S = 0.04$
B a Runs
⊙ 5.0' 1" 40-42C
△ 5.0' 2" 42D-42I
a=2"
a=1"
INLET EFFICIENCY Qi/QT
Li/FwB
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2
1.3
1.4
1.5
1.6
1.7
1.8

Fig. 17

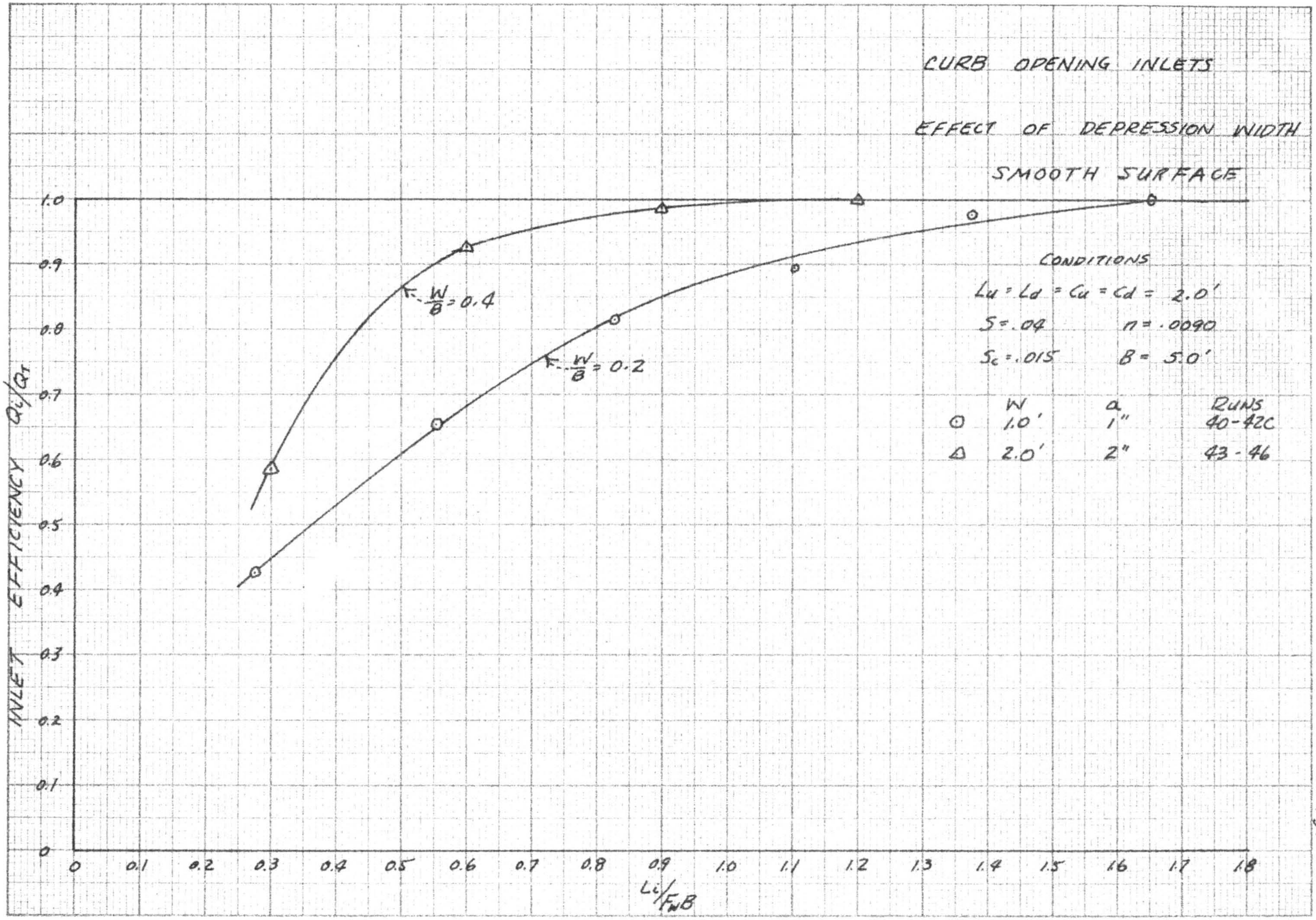
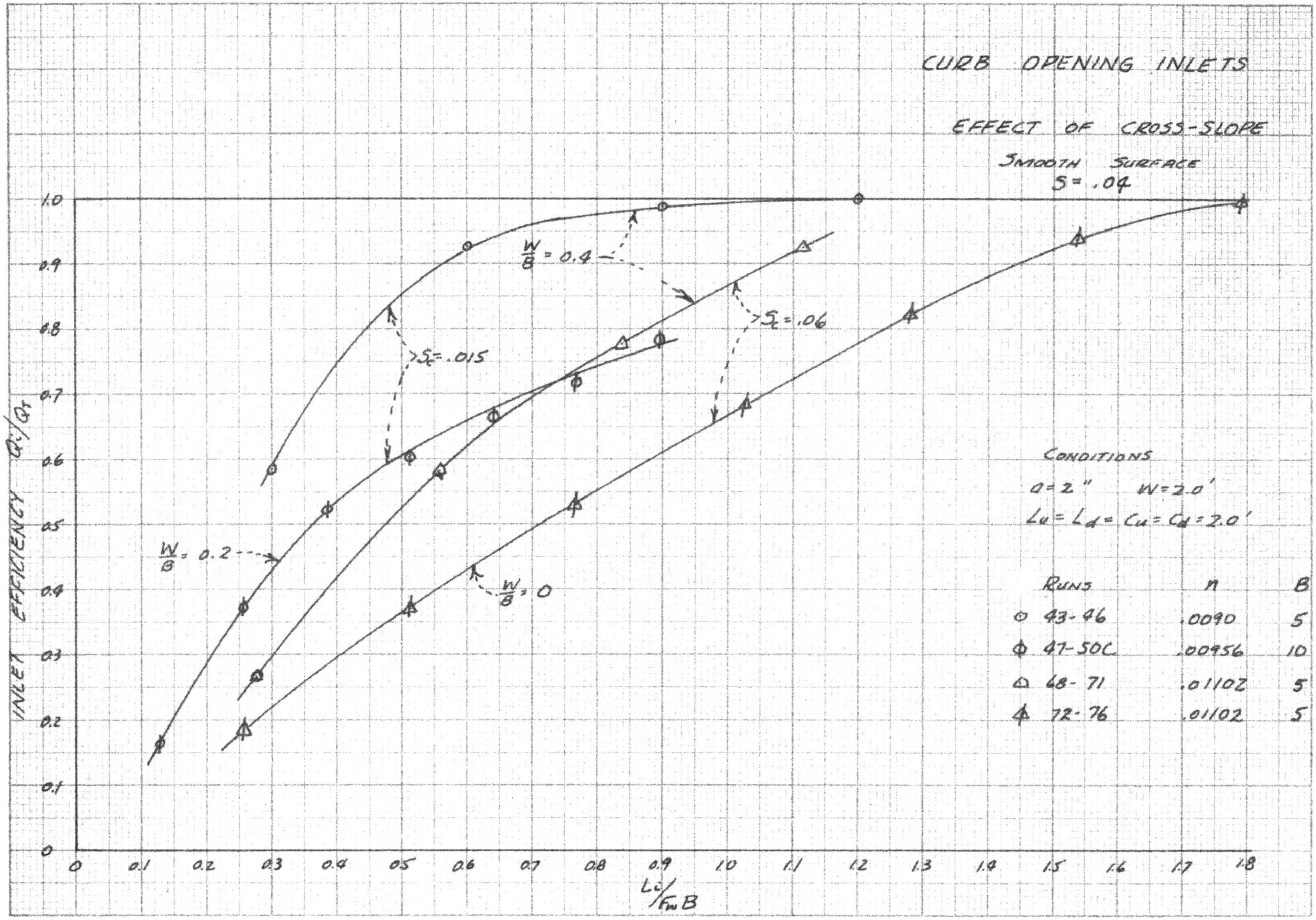

CURB OPENING INLETS
EFFECT OF DEPRESSION WIDTH
SMOOTH SURFACE
CONDITIONS
Lu = Ld = Cu = Cd = 2.0'
S = .04
n = .0090
Sc = .015
B = 5.0'
W
a
RUNS
⊙ 1.0' 1" 40-42C
△ 2.0' 2" 43-46
W/B = 0.4
W/B = 0.2
INLET EFFICIENCY Qi/QT
Li/FwB
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2
1.3
1.4
1.5
1.6
1.7
1.8

Fig. 18

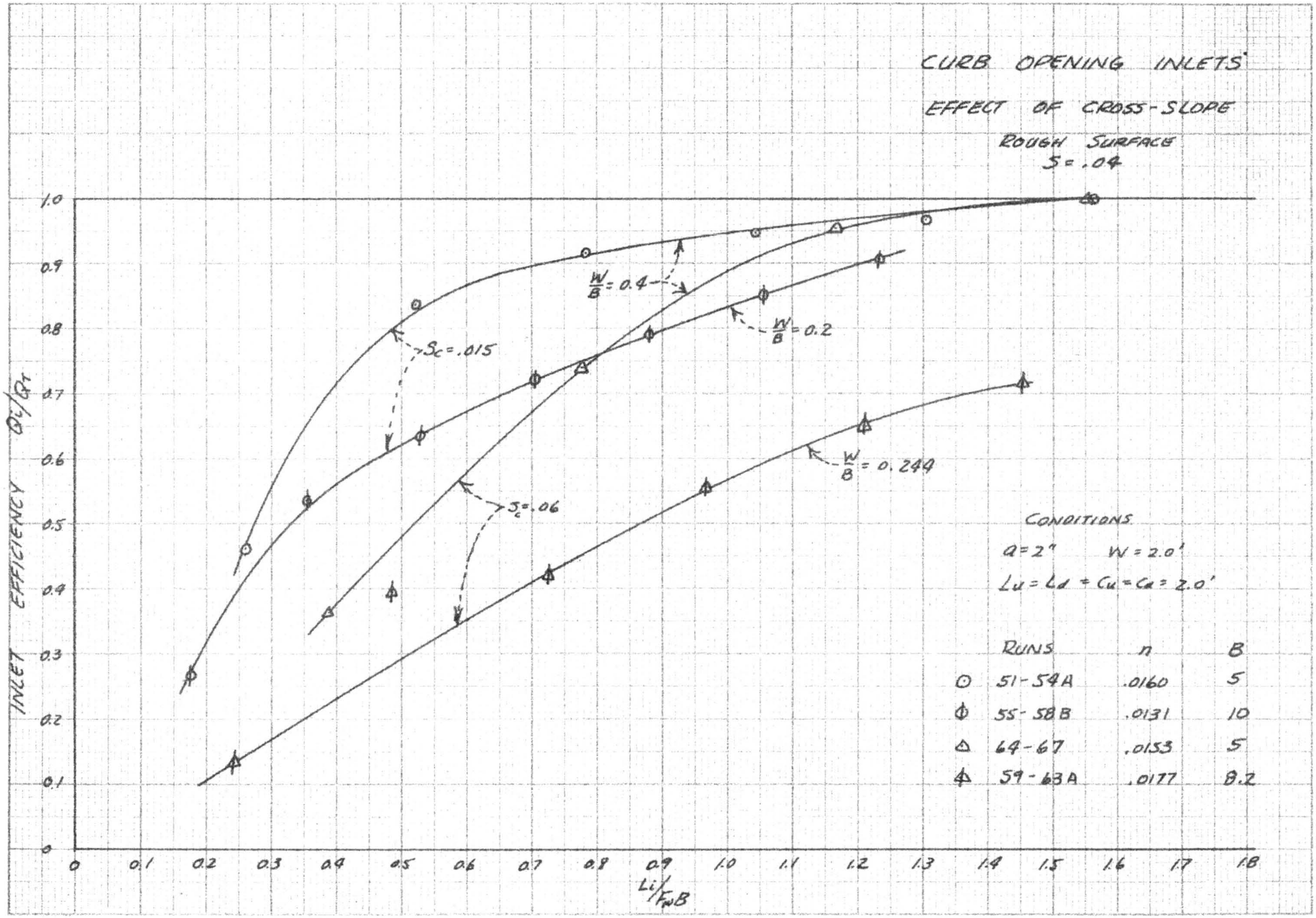


CURB OPENING INLETS

EFFECT OF CROSS-SLOPE

SMOOTH SURFACE
S = .04

FIG 19


CURB OPENING INLETS

EFFECT OF CROSS-SLOPE

ROUGH SURFACE

S = .04

FIG 20

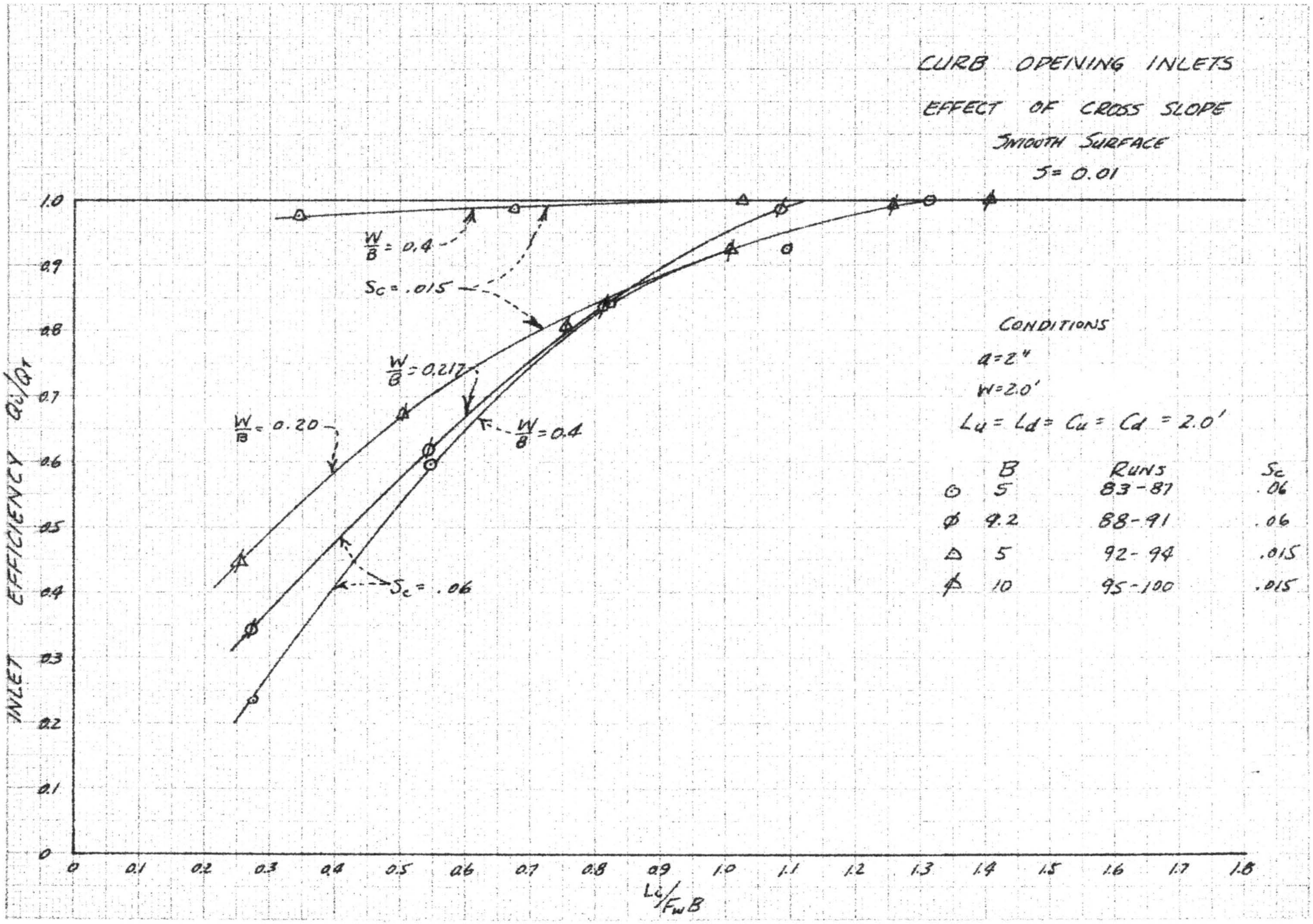

CURB OPENING INLETS
EFFECT OF CROSS SLOPE
SMOOTH SURFACE
S = 0.01
CONDITIONS
a = 2"
W = 2.0'
Lu = Ld = Cu = Cd = 2.0'
B
RUNS
Sc
5
83-87
.06
4.2
88-91
.06
5
92-94
.015
10
95-100
.015
W/B = 0.4
Sc = .015
W/B = 0.217
W/B = 0.20
W/B = 0.4
Sc = .06
INLET EFFICIENCY Qi/QT
Li/FwB
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2
1.3
1.4
1.5
1.6
1.7
1.8

FIG 21

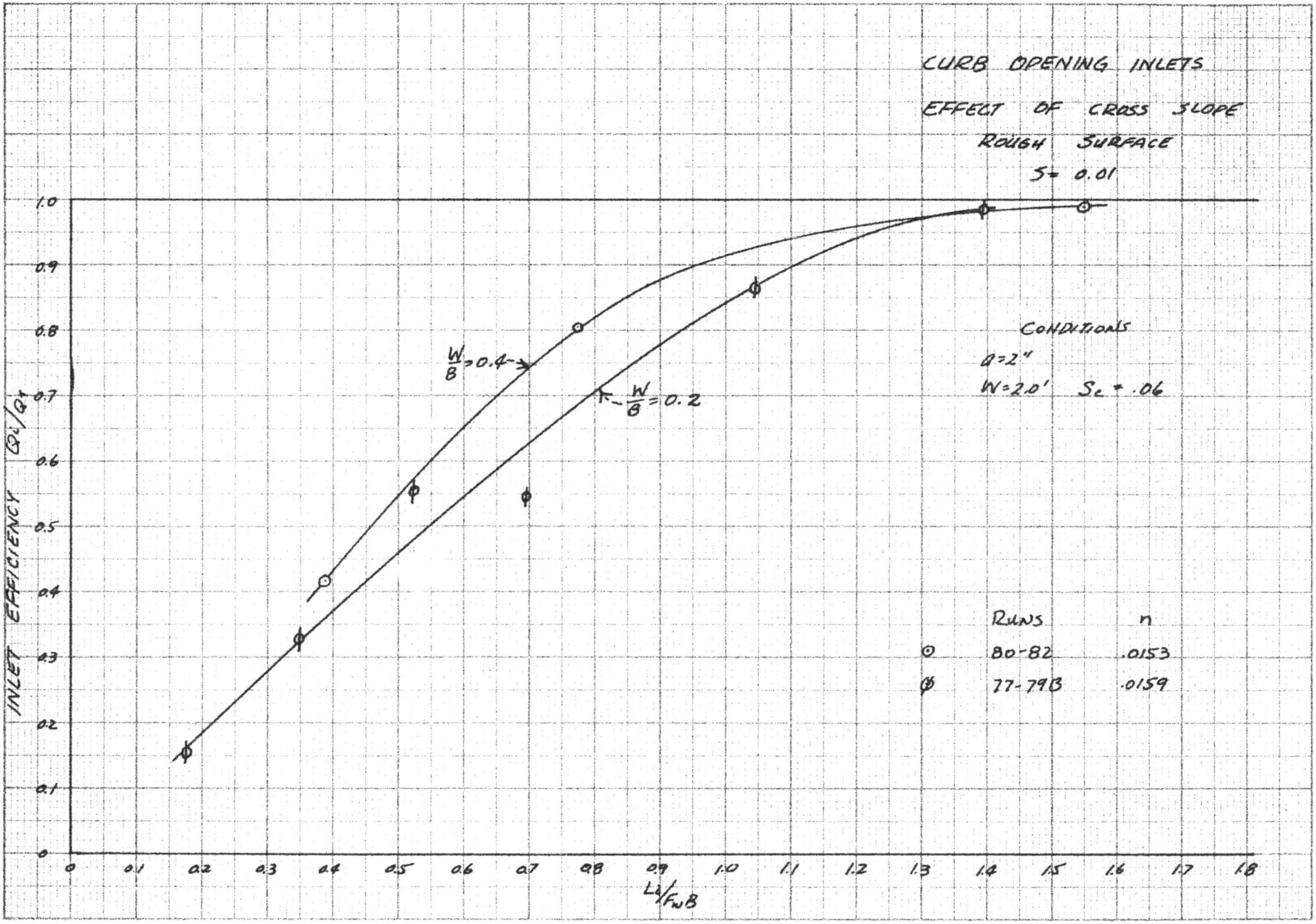

CURB OPENING INLETS
EFFECT OF CROSS SLOPE
ROUGH SURFACE
S= 0.01
CONDITIONS
a=2"
W=2.0' Sc = .06
W/B=0.4
W/B=0.2
RUNS n
⊙ 80-82 .0153
ϕ 77-79B .0159
INLET EFFICIENCY Qi/QT
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0 1.1 1.2 1.3 1.4 1.5 1.6 1.7 1.8
Li/FwB

FIG 22

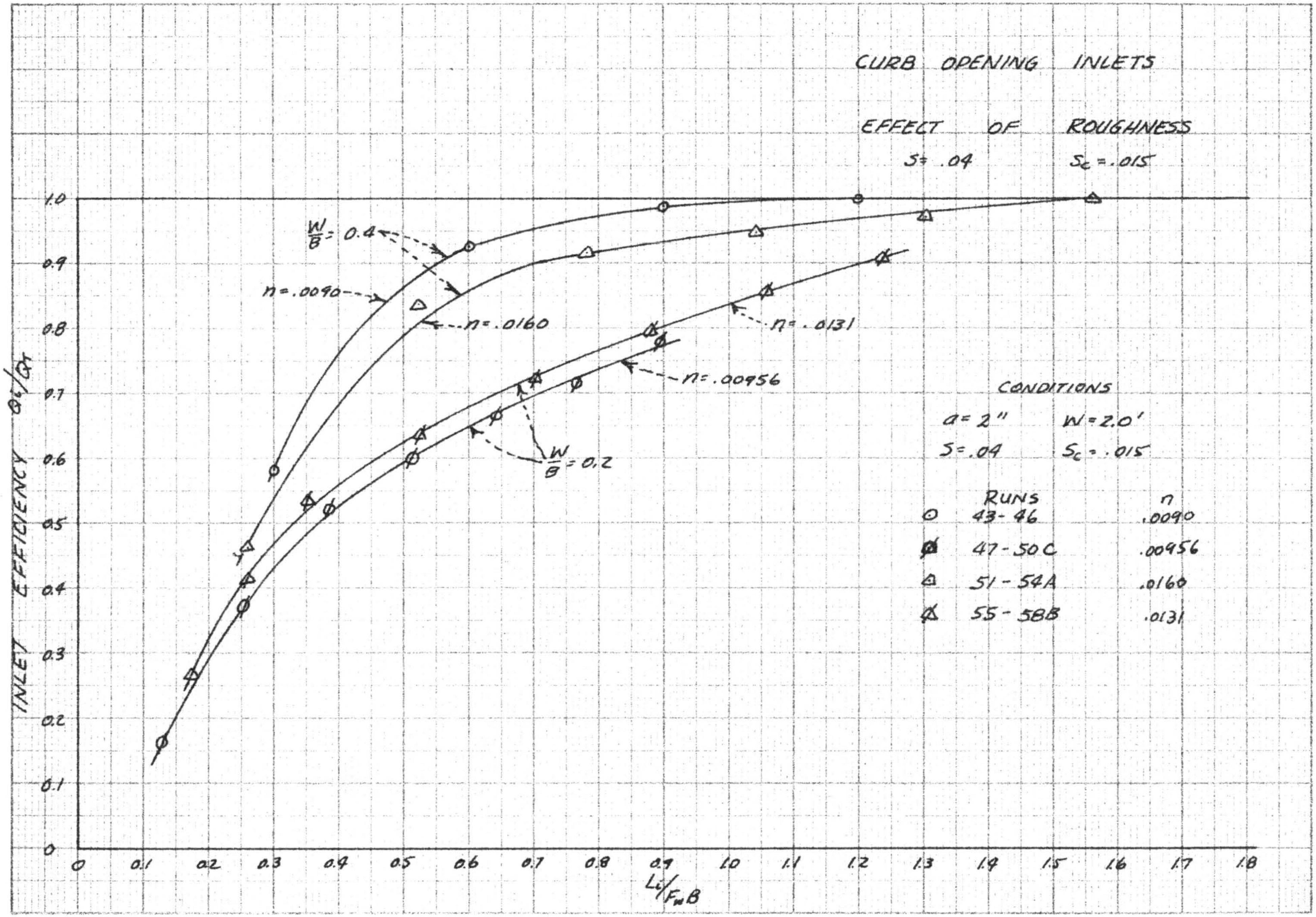

CURB OPENING INLETS
EFFECT OF ROUGHNESS
S = .04
S_c = .015
INLET EFFICIENCY Q_i/Q_T
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2
1.3
1.4
1.5
1.6
1.7
1.8
$L_i/F_w B$
$\frac{W}{B}$ = 0.4
n = .0090
n = .0160
n = .0131
n = .00956
$\frac{W}{B}$ = 0.2
CONDITIONS
a = 2"
W = 2.0'
S = .04
S_c = .015
RUNS
n
43-46
.0090
47-50C
.00956
51-54A
.0160
55-58B
.0131

FIG 23

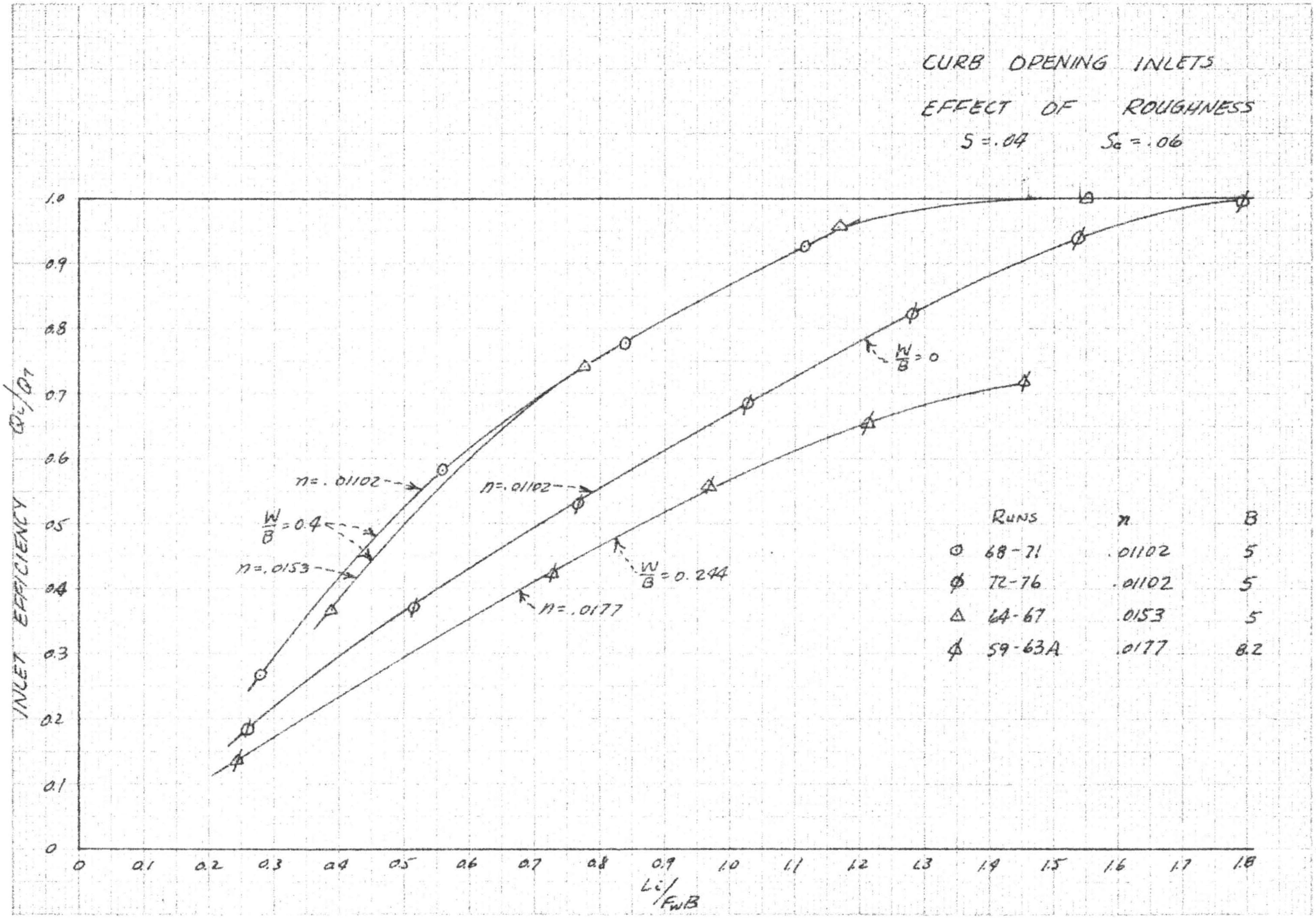

CURB OPENING INLETS
EFFECT OF ROUGHNESS
S = .04 Sc = .06
INLET EFFICIENCY Qi/QT
Li/FwB
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2
1.3
1.4
1.5
1.6
1.7
1.8
n = .01102
W/B = 0.4
n = .0153
n = .01102
W/B = 0
W/B = 0.244
n = .0177
Runs n B
⊙ 68-71 .01102 5
ϕ 72-76 .01102 5
△ 64-67 .0153 5
⏄ 59-63A .0177 8.2

Fig 24

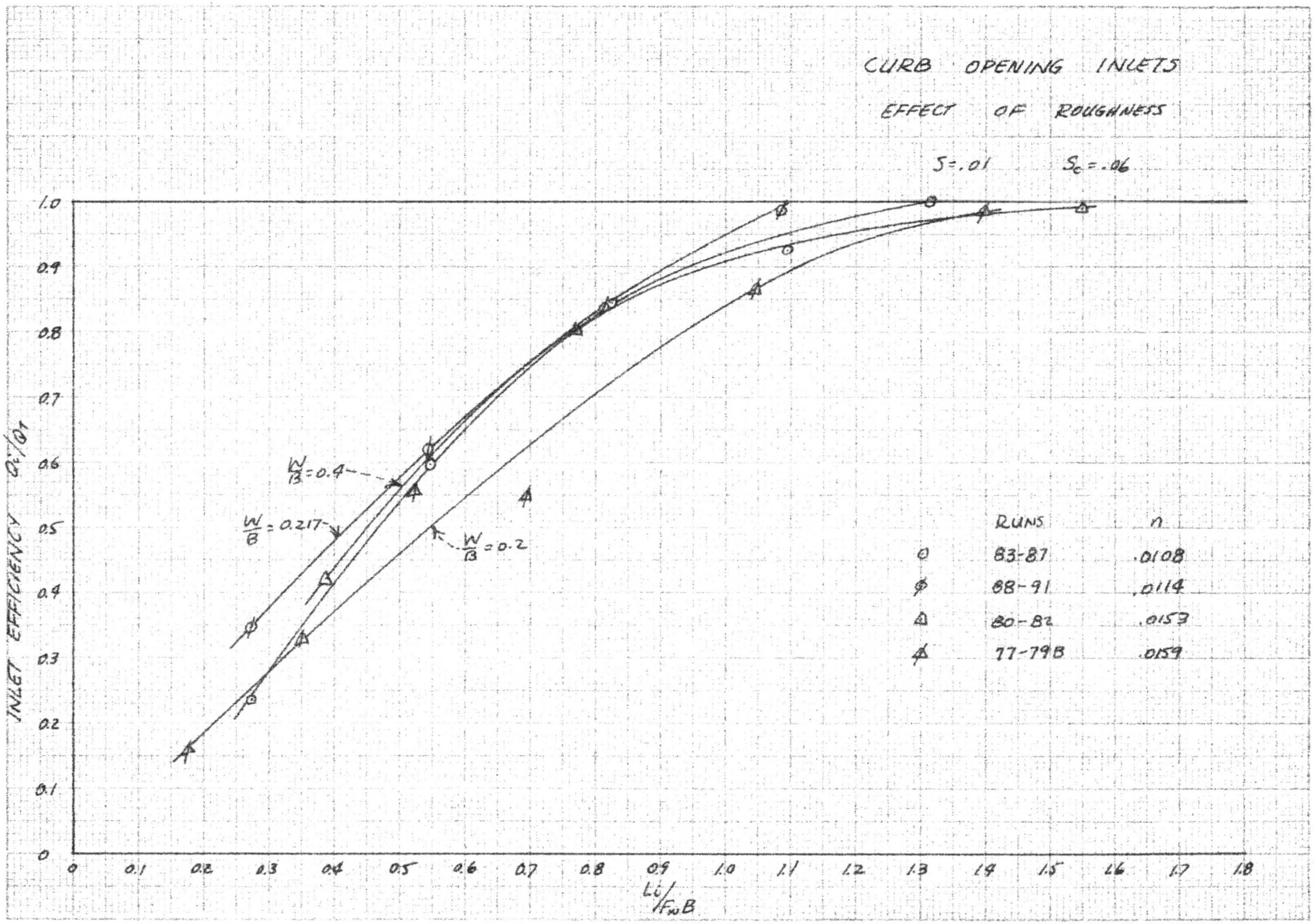

CURB OPENING INLETS
EFFECT OF ROUGHNESS
S = .01 S_c = .06
INLET EFFICIENCY Q_i/Q_T
$L_i/F_w B$
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2
1.3
1.4
1.5
1.6
1.7
1.8
$\frac{W}{B}$ = 0.4
$\frac{W}{B}$ = 0.217
$\frac{W}{B}$ = 0.2
RUNS n
83-87 .0108
88-91 .0114
80-82 .0153
77-79B .0159

FIG. 25

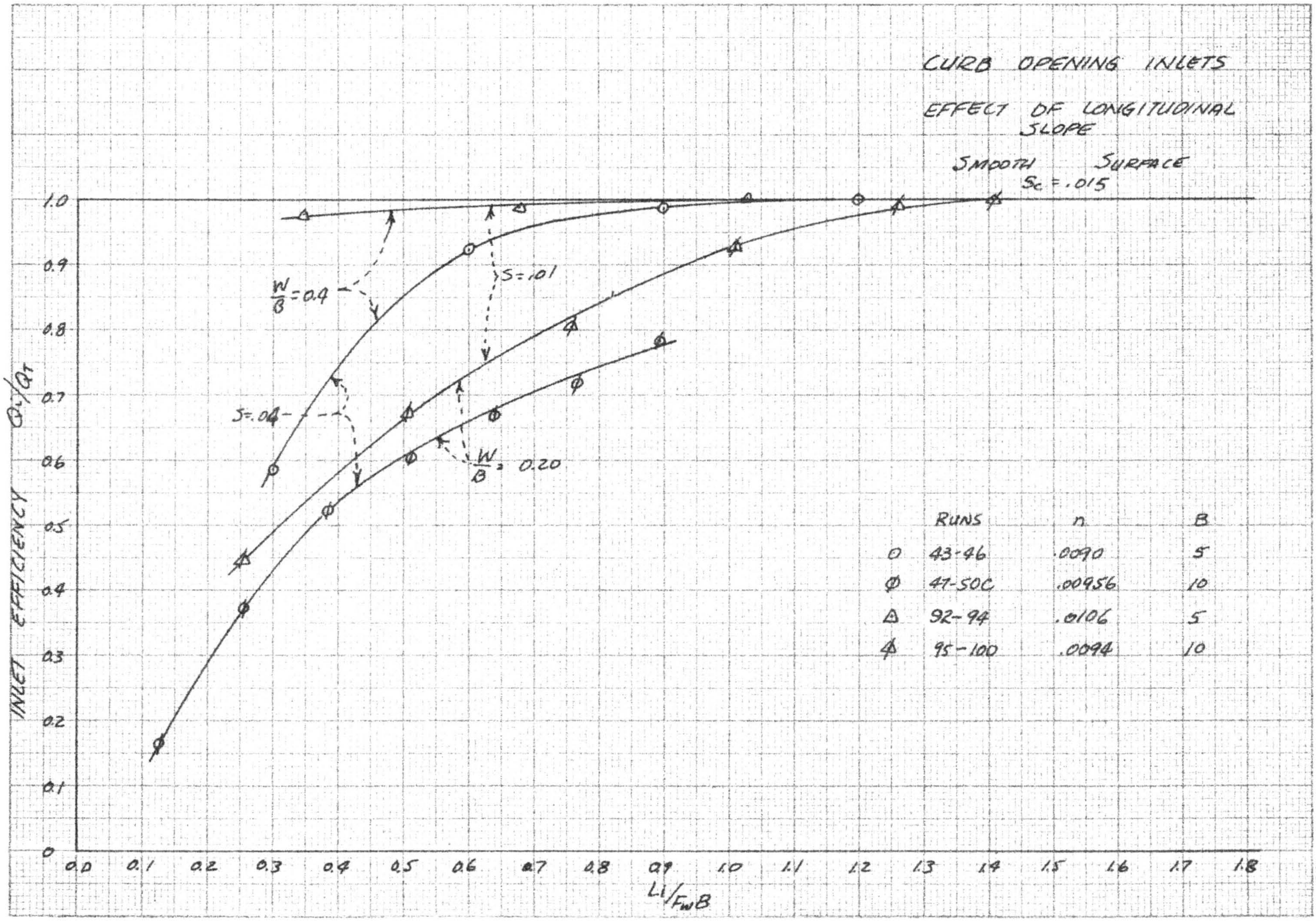
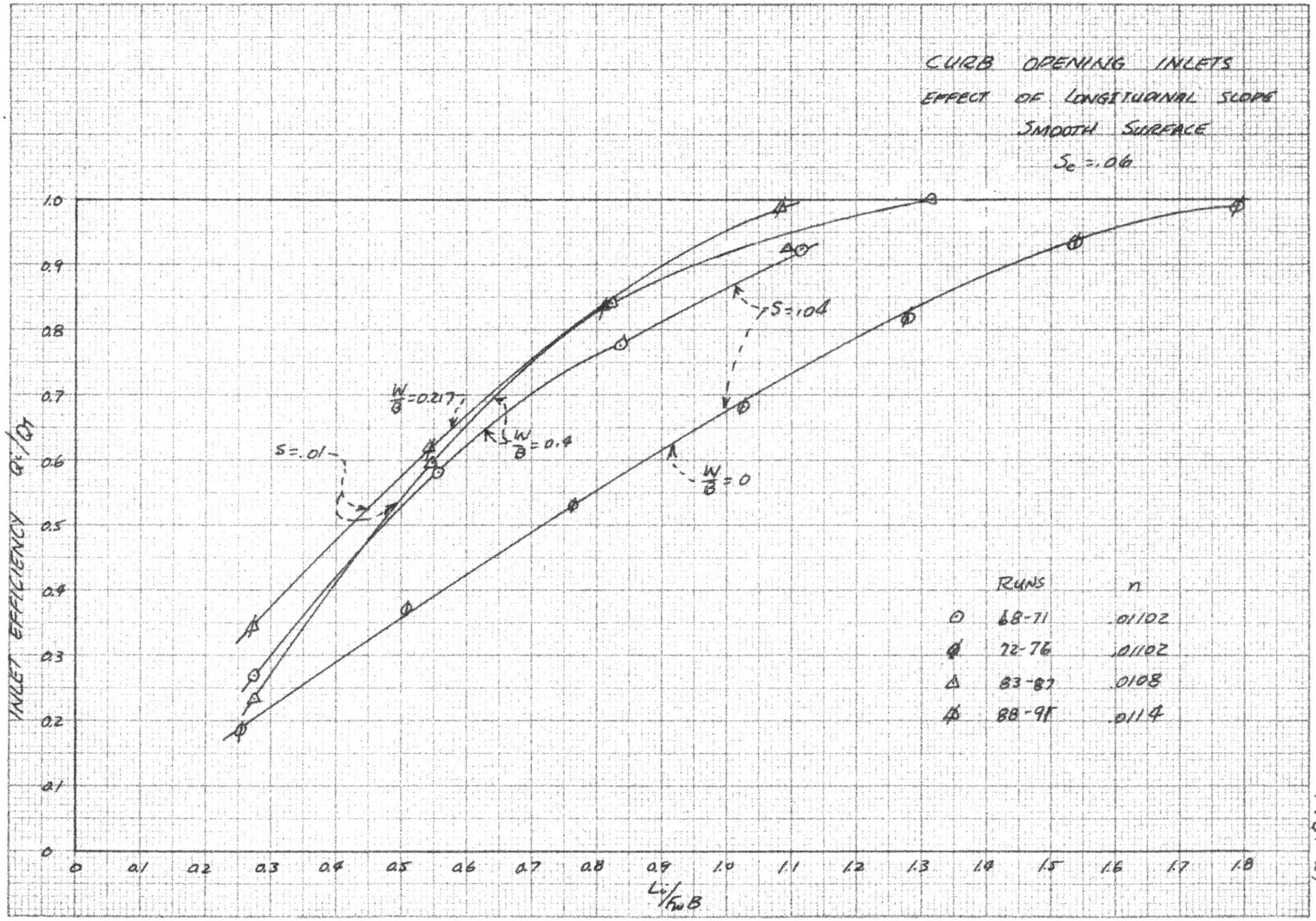

CURB OPENING INLETS
EFFECT OF LONGITUDINAL SLOPE
SMOOTH SURFACE
$S_c = .015$
INLET EFFICIENCY Q_i/Q_T
L_i/F_wB
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2
1.3
1.4
1.5
1.6
1.7
1.8
$\frac{W}{B} = 0.4$
S = .01
S = .04
$\frac{W}{B} = 0.20$
RUNS n B
○ 43-46 .0090 5
ϕ 41-50C .00956 10
△ 92-94 .0106 5
△ 95-100 .0094 10

FIG 26



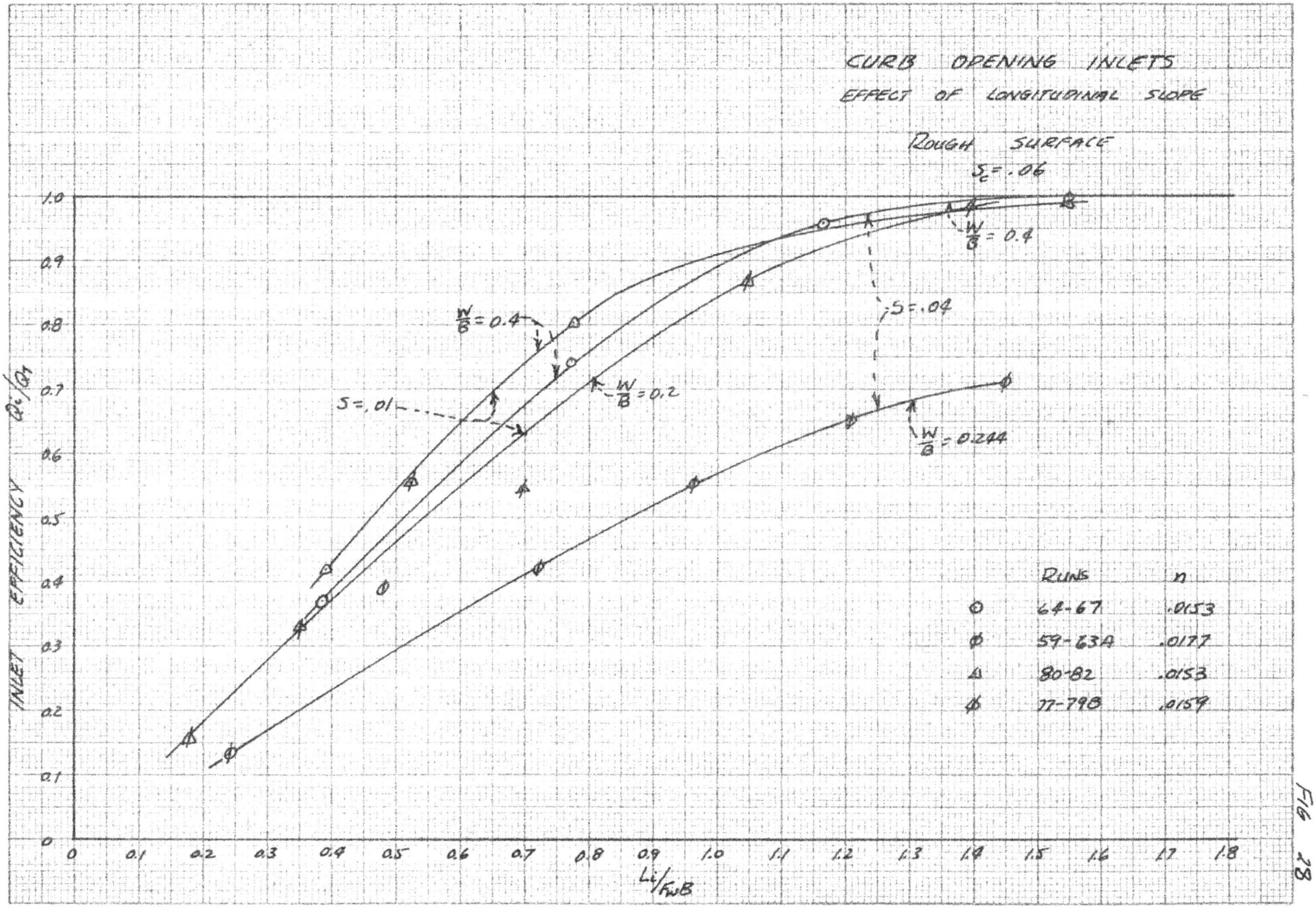

CURB OPENING INLETS
EFFECT OF LONGITUDINAL SLOPE
ROUGH SURFACE
$S_c = .06$
$\frac{W}{B} = 0.4$
$S = .04$
$\frac{W}{B} = 0.4$
$\frac{W}{B} = 0.2$
$S = .01$
$\frac{W}{B} = 0.244$
INLET EFFICIENCY Q_i/Q_T
$L_i/F_W B$
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2
1.3
1.4
1.5
1.6
1.7
1.8
RUNS n
⊙ 64-67 .0153
ϕ 59-63A .0177
△ 80-82 .0153
ϕ 77-79B .0159

FIG 28

SUMMARY

This report presents the results of laboratory experiments to determine the efficiency of depressed curb opening inlets on pavements with supercritical slopes. The program of experimental runs is presented in Figs. 5 and 6 ; the data are given in Tables 1 and 2 and the results are shown in several graphs of Q_i / Q_T vs. $L_i / F_w B$. It is not within the scope of this report to present a complete analysis of the data nor to draw conclusions from the results. A more complete discussion of the experimental results including some theoretical background is expected in a report by Dr. W. J. Bauer which will be a part of the total study.

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TABLE NO. 1.

TABLE 1: Experimental Data

Run	Independent Variables											Dependent Variables						V and d	Movie
	L_d	C_d	L_u	C_u	a	W	n	S	B	S_c	L_i	Q	Q_i	F_w	$\frac{W}{B}$	Q_i/Q	L_i/F_wB		
1	0	0	0	0	2	2	.00931	.04	5	.015	5	.784	.485	3.34	0.4	.619	.300	X	X
2	2	0	0	0								.784	.332			.423			X
3	2	2	0	0								.784	.357			.455			X
4	0	2	0	0								.789	.440			.558			X
5	0	0	2	0								.785	.385			.490			X
6	0	0	2	2								.792	.600			.757			X
7	0	0	0	0							10	.792	.705	3.34		.890	.600		
8	2	0	0	0								.792	.695			.878			
9	2	2	0	0								.792	.715			.903			
10	0	2	0	0								.792	.725			.915			
11	0	0	2	0								.792	.700			.884			
12	0	0	2	2								.784	.740			.944			
13	0	0	0	0							15	.792	.755	3.34		.953	.900		
14	2	0	0	0								.792	.752			.949			
15	2	2	0	0								.792	.770			.972			
16	0	2	0	0								.786	.770			.980			
17	0	0	2	0								.792	.755			.953			
18	0	0	2	2								.792	.770			.972			
19	0	0	0	0	2	2	.00956	.04	10	.015	10	4.76	1.70	3.90	0.20	.357	.256	X	
20	2	0	0	0								4.77	1.56			.327			
21	2	2	0	0								4.74	1.61			.340			
22	0	2	0	0								4.74	1.63			.344			
23	0	0	2	0								4.76	1.58			.332			
24	0	0	2	2								4.77	1.94			.407			
25	0	0	0	0							20	4.77	2.89	3.90	0.20	.606	.513		X
26	2	0	0	0								4.76	2.82			.592			
27	2	2	0	0								4.74	2.81			.593			
28	0	2	0	0								4.76	2.81			.590			

TABLE 1 continued: Experimental Data

Run	Independent Variables											Dependent Variables						V and d	Movie
	L_d	C_d	L_u	C_u	a	W	n	S	B	S_c	L_i	Q	Q_i	F_w	$\frac{W}{B}$	Q_i/Q	$L_i/F_w B$		
29	0	0	2	0	2	2	.00956	.04	10	.015	20	4.75	2.87			.604			
30	0	0	2	2								4.75	3.00			.632			
31	0	0	0	0							30	4.77	3.44			.721	.769		
32	2	0	0	0								4.76	3.20			.672			
33	2	2	0	0								4.77	3.39			.711			
34	0	2	0	0								4.77	3.33			.698			
35	0	0	2	0								4.76	3.43			.721			
36	0	0	2	2								4.77	3.53			.740			
37	2	2	2	2	1	2	.00956	.04	10	.015	10	4.76	1.20	3.90	0.2	.252	.256		
38											15	4.77	1.79			.375	.384		
39											20	4.76	2.40			.504	.513		
39A											25	4.76	2.855			.600	.641		
39B											30	4.73	3.17			.670	.769		
39C											35	4.75	3.455			.726	.897		
40	2	2	2	2	1	1	.00931	.04	5	.015	5	.778	.332	3.63	0.2	.427	.275		
41											10	.775	.505			.652	.551		
42											15	.775	.635			.819	.827		
42A											20	.778	.693			.891	1.101		X
42B											25	.775	.757			.977	1.377		
42C											30	.775	.775			1.000	1.653		
42D											5	.775	.429	3.50	0.2	.553	.286		X
42E											10	.775	.545			.703	.571		
42F											15	.772	.655			.849	.856		
42G											20	.781	.728			.932	1.142		
42H											25	.781	.768			.984	1.429		
42I											30	.775	.775			1.000	1.715		
43	2	2	2	2	2	2	.00931	.04	5	.015	5	.775	.451	3.34	0.40	.583	.300		
44											10	.778	.722			.928	.600		
45											15	.775	.765			.988	.900		
46											20	.775	.775			1.000	1.200		

TABLE 1 continued: Experimental Data

Run	Independent Variables											Dependent Variables						V and d	Movie
	L_d	C_d	L_u	C_u	a	W	n	S	B	S_c	L_i	Q	Q_i	F_w	$\frac{W}{B}$	Q_i/Q	$L_i/F_w B$		
47	2	2	2	2	2	2	.00956	.04	10	.015	5	4.792	0.725	3.90	0.20	1.62	.128		
48											10	4.792	1.78			.371	.256		
49											15	4.786	2.501			.522	.384		
50											20	4.798	2.884			.601	.512		
50A											25	4.786	3.19			.666	.640		
50B											30	4.780	3.435			.718	.768		
50C											35	4.774	3.73			.782	.896		
51	2	2	2	2	2	2	.0160	.04	5	.015	2.5	.442	.204	1.92	0.40	.461	.260	X	
52											5.0	.442	.370			.837	.521		
53											7.5	.447	.410			.916	.782		
53A											10.0	.448	.425			.948	1.042		
54											12.5	.449	.435			.969	1.303		
54A											15.0	.443	.443			1.000	1.563		
55	2	2	2	2	2	2	.0131	.04	10	.015	5	3.43	.920	2.84	.20	.268	.176	X	
55A											10	3.44	1.84			.535	.352		
56											15	3.46	2.20	2.84	0.2	.635	.528		
57											20	3.47	2.50			.721	.704		
58											25	3.47	2.745			.791	.880		
58A											30	3.47	2.95			.851	1.056		
58B											35	3.46	3.14			.907	1.232		
59	2	2	2	2	2	2	.0177	.04	8.2	.06	5	15.9	2.08	2.52	.244	.131	.242	X	
60											10	15.8	6.21			.393	.484		
61											15	15.75	6.59			.419	.726		
62											20	15.7	8.71			.555	.968		
63											25	15.5	10.06			.649	1.210		
63A											30	15.4	11.0			.714	1.452		
64	2	2	2	2	2	2	.0153	.04	5	.06	5	4.705	1.705	2.57	0.40	.362	.389	X	
65											10	4.679	3.46			.740	.778		
66											15	4.72	4.50			.953	1.167		
67											20	4.65	4.65			1.000	1.556		

TABLE 1 continued: Experimental Data

Run	Independent Variables											Dependent Variables						V and d	Movie
	L_d	C_d	L_u	C_u	a	W	n	S	B	S_c	L_i	Q	Q_i	F_w	$\frac{W}{B}$	Q_i/Q	$L_i/F_w B$		
68	2	2	2	2	2	2	.01102	.04	5	.06	5	6.45	1.725	3.58	0.40	.267	0.279	X	
69											10	6.49	3.77			.581	.558	X	
70											15	6.48	5.03			.776	.837	X	
71											20	6.48	5.98			.923	1.116		
72	0	0	0	0	0	0	.01102	.04	5	.06	5	6.52	1.185	3.90	0	.182	.256	X	
73											10	6.48	2.40			.370	.512	X	
74											15	6.46	3.425			.530	.768	X	
74A											20	6.47	4.41			.682	1.024	X	
75											25	6.47	5.31			.821	1.280	X	
75A											30	6.47	6.06			.937	1.536		
76											35	6.47	6.45			.997	1.792		
76A	0	0	0	0	0	0	.0153	.04	5	.06	5	4.70	1.09	2.80	0	.232	.357	X	
76B											10	4.68	2.22			.474	.714		
76C											15	4.67	3.23			.692	1.071		
76D											20	4.64	4.10			.884	1.428		
76E											25	4.63	4.58			.989	1.785		
77	2	2	2	2	2	2	.01593	.01	10	.06	2.5	15.1	2.335	1.46	0.2	.155	.174	X	
78											5.0	14.8	4.86			.328	.348		
78A											7.5	14.9	8.315			.555	.522		
79											10	14.5	7.90			.545	.696		
79A											15	14.75	12.78			.865	1.044		
79B											20	14.7	14.45			.982	1.392		
80	2	2	2	2	2	2	.01525	.01	5	.06	2.5	2.35	.980	1.292	0.40	.417	.387	X	
81											5	2.35	1.89			.804	.774		
82											10	2.35	2.32			.987	1.548		
83	2	2	2	2	2	2	.0108	.01	5	.06	2.5	3.305	0.775	1.827	0.40	.234	.274	X	
84											5.0	3.32	1.98			.597	.548		
85											7.5	3.33	2.80			.841	.822		
86											10.0	3.40	3.14			.924	1.096		
87											12.0	3.40	3.40			1.000	1.315		

TABLE 1 continued: Experimental Data

Run	Independent Variables											Dependent Variables						V and d	Movie
	L_d	C_d	L_u	C_u	a	W	n	S	B	S_c	L_i	Q	Q_i	F_w	$\frac{W}{B}$	Q_i/Q	$L_i/F_w B$		
88	2	2	2	2	2	2	.0114	.01	9.2	.06	5.0	16.30	5.60	1.995	.217	.344	.222	X	
89											10.0	16.20	10.03			.619	.544		
90											15.0	16.20	13.60			.839	.816		
91											20.0	16.10	15.91			.987	1.088		
92	2	2	2	2	2	2	.0106	.01	5	.015	2.5	.340	.331	1.46	0.40	.975	.342	X	
93											5.0	.343	.338			.991	.685		
94											7.5	.343	.343			1.000	1.027		
95	2	2	2	2	2	2	.0094	.01	10	.015	5	2.48	1.105	1.985	0.2	.446	.251	X	
96											10	2.50	1.68			.672	.503	X	
97											15	2.49	2.01			.807	.754	X	
98											20	2.50	2.31			.925	1.006	X	
99											25	2.50	2.47			.991	1.257	X	
100											28	2.50	2.50			1.000	1.411	X	

TABLE NO. 2.

TABLE 2: Velocity Traverse Data

Runs	x	b	y	v	$\overline{v}$	d	q	Q_T	Q'	n
1-18 40-42I 43-46	-2.5	0.135	.074	4.13	5.46	.075	.410	.784	.804	.00931
			.059	4.96						
			.044	5.58						
			.029	6.03						
			.014	6.18						
			.003	6.16						
		1.0	.060	4.18	5.25	.063	.331			
			.045	5.09						
			.030	5.61						
			.015	5.91						
			.004	6.07						
		2.0	.042	3.56	4.17	.046	.192			
			.027	4.27						
			.012	4.74						
			.004	4.91						
		3.0	.029	3.07	3.18	.032	.102			
			.014	3.50						
			.002	3.84						
		4.0	.013	1.84	1.70	.016	.027			
			.004	2.08						
19-36 37-39C 47-50C	-2.5	0.135	.145	5.22	7.46	.148	1.102	4.774	5.001	.00947
			.130	6.54						
			.115	7.07						
			.100	7.52						
			.085	7.84						
			.070	8.04						
			.055	8.18						
			.040	8.16						
			.025	8.03						
			.0155	7.73						

TABLE 2 continued: Velocity Traverse Data

Runs	x	b	y	v	$\bar{v}$	d	q	Q_T	Q'	n
19-36	-2.5	1.0	.133	5.99	8.41	.136	1.142			
37-39C			.121	7.51						
47-50C			.106	8.04						
			.091	8.40						
			.076	8.56						
			.061	8.90						
			.046	9.13						
			.031	9.20						
			.010	8.96						
		2.0	.115	5.58	7.69	.118	.907			
			.103	6.82						
			.088	7.49						
			.073	7.85						
			.058	8.04						
			.043	8.36						
			.028	8.58						
			.020	8.58						
		3.0	.105	5.52	7.30	.108	.788			
			.090	6.60						
			.075	7.23						
			.060	7.61						
			.045	7.82						
			.030	8.04						
			.014	8.19						
		4.0	.086	5.01	6.63	.089	.590			
			.070	6.21						
			.055	6.67						
			.040	7.11						
			.025	7.38						
			.011	7.54						
		5.0	.073	4.59	5.87	.076	.446			
			.058	5.64						
			.043	6.16						
			.028	6.52						
			.014	6.73						

TABLE 2 continued: Velocity Traverse Data

Runs	x	b	y	v	$\bar{v}$	d	q	Q_T	Q'	n
19-36	-2.5	6.0	.056	4.14	5.02	.059	.296			
37-39C			.041	4.92						
47-50C			.026	5.48						
			.012	5.80						
		7.0	.044	3.57	4.04	.047	.190			
			.029	4.20						
			.015	4.68						
		8.0	.027	2.71	2.73	.030	.082			
			.015	3.11						
51-54A	-2.88	0.135	.065	1.97	2.96	.070	.207	.445	.457	.016
			.055	2.41						
			.045	2.66						
			.035	3.21						
			.025	3.50						
			.005	3.68						
			.003	3.68						
		1.0	.058	2.12	3.08	.063	.194			
			.048	2.66						
			.038	3.21						
			.028	3.50						
			.018	3.85						
			.007	4.01						
		2.0	.040	2.27	2.73	.045				
			.030	2.66						
			.020	3.11						
		2.0	.010	3.31		.045				
			.007	3.31						
		3.0	.026	1.79	2.00	.031	.062			
			.022	1.97						
			.017	2.12						
			.012	2.27						
			.006	2.41						
		4.0	.010	.80	0.84	.015	.0126			
			.006	1.14						
			.002	1.39						

TABLE 2 continued: Velocity Traverse Data

Runs	x	b	y	v	$\bar{v}$	d	q	Q_T	Q'	n
55-58B	-2.88	.0135	.137	2.98	5.08	.142	.721	3.47	3.65	.0131
			.122	4.08						
			.107	4.66						
			.092	5.00						
			.077	5.37						
			.062	5.78						
			.047	5.94						
			.032	5.99						
			.016	5.89						
		1.0	.133	2.76	5.63	.138	.777			
			.118	4.08						
			.103	5.19						
			.088	5.60						
			.073	6.05						
			.058	6.46						
			.043	6.61						
			.028	6.89						
			.014	6.89						
		2.0	.118	3.19	5.44	.123	.669			
			.103	4.45						
			.088	5.06						
			.073	5.60						
			.058	5.89						
			.043	6.15						
			.028	6.41						
			.014	6.56						
		3.0	.106	3.29	5.21	.111	.579			
			.091	4.38						
			.076	5.00						
			.061	5.43						
			.046	5.78						
			.021	5.94						
			.004	6.23						

TABLE 2 continued: Velocity Traverse Data

Runs	x	b	y	v	$\bar{v}$	d	q	Q_T	Q'	n
55-58B	-2.88	4.0	.091	2.98	4.50	.096	.432			
			.076	3.75						
			.061	4.54						
			.046	4.87						
			.021	5.19						
			.006	5.37						
			.004	5.43						
		5.0	.075	2.64	4.12	.080	.329			
			.060	3.75						
			.045	4.31						
			.030	4.66						
			.015	4.87						
		6.0	.056	3.19	3.76	.061	.229			
			.041	3.83						
			.026	4.23						
			.013	4.52						
		7.0	.039	1.76	2.27	.044	.100			
			.024	2.24						
			.014	2.76						
		8.0	.021	1.56	1.87	.026	.0505			
			.017	1.76						
			.013	1.93						
59-63	-2.8	0.135	.485	4.40	9.00	.490	4.410	15.8	15.98	.0177
			.435	7.18						
			.385	8.45						
			.335	9.36						
			.285	9.56						
			.235	9.96						
			.185	10.25						
			.135	10.09						
			.085	9.93						
			.035	9.39						
			.006	8.94						

TABLE 2 continued: Velocity Traverse Data

Runs	x	b	y	v	$\overline{v}$	d	q	Q_T	Q'	n
59-63	-2.8	1.00	.428	4.53	10.14	.433	4.391			
			.378	8.56						
			.328	9.62						
			.278	10.27						
			.228	10.79						
			.178	11.06						
			.128	11.31						
			.078	11.37						
			.024	11.26						
		2.00	.367	4.46	9.10	.372				
			.317	7.98						
			.267	8.68						
			.217	9.29						
			.167	9.76						
			.117	10.12						
			.067	10.37						
			.017	10.24						
			.011	10.08						
		3.00	.309	4.52	8.77	.314	2.754			
			.259	7.68						
			.209	8.78						
			.159	9.28						
			.109	9.92						
			.059	10.27						
			.019	9.79						
		4.00	.248	3.91	7.46	.253	1.887			
			.198	6.89						
			.148	7.77						
			.098	8.45						
			.048	8.78						
			.014	8.29						
		5.00	.186	4.17	7.06	.191	1.348			
			.136	6.90						
			.086	7.86						
			.036	8.30						
			.019	7.70						

TABLE 2 continued: Velocity Traverse Data

Runs	x	b	y	v	$\overline{v}$	d	q	Q_T	Q'	n
59-63	-2.8	6.00	.121	4.21	5.95	.126	0.750			
			.071	6.24						
			.021	6.69						
		7.00	.050	2.49	3.30	.055	0.182			
			.030	3.55						
			.008	3.90						
64-67	-2.8	0.135	.287	4.25	7.36	.292	2.149	4.68	4.88	.0153
			.257	6.12						
			.227	6.81						
			.197	7.49						
			.167	7.91						
			.137	8.23						
			.107	8.46						
			.077	8.27						
			.047	7.91						
			.035	7.74						
		1.00	.235	4.55	7.96	.240	1.910			
			.205	6.57						
			.175	7.49						
			.145	8.03						
			.115	8.46						
			.085	8.72						
			.055	9.05						
			.030	8.79						
		2.00	.177	4.69	6.97	.182	1.269			
			.147	6.01						
			.117	6.67						
			.087	7.23						
			.057	7.70						
			.029	7.83						
		3.00	.119	3.22	5.52	.124	.684			
			.089	5.14						
			.059	5.85						
			.025	6.27						
		4.00	.056	2.14	3.31	.061	.202			
			.026	3.60						
			.021	3.51						

TABLE 2 continued: Velocity Traverse Data

Runs	x	b	y	v	$\bar{v}$	d	q	Q_T	Q'	n
68 and 72	-2.1	0.135	.274	6.94	9.09	0.285	2.591	6.47	6.77	.0110
			.244	8.13						
			.214	8.67						
			.184	9.17						
			.154	9.55						
			.124	9.95						
			.094	10.14						
			.064	10.11						
			.034	9.82						
			.021	9.55						
		1.00	.231	7.68	9.96	.242	2.410			
			.201	9.24						
			.171	9.82						
			.141	10.27						
			.111	10.55						
			.081	10.82						
			.051	10.94						
			.023	11.05						
		2.00	.181	6.55	8.98	.184	1.652			
			.151	8.21						
			.121	8.93						
			.091	9.31						
			.061	9.72						
			.031	9.88						
			.023	9.88						
		3.00	.121	6.46	7.98	.124	.990			
			.091	7.77						
			.061	8.25						
			.031	8.59						
			.011	8.59						
		4.00	.057	5.31	5.60	.060	0.336			
			.027	5.71						
			.012	6.04						

TABLE 2 continued: Velocity Traverse Data

Runs	x	b	y	v	$\bar{v}$	d	q	Q_T	Q'	n
69-71	-.05	0.135	.297	6.67	9.60	.300				
			.267	8.18						
			.237	8.97						
			.207	9.50						
			.177	9.93						
			.147	10.34						
			.117	10.62						
			.087	10.71						
			.057	10.56						
			.027	10.28						
	-.05	1.0	.254	6.65	10.06	.257				
			.224	8.88						
			.194	9.88						
			.164	10.23						
			.134	10.63						
			.104	10.90						
			.074	11.11						
			.044	11.25						
			.033	11.16						
	-.05	2.00	.167	5.91	8.93	.170				
			.137	8.35						
			.107	9.23						
			.077	9.80						
			.047	9.94						
			.017	9.74						
	-.05	3.00	.117	5.52	7.56	.120				
			.087	7.37						
			.057	8.12						
			.027	8.62						
			.015	8.65						
	-.05	4.00	.057	4.04	4.84	.060				
			.027	5.52						
			.006	5.46						

TABLE 2 continued· Velocity Traverse Data

Runs	x	b	y	v	$\bar{v}$	d	q	Q_T	Q'	n
68-71	+2.0	0.198	.227	7.35	10.72	.230				
			.197	9.63						
			.167	10.43						
			.137	10.97						
			.107	11.29						
			.077	11.60						
			.047	11.82						
			.017	11.95						
			.000	11.68						
68-71	+2.0	0.917	.234	6.68	10.35	.237				
			.204	9.57						
			.174	10.32						
			.144	10.89						
			.114	11.24						
			.084	11.30						
			.053	11.16						
		1.896	.161	6.45	9.09	.164				
			.131	8.59						
			.101	9.34						
			.071	9.78						
			.041	10.14						
			.020	10.11						
		3.00	.117	5.81	7.69	.120				
			.087	7.55						
			.057	8.44						
			.027	8.84						
			.003	8.16						
		4.0	.077	4.05	4.97	.080				
			.047	5.29						
			.017	5.47						
68-71	+5.1	0.60	.181	7.81	10.74	.184				
			.151	10.30						
			.121	10.96						
			.091	11.56						
			.061	11.76						
			.053	11.84						

TABLE 2 continued: Velocity Traverse Data

Runs	x	b	y	v	$\bar{v}$	d	q	Q_T	Q'	n
68-71	+5.1	1.75	.140	6.45	9.21	.143				
			.110	8.92						
			.080	9.78						
			.050	10.23						
			.020	10.20						
		3.0	.102	5.92	7.85	.105				
			.072	7.92						
			.042	8.62						
			.026	8.91						
		4.0	.057	4.24	4.99	.060				
			.027	5.55						
			.010	5.95						
68-71	+7.4	1.4	.124	6.46	9.21	0.127				
			.094	9.11						
			.064	9.95						
			.034	10.43						
			.019	10.37						
		2.85	.091	5.88	8.01	.094				
			.061	8.13						
			.031	8.74						
			.016	8.99						
		4.0	.053	4.13	4.88	.056				
			.023	5.65						
			.001	4.36						
68-71	+9.7	0.917	.116	6.66	9.57	0.119				
			.086	9.35						
			.056	10.30						
			.026	10.91						
			.014	10.88						
		2.65	.089	5.96	8.08	.092				
			.059	8.15						
			.029	8.91						
			.015	6.77						
		3.9	.055	4.18	5.33	.058				
			.025	5.85						
			.016	6.01						

TABLE 2 continued: Velocity Traverse Data

Runs	x	b	y	v	$\bar{v}$	d	q	Q_T	Q'	n
68-71	+12.5	0.25	.095	7.60	9.60	.098				
			.065	9.89						
			.035	10.79						
			.012	10.08						
		2.4	.073	5.76	7.62	.076				
			.043	8.08						
			.020	8.51						
		3.75	.039	3.86	4.76	.042				
			.009	5.55						
			.004	5.55						
68-71	+15.0	1.75	.043	5.87	7.34	.046				
			.013	8.36						
			.004	8.24						
		3.35	.035	4.73	5.19	.038				
			.005	6.10						
			.001	6.20						
68-71	+17.5	0.35	.032	6.60	7.07	.035				
			.004	8.13						
		2.75	.039	5.25	5.69	.042				
			.007	6.51						
72-76	0	0.135	.287	6.28	9.26	.290				
			.257	8.00						
			.227	8.58						
			.197	9.16						
			.167	9.61						
			.137	10.00						
			.107	10.29						
			.073	10.26						
			.043	10.06						
			.032	10.00						
		1.0	.243	6.53	10.01	.246				
			.213	8.73						
			.183	9.67						
			.153	10.22						
			.123	10.56						
			.093	10.86						
			.063	11.13						
			.033	11.19						
			.021	11.24						

TABLE 2 continued: Velocity Traverse Data

Runs	x	b	y	v	$\overline{v}$	d	q	Q_T	Q'	n
72-76	0	2.0	.180	5.97	8.99	.183				
			.150	8.37						
			.120	9.02						
			.090	9.54						
			.060	9.87						
			.030	10.00						
			.014	10.13						
		3.0	.120	5.69	7.74	.123				
			.090	7.58						
			.060	8.23						
			.030	8.69						
			.017	8.80						
		4.0	.059	4.19	5.45	.062				
			.029	5.52						
			.015	5.91						
72-76	+ 2.5	0.1	.141	7.33	10.16	.144				
			.111	10.13						
			.081	10.81						
			.051	11.16						
			.026	11.05						
		1.0	.222	6.90	10.22	.225				
			.192	9.22						
			.162	10.15						
			.132	10.52						
			.102	10.92						
			.072	11.12						
			.042	11.29						
			.016	11.29						
		2.0	.173	6.11	9.03	.176				
			.143	8.49						
			.113	9.25						
			.083	9.53						
			.053	9.92						
			.023	10.31						
			.015	10.13						

TABLE 2 continued: Velocity Traverse Data

Runs	x	b	y	v	$\overline{v}$	d	q	Q_T	Q'	n
72-76	+2.5	3.0	.119	5.69	7.80	.122				
			.089	7.71						
			.059	8.35						
			.029	8.73						
			.011	8.77						
		4.0	.056	4.06	5.03	.059				
			.026	5.54						
			.009	5.71						
72-76	+5.0	0.9	.181	7.16	10.47	.184				
			.151	9.79						
			.121	10.58						
			.091	10.99						
			.061	11.40						
			.031	11.62						
			.023	11.68						
		2.0	.167	6.24	9.26	.170				
			.137	8.66						
			.107	9.71						
			.077	9.89						
			.047	10.17						
			.022	10.45						
		3.0	.112	5.90	7.51	.115				
			.082	7.90						
			.052	8.53						
			.022	8.97						
			.004	9.08						
		4.0	.055	4.30	5.19	.058				
			.025	5.60						
			.011	5.99						
72-76	+7.5	0.75	.149	7.48	10.64	0.152				
			.119	10.02						
			.089	10.88						
			.059	11.51						
			.036	11.71						

TABLE 2 continued: Velocity Traverse Data

Runs	x	b	y	v	$\overline{v}$	d	q	Q_T	Q'	n
72-76	+7.5	1.90	.166	6.43	9.52	0.169				
			.136	8.98						
			.106	9.77						
			.076	10.22						
			.046	10.53						
			.038	10.50						
		3.00	.116	5.76	8.08	.119				
			.086	8.01						
			.056	8.67						
			.026	9.10						
			.017	9.17						
		4.00	.057	4.28	5.39	.060				
			.027	5.87						
			.004	6.16						
72-76	+10.0	0.35	.119	7.45	10.44	.122				
			.089	10.35						
			.059	11.24						
			.030	11.66						
		1.9	.140	7.30	9.57	.143				
			.110	9.32						
			.080	9.95						
			.050	10.49						
			.031	10.61						
		3.0	.109	6.13	8.00	.112				
			.079	8.00						
			.049	8.62						
			.019	9.16						
		4.0	.057	4.43	5.55	.060				
			.027	6.09						
			.008	6.24						
72-76	+12.4	1.75	.111	6.62	9.26	.114				
			.081	9.33						
			.051	10.00						
			.021	10.53						
			.013	10.44						
		3.00	.095	6.18	7.58	.098				
			.065	8.12						
			.035	8.84						
			.025	8.98						

TABLE 2 continued: Velocity Traverse Data

Runs	x	b	y	v	$\bar{v}$	d	q	Q_T	Q'	n
72-76	+12.4	4.00	.054	4.42	5.62	.057				
			.024	6.13						
			.007	6.29						
72-76	+14.95	1.25	.101	6.69	9.41	.104				
			.071	9.47						
			.041	10.35						
			.015	10.78						
		2.85	.079	6.22	7.92	.082				
			.049	8.34						
			.019	8.97						
			.010	9.20						
		4.00	.050	4.47	5.31	.053				
			.020	5.79						
			.006	6.11						
72-76	+17.5	0.75	.088	6.61	9.20	0.091				
			.058	9.56						
			.028	10.49						
			.017	10.58						
		2.60	.071	6.09	7.64	.074				
			.041	8.20						
			.011	8.92						
			.005	8.95						
		3.90	.042	4.22	5.05	.045				
			.012	5.65						
			.003	5.82						
77-79B	-2.85	0.135	.587	1.865	5.48	.592	3.244	14.75	15.03	.0159
			.536	4.20						
			.476	5.04						
			.416	5.58						
			.356	5.81						
			.296	6.08						
			.236	6.19						
			.176	6.24						
			.116	6.08						
			.056	5.75						
			.022	5.41						

TABLE 2 continued: Velocity Traverse Data

Runs	x	b	y	v	$\bar{v}$	d	q	Q_T	Q'	n
77-79B	-2.85	1.0	.543	3.05	6.32	.548	3.463			
			.483	5.35						
			.423	5.92						
			.363	6.39						
			.303	6.83						
			.243	6.78						
			.183	6.78						
			.123	6.97						
			.063	6.88						
			.018	6.78						
		2.0	.482	3.05	5.85	.487	2.849			
			.422	4.91						
			.362	5.53						
			.302	5.86						
			.242	6.19						
			.182	6.44						
			.122	6.54						
			.062	6.64						
			.019	6.59						
		3.0	.426	3.15	5.94	.431	2.560			
			.366	5.10						
			.306	5.86						
			.246	6.19						
			.186	6.49						
			.126	6.54						
			.066	6.64						
			.027	6.64						
		4.0	.362	2.46	4.82	.367	1.769			
			.293	4.12						
			.233	4.91						
			.173	5.16						
			.113	5.35						
			.053	5.49						
			.014	5.70						

TABLE 2 continued: Velocity Traverse Data

Runs	x	b	y	v	$\bar{v}$	d	q	Q_T	Q'	n
77-79B	-2.85	5.0	.302	2.46	4.73	.307	1.452			
			.242	4.20						
			.182	4.91						
			.122	5.16						
			.062	5.41						
			.013	5.58						
		6.0	.239	2.94	4.35	.244	1.061			
			.191	4.04						
			.131	4.50						
			.091	4.84						
			.037	4.84						
		7.0	.177	1.68	3.24	.182	0.590			
			.132	3.25						
			.082	3.53						
			.032	3.71						
			.018	3.80						
		8.0	.113	1.24	2.02	.118	.238			
			.081	1.86						
			.056	2.18						
			.031	2.33						
			.017	2.46						
		9.0	.056	0.51	0.51	.061	.031			
			.037	0.51						
			.027	0.51						
			.013	0.51						
80-82	-2.85	.135	.280	0.417	3.46	.285	0.986	2.35	2 .45	.01525
			.250	2.43						
			.220	3.11						
			.190	3.45						
			.160	3.73						
			.130	4.02						
			.100	4.14						
			.070	4.17						
			.040	4.02						
			.018	3.79						

TABLE 2 continued: Velocity Traverse Data

Runs	x	b	y	v	$\bar{v}$	d	q	Q_T	Q'	n
80-82	- 2.85	1.00	.232	1.63	3.53	.237	.837			
			.202	2.63						
			.172	3.43						
			.142	3.62						
			.112	3.95						
			.082	4.02						
			.052	4.20						
			.022	4.26						
			.005	4.32						
		2.00	.174	1.91	3.31	0.179	.592			
			.144	2.84						
			.114	3.22						
			.084	3.55						
			.054	3.79						
			.024	3.95						
			.010	4.02						
		3.00	.115	1.29	2.30	.120	.276			
			.106	1.47						
			.086	2.10						
			.066	2.33						
			.046	2.53						
			.026	2.63						
			.009	2.81						
		4.00	.052	0.96	1.30	0.057	.074			
			.046	1.08						
			.036	1.27						
			.026	1.39						
			.016	1.63						
			.008	1.63						
83-87	- 2.85	0.10	.278	3.56	5.03	.282	1.418	3.32	3.48	.0108
			.249	4.61						
			.219	4.97						
			.189	5.18						
			.159	5.29						
			.129	5.40						
			.099	5.42						
			.069	5.42						
			.039	5.25						
			.023	4.92						

TABLE 2 continued: Velocity Traverse Data

Runs	x	b	y	v	$\overline{v}$	d	q	Q_T	Q'	n
83-87	-2.85	1.00	.239	4.28	5.62	.243	1.366			
			.218	4.99						
			.188	5.32						
			.158	5.62						
			.128	5.78						
			.098	5.90						
			.068	6.01						
			.038	6.11						
			.016	6.22						
		2.00	.176	4.01	5.00	.180	0.900			
			.153	4.59						
			.123	4.99						
			.093	5.16						
			.063	5.34						
			.033	5.40						
			.012	5.42						
		3.00	.111	3.50	4.28	.115	.492			
			.095	3.98						
			.065	4.39						
			.035	4.64						
			.015	4.71						
			.005	4.78						
		4.00	.057	2.66	2.89	.061	.176			
			.045	2.86						
			.035	3.01						
			.025	3.09						
			.015	3.16						
87-91	-2.88	0.135	.535	4.20	6.50	.539	3.504	16.30	16.75	.0114
			.490	5.58						
			.430	6.24						
			.370	6.54						
			.310	6.78						
			.250	6.97						
			.190	6.92						
		.135	.130	6.88						
			.070	6.78						
			.010	6.08						

TABLE 2 continued: Velocity Traverse Data

Runs	x	b	y	v	$\overline{v}$	d	q	Q_T	Q'	n
87-91	-2.88	1.00	.496	4.77	7.00	.500	3.50			
			.442	6.29						
			.392	7.01						
			.332	7.20						
			.272	7.37						
			.212	7.46						
			.152	7.42						
			.092	7.37						
			.032	7.37						
			.017	7.15						
		2.00	.435	4.71	6.73	.439	2.954			
			.391	5.86						
			.331	6.49						
			.271	6.78						
			.211	7.01						
		2.00	.151	7.24						
			.091	7.28						
			.031	7.24						
			.018	7.20						
		3.00	.377	4.50	6.73	.381	2.564			
			.341	5.81						
			.281	6.54						
			.221	6.83						
			.161	7.06						
			.101	7.28						
			.041	7.42						
			.020	7.42						
		4.00	.316	4.04	5.75	.320	1.840			
			.291	4.91						
			.231	5.53						
			.171	5.81						
			.111	6.13						
			.051	6.39						
		4.00	.031	6.44						
			.017	6.44						
		5.00	.255	3.88	5.47	.259	.142			
			.211	4.97						
			.161	5.53						
			.111	5.81						
			.061	5.92						
			.015	6.08						

TABLE 2 continued: Velocity Traverse Data

Runs	x	b	y	v	$\bar{v}$	d	q	Q_T	Q'	n
87-91	-2.88	6.00	.193	3.62	4.97	.197	.980			
			.163	4.42						
			.133	4.91						
			.103	5.23						
			.073	5.35						
			.043	5.47						
			.018	5.53						
		7.00	.123	3.05	4.06	.127	.516			
			.084	4.04						
			.064	4.20						
			.044	4.50						
			.024	4.57						
			.019	4.57						
		8.00	.061	1.86	2.33	.065	.151			
			.051	2.03						
			.041	2.33						
			.031	2.46						
			.021	2.59						
92-94	-2.85	.01	.065	1.71	2.21	.068	.150	.345	.351	.0106
			.058	1.89						
			.053	2.11						
			.043	2.23						
			.033	2.38						
			.023	2.38						
			.006	2.41						
		1.00	.051	1.75	2.17	.051	.117			
			.044	1.89						
			.034	2.18						
		1.00	.024	2.30						
			.014	2.41						
			.004	2.48						
		2.00	.042	1.55	1.71	.042	.077			
			.035	1.60						
			.025	1.75						
			.015	1.80						
			.008	1.89						
		3.00	.028	1.09	1.16	.031	.036			
			.017	1.17						
			.007	1.31						

TABLE 2 continued: Velocity Traverse Data

Runs	x	b	y	v	$\bar{v}$	d	q	Q_T	Q'	n
95-100	-2.85	0.10	.141	2.32	3.21	.144	.462	2.49	2.545	.0094
			.130	2.63						
			.115	2.96						
			.100	3.26						
			.085	3.39						
			.070	3.51						
			.055	3.58						
			.040	3.58						
			.025	3.48						
			.010	3.26						
		1.00	.128	2.89	3.92	.131	.514			
			.115	3.34						
			.100	3.70						
			.085	3.88						
			.070	4.03						
			.055	4.11						
			.040	4.21						
			.025	4.33						
			.015	4.39						
			.003	4.39						
		2.00	.116	2.93	3.86	.119	.459			
			.105	3.24						
			.090	3.58						
			.075	3.84						
			.060	4.03						
			.045	4.13						
			.030	4.25						
			.015	4.35						
			.005	4.37						
		3.00	.103	2.69	3.73	.106	.395			
			.088	3.34						
			.073	3.60						
			.058	3.86						
			.043	4.01						
			.028	4.15						
			.013	4.17						
			.004	4.25						

TABLE 2 continued: Velocity Traverse Data

Runs	x	b	y	v	$\bar{v}$	d	q	Q_T	Q'	n
95-100	-2.85	4.00	.088	2.42	3.36	.091	.306			
			.075	3.02						
			.060	3.34						
			.045	3.51						
			.030	3.65						
			.015	3.79						
			.005	3.81						
		5.00	.068	2.40	3.12	.071	0.222			
			.053	2.94						
			.038	3.27						
			.023	3.42						
			.008	3.56						
			.002	3.54						
		6.00	.054	2.14	2.66	.057	.152			
			.042	2.46						
			.027	2.85						
			.012	3.05						
			.003	3.11						
		7.00	.037	1.69	2.03	.040	.081			
			.029	1.88						
			.019	2.09						
			.009	2.25						
			.004	3.36						
		8.00	.021	0.99	1.18	.024	.028			
			.014	1.72						
			.004	1.41						
95-100	0	0.1	.123	3.20	4.23	.127				
			.111	3.56						
			.096	4.20						
			.081	4.63						
			.066	4.70						
			.051	4.86						
			.036	4.93						
			.021	4.91						
			.008	4.75						

TABLE 2 continued: Velocity Traverse Data

Runs	x	b	y	v	$\bar{v}$	d	q	Q_T	Q'	n
95-100	0	1	.141	2.99	4.23	.145				
			.128	3.52						
			.113	3.91						
			.098	4.16						
			.083	4.33						
			.068	4.46						
			.053	4.56						
			.038	4.69						
			.023	4.79						
			.009	4.83						
		2	.084	3.29	4.26	.088				
			.069	4.05						
			.054	4.34						
			.039	4.55						
			.024	4.70						
			.009	4.79						
		3	.099	2.97	3.81	.103				
			.083	3.54						
			.068	3.76						
			.058	3.92						
			.048	4.02						
			.033	4.19						
			.007	4.32						
		4	.084	2.73	3.45	.088				
			.072	3.08						
			.057	3.45						
			.042	3.62						
			.027	3.79						
			.012	3.87						
			0.0	3.95						
		5	.068	2.33	3.06	.072				
			.052	2.95						
			.037	3.23						
			.022	3.38						
			.009	3.52						
		6	.054	2.03	2.41	.058				
			.043	2.33						
			.028	2.53						
			.014	2.82						

TABLE 2 continued: Velocity Traverse Data

Runs	x	b	y	v	$\bar{v}$	d	q	Q_T	Q'	n
95-100	0	7	.039	1.73						
			.028	1.96						
			.018	2.24						
			.010	2.28						
		8	.024	0.67	0.80	0.028				
			.019	0.78						
			.014	0.89						
			.009	0.98						
95-100	3	1.0	.082	3.55	4.78	0.086				
			.071	4.37						
			.056	4.70						
			.041	5.08						
			.026	5.28						
			.011	5.37						
		2.52	.068	3.08	4.11	0.072				
			.055	3.87						
			.040	4.25						
			.025	4.52						
			.010	4.69						
			0.0	4.77						
		3.75	.077	2.81	3.66	0.081				
			.062	3.44						
			.047	3.77						
			.032	4.02						
	3	3.75	.017	4.16						
			.007	4.18						
		5.0	.070	2.50	3.11	0.074				
			.059	2.86						
			.044	3.17						
			.029	3.37						
			.014	3.55						
			0.0	3.60						
		6.0	.055	2.01	2.40	0.059				
			.040	2.33						
			.025	2.60						
			.010	2.77						
			.004	2.83						

TABLE 2 continued: Velocity Traverse Data

Runs	x	b	y	v	$\bar{v}$	d	q	Q_T	Q'	n
95-100	3	7.0	.034	1.16	1.32	0.038				
			.025	1.30						
			.015	1.48						
			.003	1.59						
95-100	6	1.6	.035	3.34	4.14	0.039				
			.024	4.27						
			.009	4.86						
		3.18	.060	2.83	3.65	0.064				
			.051	3.41						
			.041	3.72						
			.026	4.07						
			.011	4.22						
			0.0	4.22						
		4.8	.059	2.52	3.20	0.063				
			.046	3.07						
			.036	3.26						
			.026	3.49						
			.016	3.63						
			0.0	3.70						
		6.0	.040	2.16	2.30	0.044				
			.030	2.46						
			.020	2.72						
		6.0	.010	2.86	2.30	0.044				
			0.0	2.93						
		7.0	.028	1.39	1.64	0.032				
			.022	1.77						
			.012	2.08						
			.002	2.20						
95-100	9	2.48	.046	2.94	3.53	0.050				
			.037	3.50						
			.027	3.71						
			.017	3.96						
			.002	4.10						
		4.34	.044	2.47	3.07	0.048				
			.035	2.88						
			.025	3.27						
			.015	3.53						
			.007	3.62						

TABLE 2 continued: Velocity Traverse Data

Runs	x	b	y	v	$\bar{v}$	d	q	Q_T	Q'	n
95-100	9	5.9	.039	1.93	2.32	0.043				
			.035	1.97						
			.030	2.18						
			.025	2.44						
			.015	2.64						
			.008	2.74						
		7.0	.029	1.71	1.81	0.033				
			.022	1.72						
			.017	2.00						
			.012	2.04						
			.004	2.12						
95-100	12	2.14	.035	2.67	3.10	0.039				
			.022	3.22						
			.012	3.55						
			.002	3.78						
		3.8	.045	2.32	2.86	0.049				
			.039	2.61						
			.029	2.98						
			.019	3.22						
			.005	3.35						
		5.5	.037	1.98	2.24	0.041				
			.027	2.22						
			.017	2.44						
			.007	2.62						
			0.0	2.68						
95-100	15	3.13	.037	2.18	2.59	0.041				
			.031	2.40						
			.021	2.74						
			.011	3.00						
			.002	3.09						
		4.55	.043	2.04	2.54	0.047				
			.037	2.28						
			.027	2.59						
			.017	2.72						
			.012	2.72						
		6.0	.028	1.49	1.63	0.032				
			.021	1.65						
			.011	1.89						
			.006	1.85						