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Office of Transportation Laboratory

Performance Evaluation of Coastal Gabion Installations (Interim Report)

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16. ABSTRACT

This interim report describes the installation, evaluation techniques and provides limited results for two types of coastal installations of gabions. Gabions are flexible wire mesh baskets for encapsulating rocks which protect erodible slopes. They are normally interconnected to form monolithic structures. Their tensile characteristics allow them to experience differential movements while maintaining structural integrity. Caltrans used them to construct two retaining walls and as underlayment for two installations of 6-ton rock slope protection.

All installations are in a coastal environment. Their stability and resistance to corrosion are being monitored as is their overall effectiveness. Monitoring is planned to stop in 1993 with the preparation of a final report.

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CONVERSION FACTORS

English to Metric System (SI) of Measurement

Quanity	English unit	Multiply by	To get metric equivalent
Length	inches (in)or(")	25.40	millimetres (mm)
		.02540	metres (m)
	feet (ft)or(')	.3048	metres (m)
	miles (mi)	1.609	kilometres (km)
Area	square inches (in^2)	6.432×10^{-4}	square metres (m^2)
	square feet (ft^2)	.09290	square metres (m^2)
	acres	.4047	hectares (ha)
Volume	gallons (gal)	3.785	litres (l)
	cubic feet (ft^3)	.02832	cubic metres (m^3)
	cubic yards (yd^3)	.7646	cubic metres (m^3)
Volume/Time (Flow)	cubic feet per second (ft^3/s)	28.317	litres per second (l/s)
	gallons per minute (gal/min)	.06309	litres per second (l/s)
Mass	pounds (lb)	.4536	kilograms (kg)
Velocity	miles per hour(mph)	.4470	metres per second (m/s)
	feet per second(fps)	.3048	metres per second (m/s)
Acceleration	feet per second squared (ft/s^2)	.3048	metres per second squared (m/s^2)
	acceleration due to force of gravity(G)	9.807	metres per second squared (m/s^2)
Weight Density	pounds per cubic (lb/ft^3)	16.02	kilograms per cubic metre (kg/m^2)
Force	pounds (lbs)	4.448	newtons(N)
	kips (1000 lbs)	4.448	newtons (N)
Thermal Energy	British thermal unit (BTU)	1055	joules (J)
Mechanical Energy	foot-pounds(ft-lb)	1.356	joules (J)
	foot-kips (ft-k)	1.356	joules (J)
Bending Moment or Torque	inch-pounds(ft-lbs)	.1130	newton-metres (Nm)
	foot-pounds(ft-lbs)	1.356	newton-metres (Nm)
Pressure	pounds per square inch (psi)	6895	pascals (Pa)
	pounds per square foot (psf)	47.88	pascals (Pa)
Stress Intensity	kips per square inch square root inch (ksi $\sqrt{in}$)	1.0988	mega pascals $\sqrt{metre}$ (MPa $\sqrt{m}$)
	pounds per square inch square root inch (psi $\sqrt{in}$)	1.0988	kilo pascals $\sqrt{metre}$ (KPa $\sqrt{m}$)
Plane Angle	degrees (°)	0.0175	radians (rad)
Temperature	degrees fahrenheit (F)	$\frac{tF - 32}{1.8} = tC$	degrees celsius (°C)

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NOTICE

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Neither the State of California nor the United States Government endorse products or manufacturers. Trade or manufacturers' names appear herein only because they are considered essential to the object of this document.

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INTRODUCTION

This project is documenting the performance of two types of application for gabions in a coastal environment. Gabions are mesh baskets for encapsulating rock which protect erodible slopes. They are normally interconnected to form monolithic structures. This interim report provides the details of the evaluation techniques and a limited evaluation of the installations. The evaluation is limited by the short time of data collection; it will be updated when the monitoring is completed in 1993.

The two types of gabion installation investigated are: 1) a surcharged retaining wall system, and 2) as the underlayment for large size rock slope protection, (RSP). The retaining wall is an alternative to large size RSP. Its application would be particularly advantageous in locations where large stones are not readily available. The underlayment using gabion mattresses is being considered where insufficient room exists for proper installation of multiple layers of RSP.

Two wall sites and two underlayment sites are being monitored pictorially and topographically for their ability to protect the erodible back slope. All are exposed to the open ocean. They were constructed under contract using standard gabion installation techniques. Additionally, panels of gabion fabric were affixed to the face of the two walls to provide some comparative evaluations of gabion susceptibility to corrosion in a coastal environment. Additional comparative corrosion investigation is being pursued in a separate project, F87TL34, scheduled for completion in 1991.

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This project was initiated because coastal shoreline erosion is difficult to minimize in areas where stone for RSP is not readily available or where adequate room for proper installation of RSP is unavailable. Historically, a concrete seawall would be the normal alternative used. Concrete sea walls are rigid structures. Their inflexibility makes them especially subject to scour, the washing away of foundation material. And, when foundation support is removed by this scour, they begin to crack, permitting excessive water infiltration and possible failure due to lack of support. This type of failure to protect the back slope and have the wall itself degenerate is illustrated by the poor performance of the rigid concrete seawall at Rocky Creek along Highway 1, in Monterey County, California.

In some locations, even though RSP is readily available, it cannot be used. Where insufficient room exists between the shoreline and adjacent constructed facilities for placing the multiple layers of RSP required to protect the exposed soils, a rigid seawall has been used. The walls, however, do not provide the same degree of protections as the flexible systems, and, in many cases cost substantially more to construct.

Although gabions have a long history of performance as retaining walls and in inland shore protection, we do not have documented performance records for coastal installations along California. Thus, this project was initiated to monitor four recent installations within California's coastal region.

CONCLUSIONS

Based upon the limited observation time, it is too soon to draw firm conclusions. At this time, the limited exposure has not sufficiently degraded the installations to establish failure.

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Some data and photo comparisons in figures C13 & C14 (Appendix C) indicate substantial large rock movement in the mattress installations. Topographic data indicate minor movement, but none of the points happened to be located in areas of major movement.

o Topographic data show no movements in the wall installations.

o Wire data suggest that coatings damaged during construction would indeed be more susceptible to corrosion than undamaged wire. Much of the contract installed wire was damaged.

o There is substantial scatter to the 2 wire weight and strength values. The data show many wires that appear stronger with exposure. Thus no real conclusions can be drawn from this limited time study. They will have to be drawn in the final report in the spring of 1993.

RECOMMENDATIONS

Because of the short monitoring time the primary recommendations concern the completion of the research. Monitoring should continue as planned with additional topographic and wire evaluations. Near future applications should be limited and monitored since no real conclusions have been determined. Great care should be used in construction to minimize damage to the coatings.

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EXPERIMENTAL PROCEDURE

Performance monitoring of metal wire gabions at four separate sites near Villa Creek, south of Big Sur, in Monterey County, California was begun in October/November 1986. Gabion test panels were wired to the face of two separate gabion walls. The test panels permitted destructive strength testing of wires exposed to the corrosive environment of the open ocean. Topographic surveying control points were established to evaluate horizontal and vertical movement of the walls. Photographic documentation of both the baskets and rocks within them was established at both walls as well as at two sites where six ton RSP was installed over gabion mattresses.

All installations are along Highway 1 near Post Mile 8 in Monterey County (Figure 1). Construction of the walls and installation of the large RSP was completed early in 1985. The test documentation process was initiated after construction was completed and before the stormy season.

Panel Installation

Test panels for evaluation of the strength reduction were standard gabion diaphragms. The wire configuration is illustrated in Figures 2 through 6. They were provided by the same supplier as used in the construction contract. They are a twisted metal wire mesh fabric (Figure 2). Both the standard galvanized, 11 gage wire, and the pvc coated, 12 gage wire, panels were installed. Panels were affixed to the front face of the two walls (Figure 2). Panels were wired to the existing wall faces in the same manner as normally used to construct gabions. The contract specifications are in Appendix A. Ten galvanized and 36 pvc coated panels were installed (Figures 3 and 4).

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The galvanized panels were installed as received. The wires of the pvc coated panels were damaged in a random/systematic manner. That is, pvc coated wire pairs were randomly selected for strength testing with three systematic coating damage conditions. On each panel one row of wires was and will be evaluated as received, one row of wires has longitudinal cuts in the pvc to represent cracking of the coating, and one row of wires has blazes to represent rock abrasion of the pvc coating. Rows of ordered pairs of wires have to be used for all sampling because of the normal scatter associated with the strength of wires used to fabricate gabions. This is readily observed in Appendix B by looking at the scatter of wire strengths for the initial unweathered ordered pair tests. While all wires meet the minimum specifications, some substantially exceed the required minimums.

The photograph in Figure 3 illustrates the installed panels. And, photos in Figure 5 illustrate the damage mode locations. Initial sampling to establish an unweathered data base was performed after all panels were affixed to the wall faces. Subsequent sampling will be of the same ordered pairs as the initial nonexposed samples.

Wire Evaluation

Two types of test information were sought through this research. The change in weight was measured as was the change in tensile strength. Galvanized wire samples were cleaned gently prior to testing. PVC coated samples had the plastic coating removed prior to any testing.

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LOCATION MAP

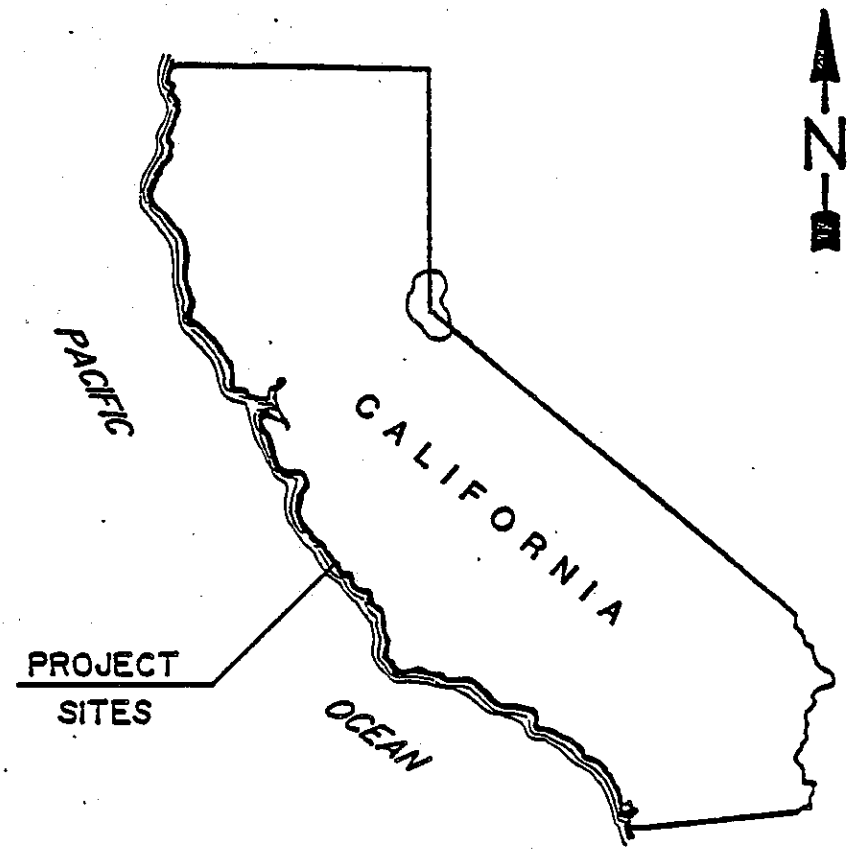

Figure 1

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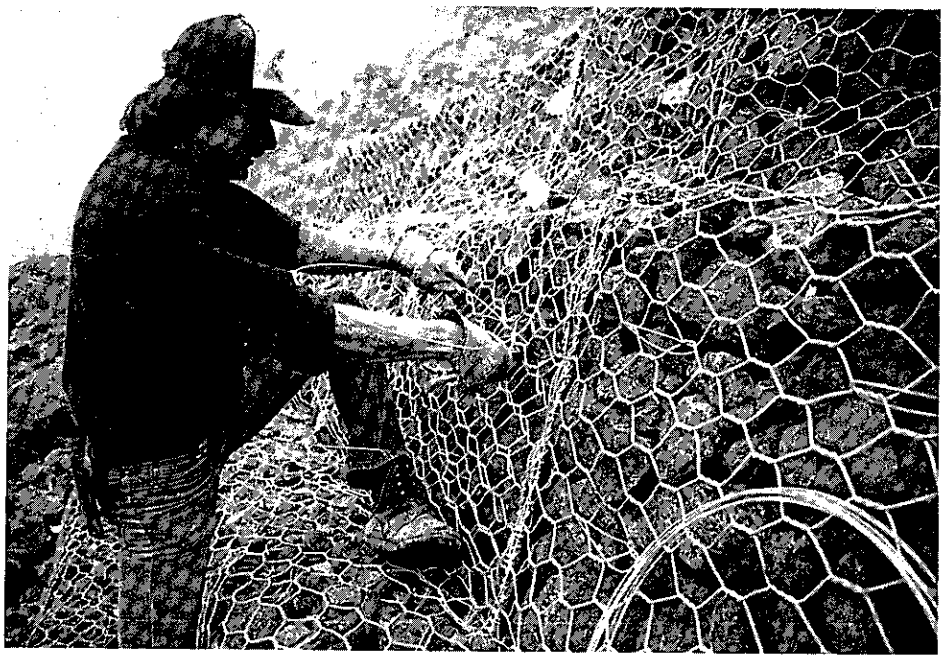

Twisted mesh gabion wall with panel being laced against wall face.

Pulling lacing tight to secure test panel to wall face.

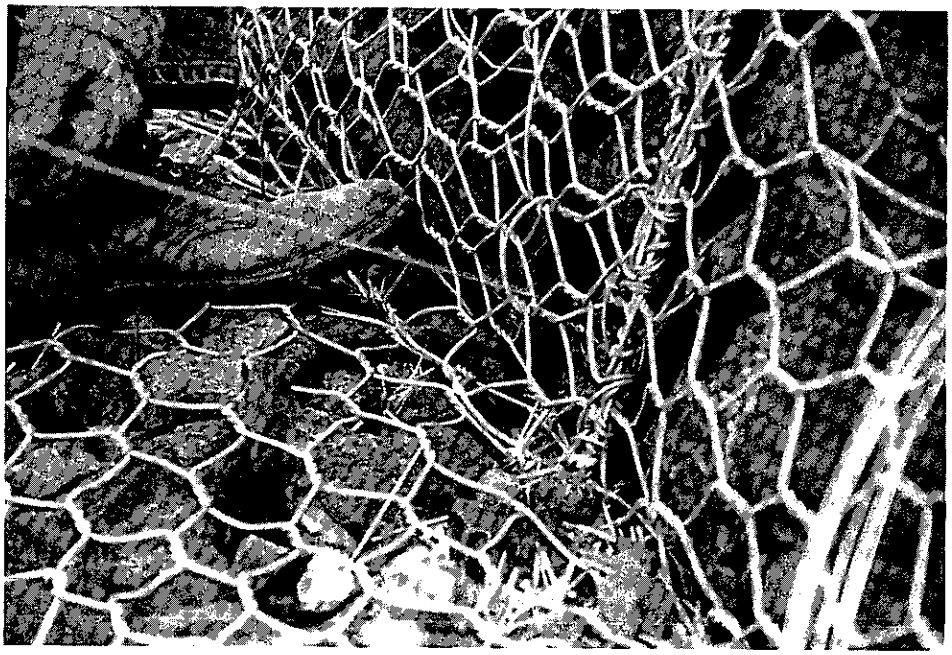

Figure 2 Lacing Panels in Place

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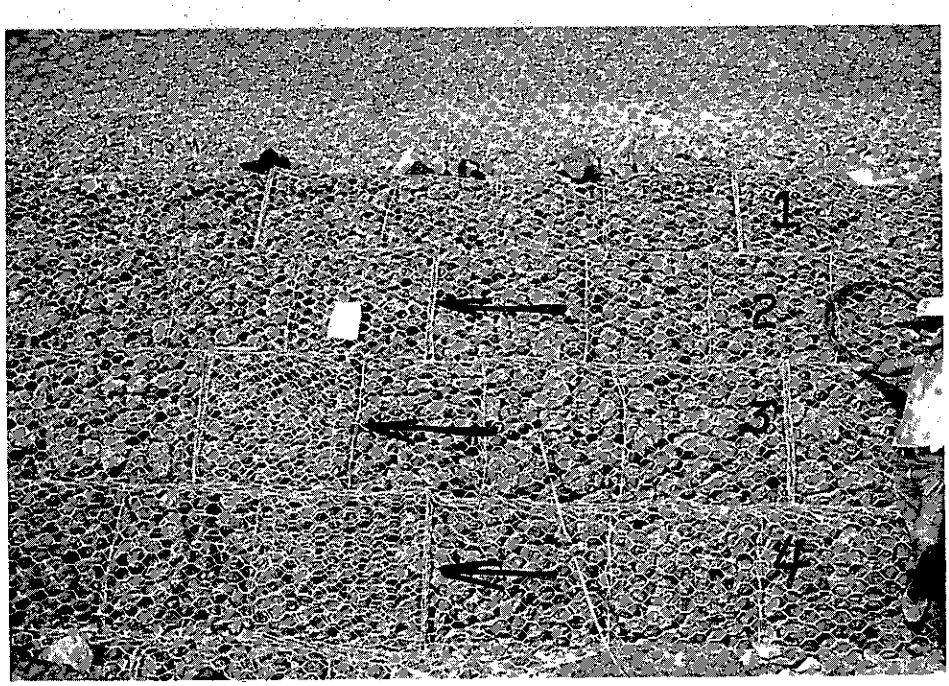

Southerly Wall showing 3 installed panels: Row 2, PVC; Row 3, galvanized; Row 4, PVC.

Figure 3 Panel Types and Locations

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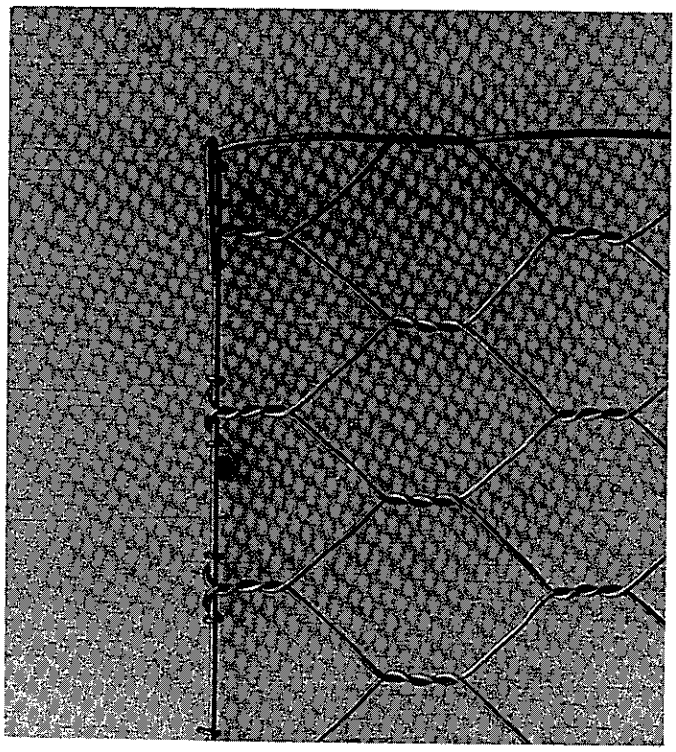
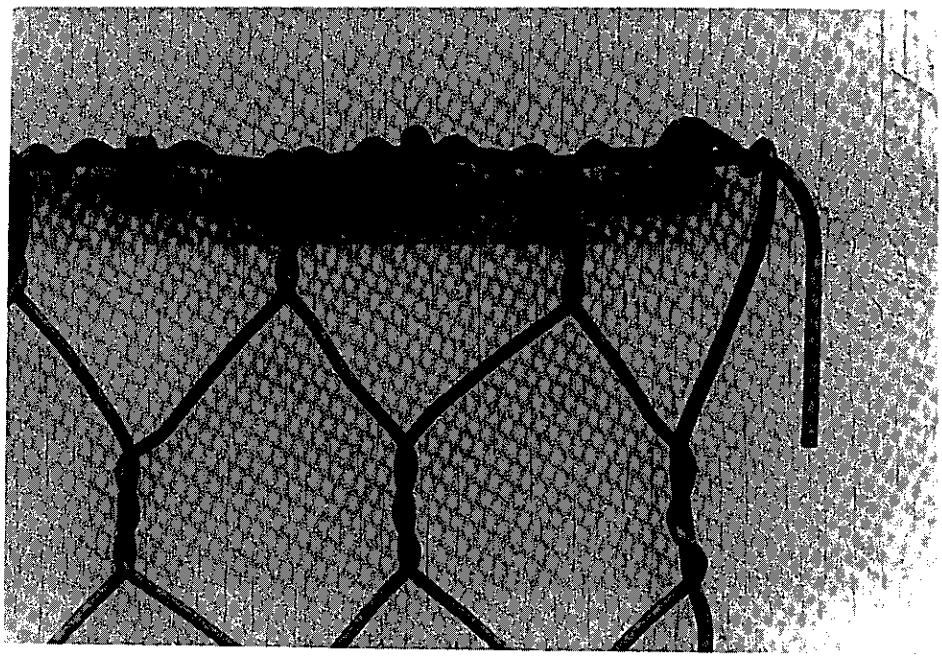
Galvanized Panel





PVC clad panel

Figure 4 Panel Types

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The change in weight was thought to be a way of evaluating the volume of wire corroded away. The nonuniform twist of the wires made this type of evaluation very difficult. A uniform sample size was achieved by straightening the samples and cutting them to a standard four inch length before weighing. This will most likely create a problem in some future sample evaluations as the corrosion affects the strength. Wires may break during the straightening process, thus, precluding a tensile strength evaluation.

Because there appears to be a 23 percent scatter in the wire strengths from strand to strand, all tests are of ordered pairs of wires. (See Figure 6) The PVC coated wire stength ranges from 595 to 732 lb, and the galvanized varies from 694 to 857 lb.

Wires strengths have been evaluated both in the twisted and straightened configuration. Straightening has a slight strain hardening effect, increasing the observed tensile strength by about four percent, (4%). If the straightening process does break the samples, then unstraightened samples will be tensile tested and the weight loss data discontinued. Discontinuation of the weight parameter is thought to be of less significance than the loss of strength data. The weight loss is only an indirect evaluation of the wires rock containment capabilities and, does not reflect the type of corrosive action, i.e. pitting, uniform surface degradation or combinations thereof.

Strength testing was performed on the four-inch straightened samples after the weight change was recorded, (Appendix B). Testing complied with ASTM A-370.

Data and comparisons are in Appendix B. Comparisons are limited due to the short observation time.

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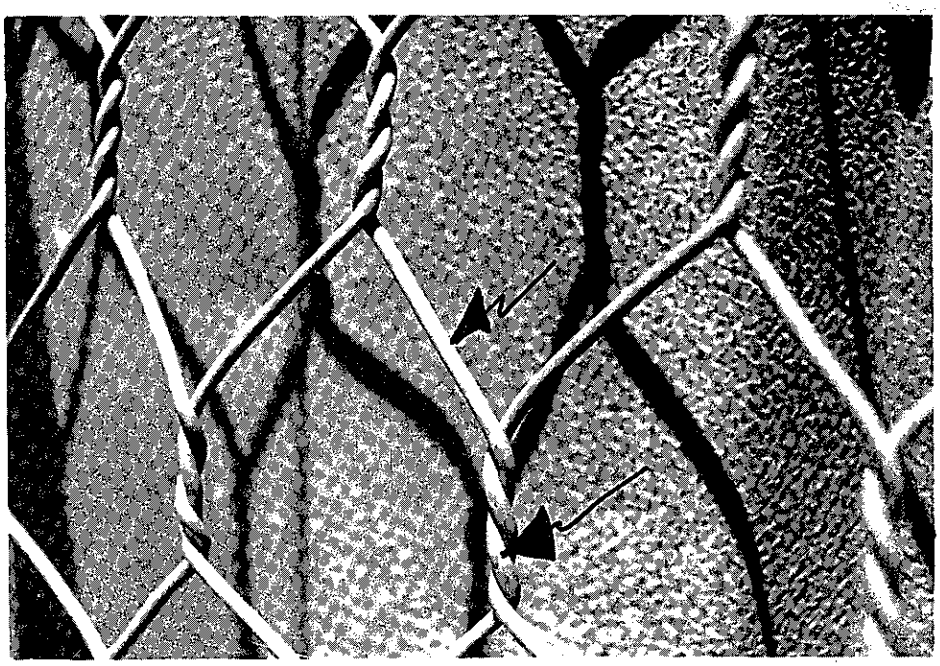
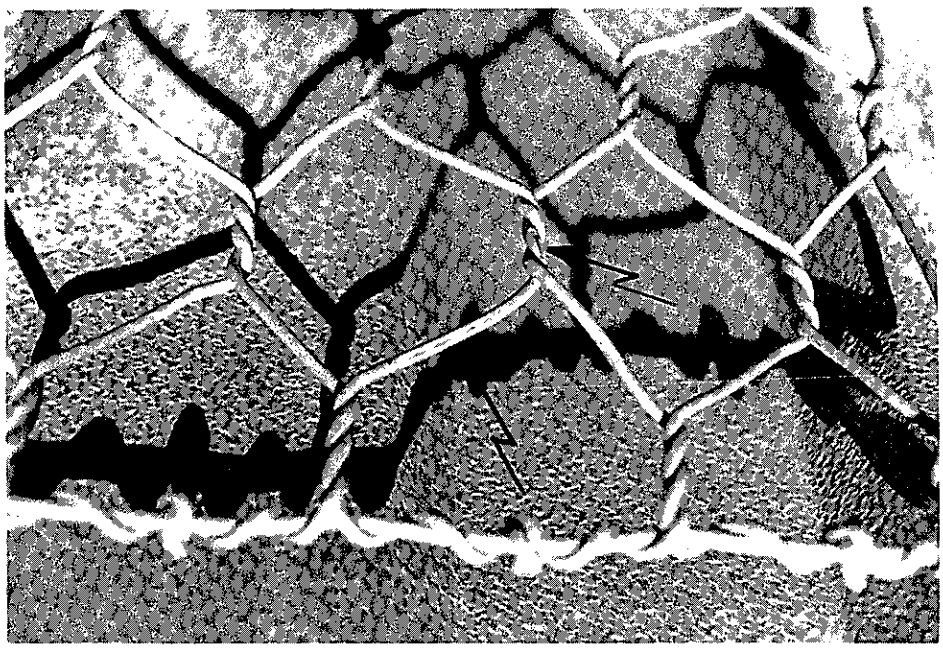
Two types
of cut





Two types
of blaze

Figure 5 Damage Locations

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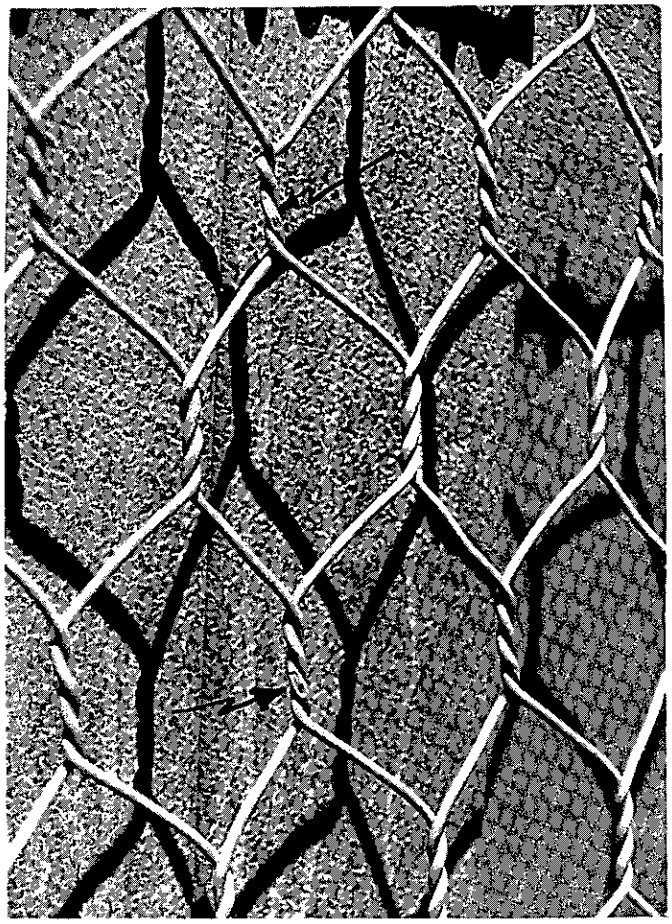

Two subsequent blazes on a
single ordered wire pair.

Figure 6 Ordered Pair

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Topographic Monitoring

Horizontal and vertical alignment of the walls was established relative to a control line along the highway (Figures 7 through 10). Stability of the alignment was evaluated by subsequent comparison of the established alignment as referenced to the control line. Cross sections of nonprotected portions of the beach were also established and subsequently back referenced.

Photographic Documentation

Picture points were established for all locations . Photos were taken at least at annual intervals. Photographic points were marked with permanent wire markers at all wall locations to permit rapid re-establishment of photo points. Pictures were taken at 6 and 20 ft distances from the wall face. Wall photo points are referenced to the diagrams in Figures 11 and 12. Selected comparative photos are in Appendix C as are selected wave attack photos.

Background or adjacent large rock configurations were used to identify photo points within the mattress installations. Exact photo point location is very difficult to establish in a movable material. Every effort was made to duplicate perspective and picture extent for valid comparisons. Due to rock movement some photo points no longer exist. The photos were used to monitor wire condition and rock position as well as overall movement of the installations.

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PROJECT SITE I

MATTRESS INSTALLATION - PM 7.3
1988

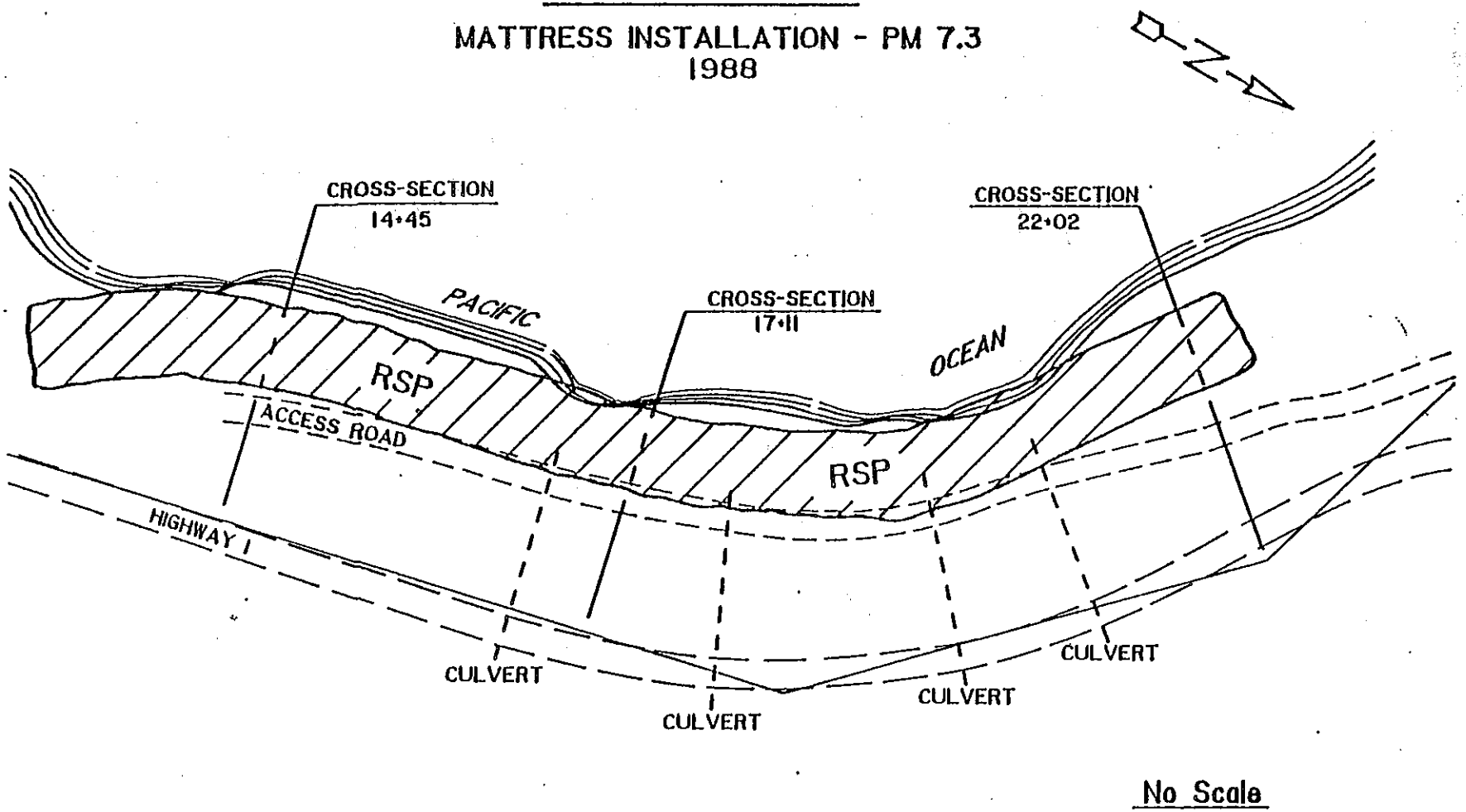

Figure 7

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PROJECT SITE II

MATTRESS INSTALLATION - PM 7.5
1988

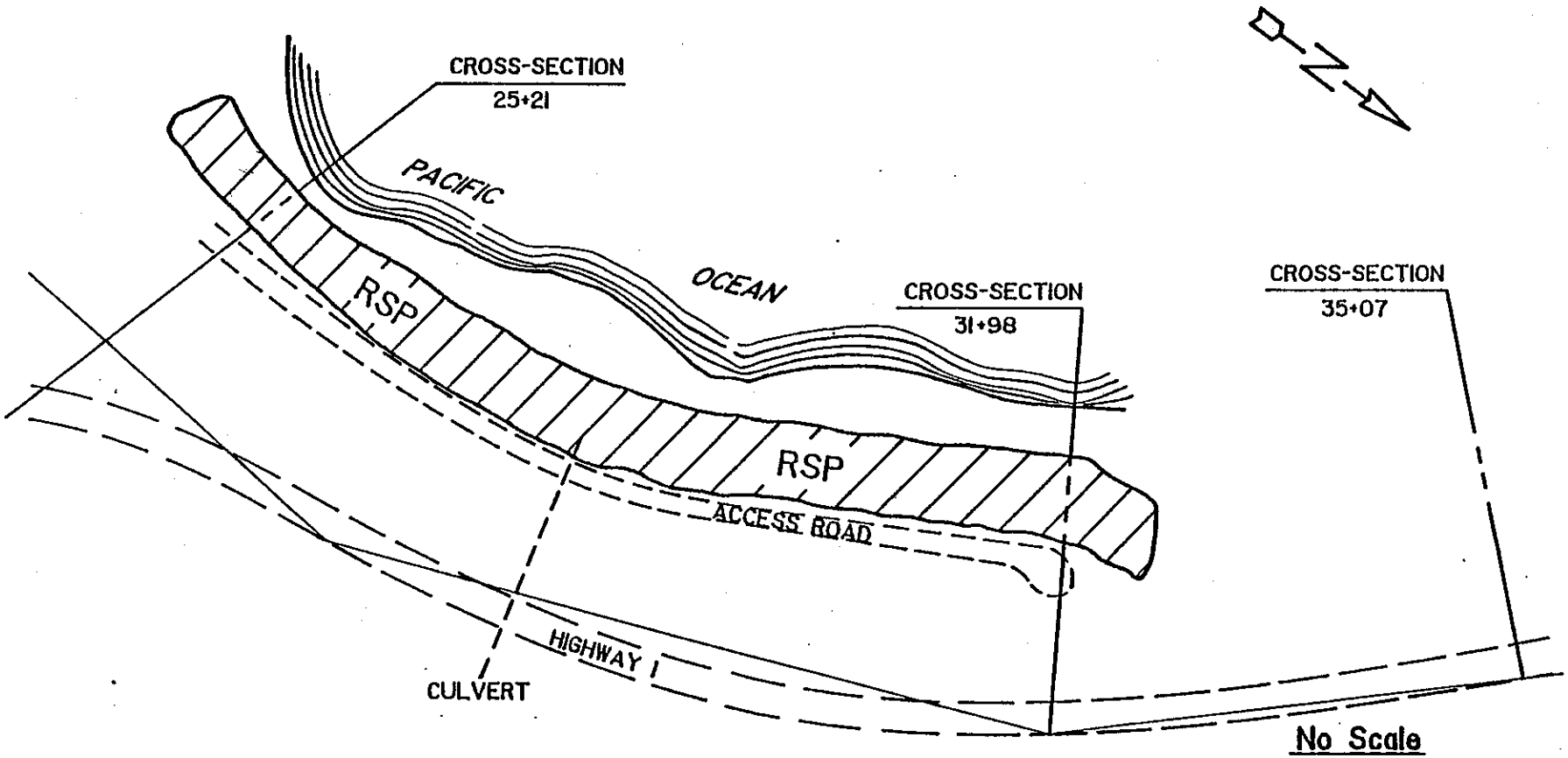

Figure 8

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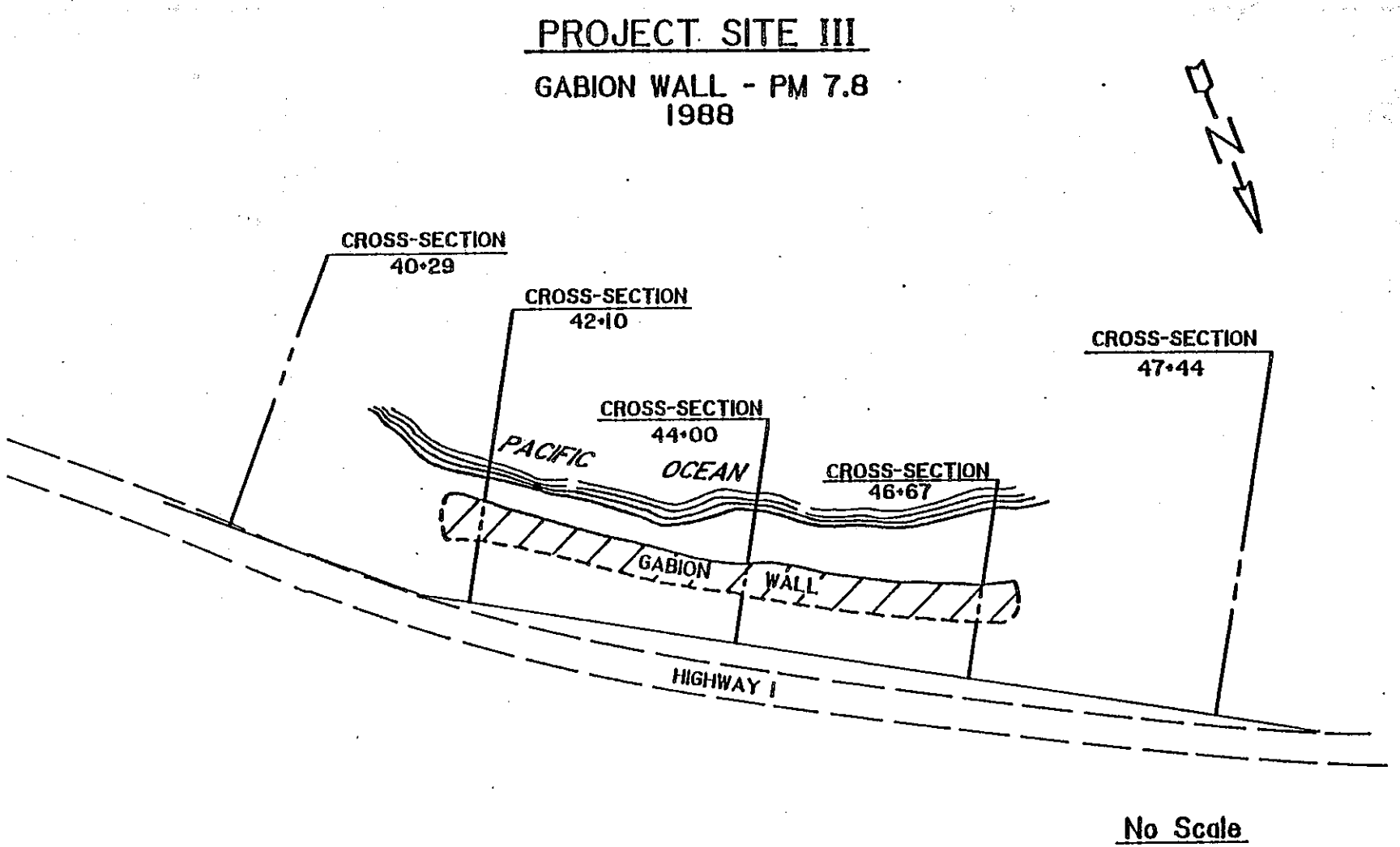
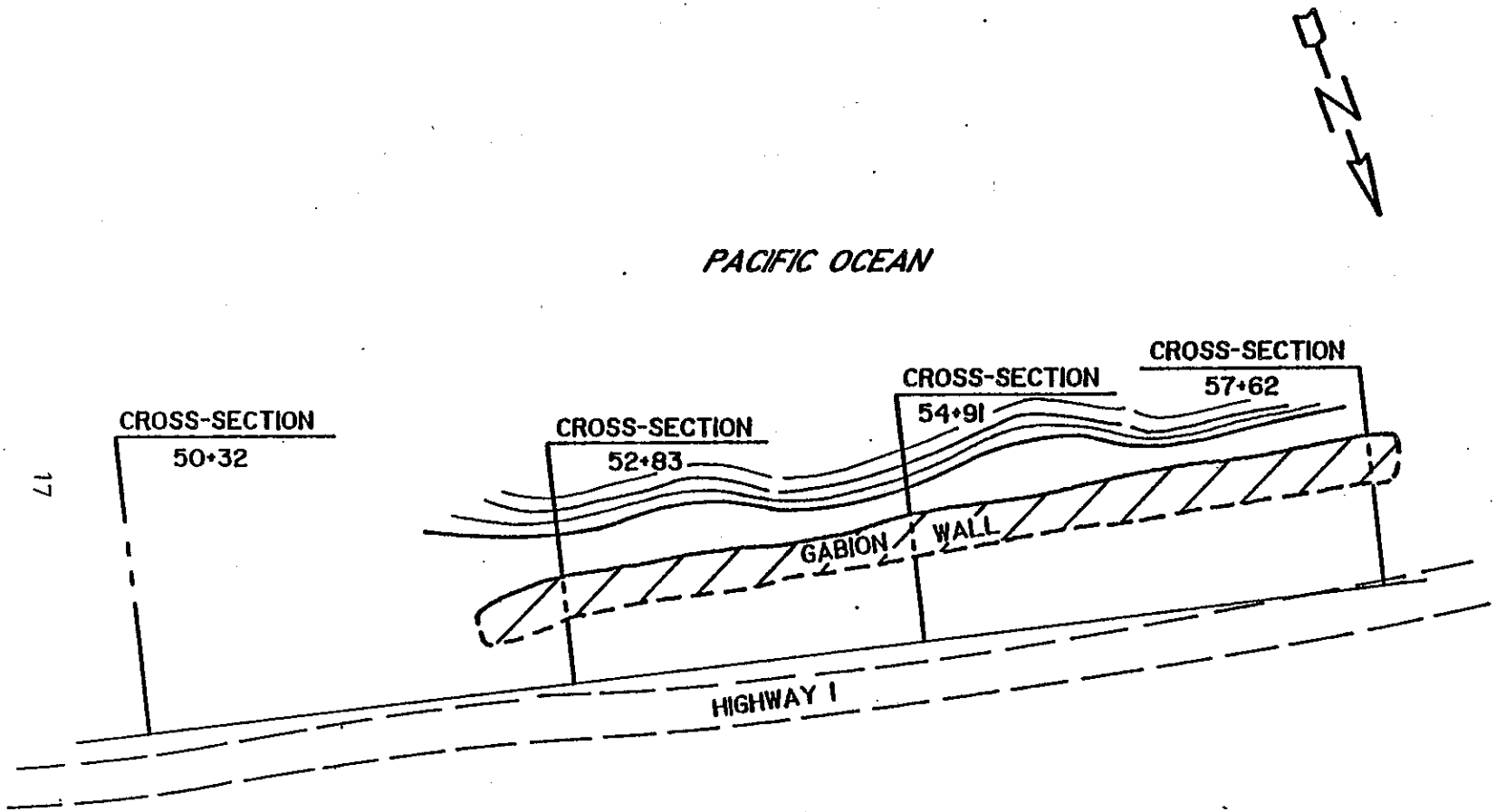


Figure 9

PROJECT SITE IV

GABION WALL - PM 8.1
1988



No Scale

Figure 10

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GABION MONITORING RESEARCH

FACE LAYOUT OF 3'x 3' TEST PANELS (□)

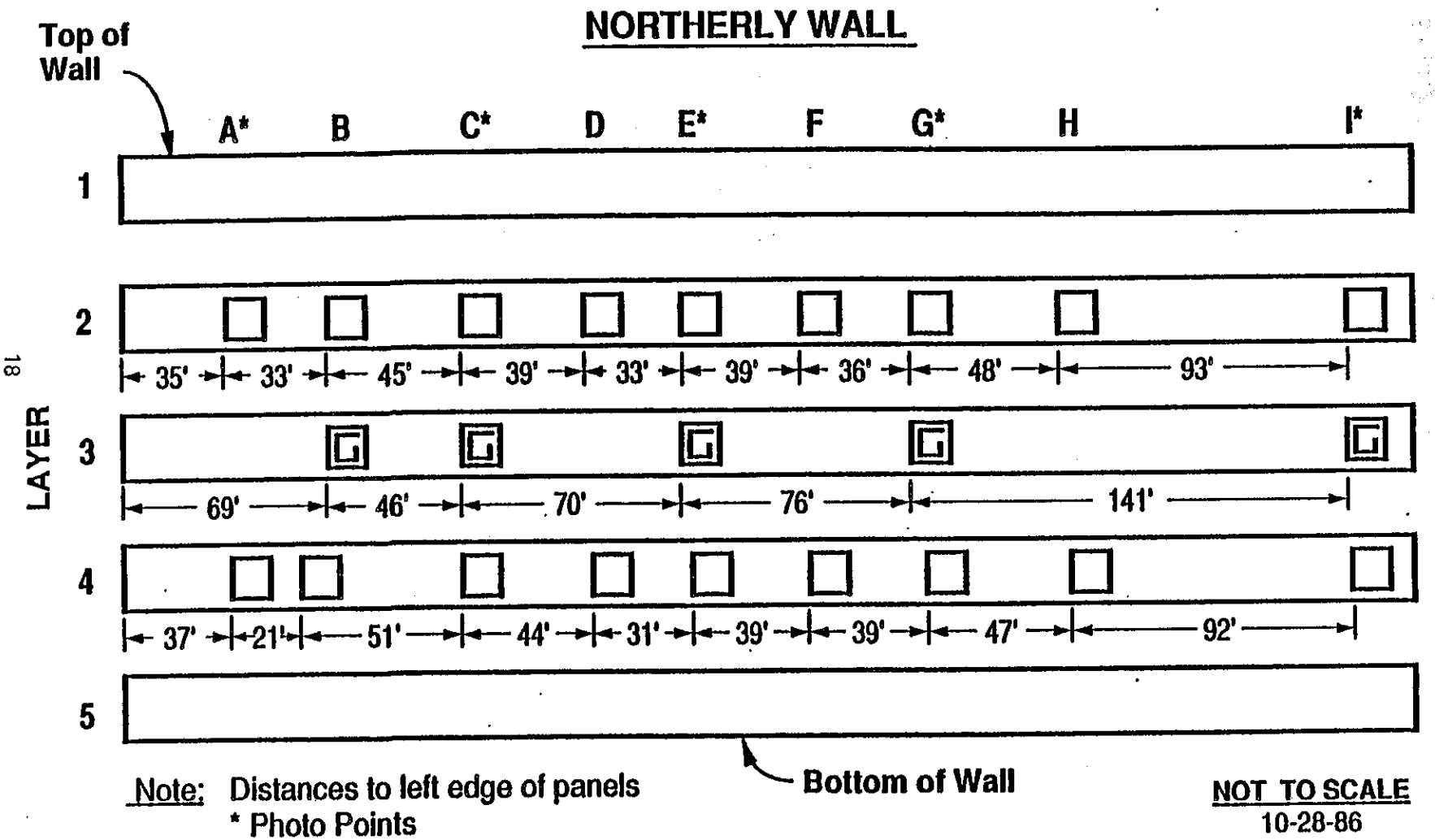

Figure 11

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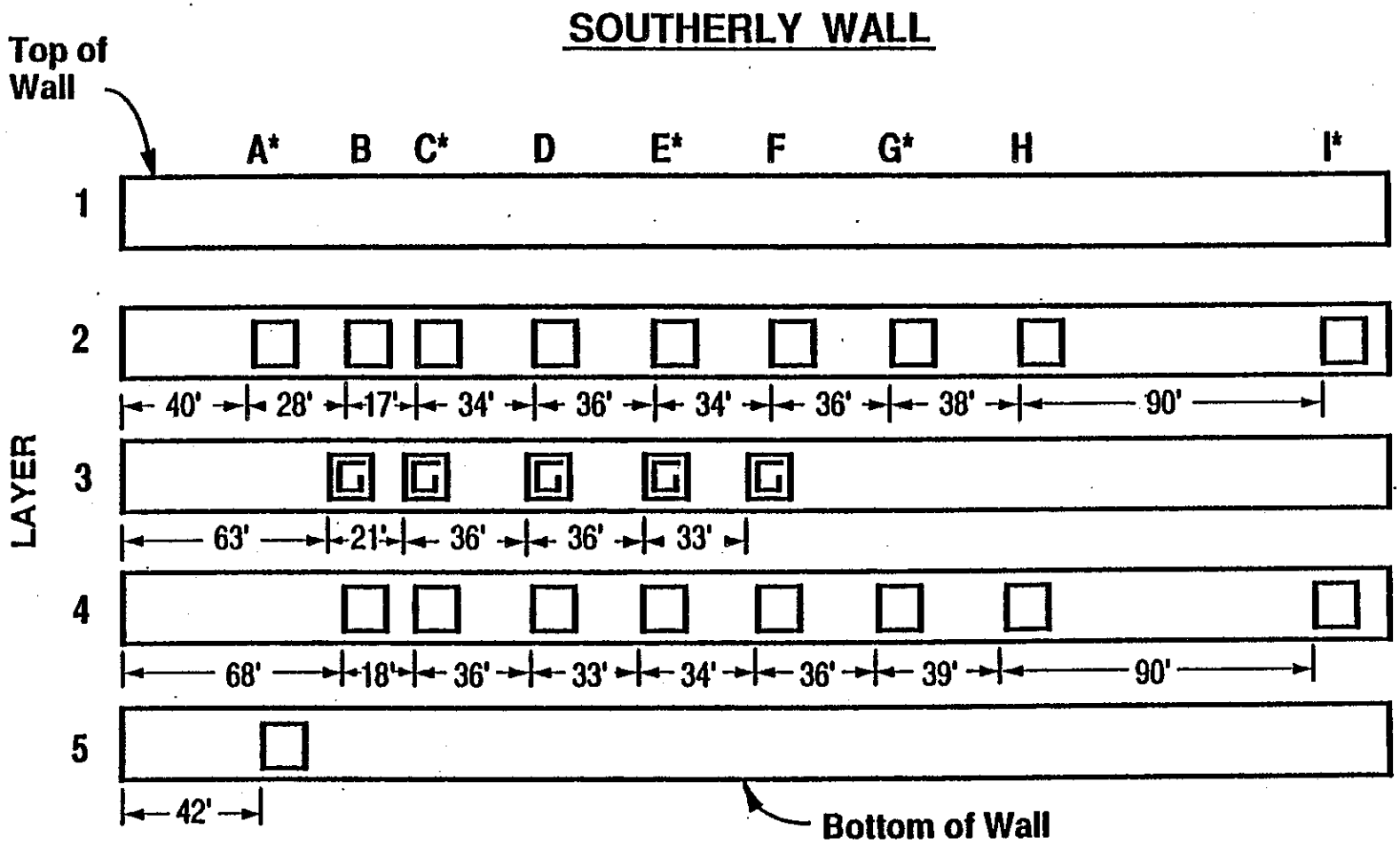
GABION MONITORING RESEARCH

FACE LAYOUT OF 3'x 3' TEST PANELS (□)



Note: South end of wall covered with debris.
Distances to left edge of panels.
* Photo Points

NO SCALE
10-28-86

Figure 12

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APPENDIX A

Construction Specifications

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APPENDIX A

GABIONS.-- Gabion construction shall consist of furnishing, assembling, tying and filling with rock, wire mesh baskets, constructed in accordance with these specifications and placed in conformance with the lines, grades and dimensions shown on the plans and as specified in these special provisions.

Gabion baskets shall be of the dimensions shown on the plans. Dimensions for heights, lengths, and widths are subject to a tolerance limit of ±5 percent.

Gabions shall be fabricated in such a manner that the sides, ends, lid and diaphragms can be assembled at the construction site into a rectangular basket of the specified sizes. Gabions shall be of single unit construction. The base, lid, ends, and sides shall be either woven into a single unit or one edge of these members connected to the base section of the gabion in such a manner that strength and flexibility at the point of connection is at least equal to that of the mesh.

Gabions shall be equally divided by diaphragming with the same wire mesh as used for the gabion body. Each gabion shall be fabricated with the necessary diaphragm or diaphragms secured in proper position on the base in such a manner that no additional tying at the base will be necessary.

All perimeter edges of the mesh forming the gabion shall be securely selvaged to prevent raveling and the joints formed by tying the selvages shall have at least the same strength and flexibility as the body of the mesh.

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Tiewire or connecting wire shall be supplied in sufficient quantity for securely fastening all edges of the gabion, and diaphragm. The tiewire is to meet the same specifications as the wire used in the mesh except that it shall have a minimum size of U.S. steel wire gage No. 13 1/2.

The wire mesh shall be made of galvanized steel wire having a minimum size of U.S. steel wire gage No. 12. The tensile strength of the wire shall be 60,000 pounds per square inch minimum. The minimum zinc coating of the wire shall be 0.80-ounce per square foot of uncoated wire surface as determined by tests conducted in accordance with ASTM Designation: A 90. The maximum line dimension of the mesh opening shall not exceed 4 1/2 inches.

A coating of gray PVC (polyvinyl chloride) having a minimum thickness of 0.40 millimeter (0.0157 inch) shall be bonded to all galvanized steel wire. Said coating shall be suitable to resist destructive effects of immersion in acidic, salt, or polluted water, exposure to ultraviolet light and abrasion and retain these characteristics after a period of not less than 3,000 hours under test, in accordance with A.S.T.M. E 42/65 CAM BASE N.7(E).
The wire mesh shall have sufficient elasticity to permit elongation of the mesh equivalent to a minimum of 10 percent of the length of the section of the mesh under test without reducing the gage or tensile strength of individual wires to values less than those for similar wire one gage smaller in diameter.

A sample of the wire mesh, consisting of an uncut section 6 feet long, not less than 3 feet wide, including all selvaged bindings, shall withstand a 6,000-pound load without rupture of any wire or opening of any mesh fastening when tested as follows:

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The mesh shall have the end securely clamped at both ends for 3 feet along the width of the sample. When the width of the test section exceeds 3 feet, the clamps will be placed in the middle portion of the width and the excess width will be allowed to fall free on each side of the clamped section. The test section shall then be subjected to sufficient tension to cause 10 percent elongation of the sample section between the clamps. After elongation and while clamped as described above, the section shall be subjected to a 6,000-pound load applied in a direction perpendicular to the direction of the tensile force to an area of one square foot located approximately in the center of the test section between the clamps.

The ram head used in the test shall be circular with its edges beveled or rounded to prevent cutting of the wires.

The wire mesh shall be fabricated in such a manner as to be nonraveling. This is defined as the ability to resist pulling apart at any of the twists or connections forming the mesh when a single wire in a section of mesh is cut and the section of mesh then subjected to the load test described in the elasticity test above.

Each shipment of gabions to the job site shall be accompanied with a Certificate of Compliance as provided in Section 6-1.07, "Certificates of Compliance," of the Standard Specifications. The certification shall be on manufacturer's company letterhead and shall be signed by an officer of the company having legal authority to bind the company.

The baskets shall be filled with rock varying in size in greatest dimension from a minimum of 4 inches to a maximum of 10 inches.

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The quality of the rock used in the gabions shall, when tested in accordance with California Test 229, have a Durability Index of not less than 52.

Each gabion unit shall be assembled by binding together all edges with a continuous piece of connecting wire stitched around the edges with a coil about every 4 inches with alternating single "half hitches" and double "half hitches" pulled tight. Empty gabion units shall be set to line and grade as shown on the plans. Each layer shall be tied to the underlying layer along their adjoining edges in the same manner as described above for assembling. Internal tiewires shall be uniformly spaced and securely fastened in each outside cell of the structure or where ordered by the Engineer.

A standard fence stretcher, chain fall, or iron rod may be used to stretch the wire baskets and hold alignment.

The gabions shall be filled with rock carefully placed to assure alignment and avoid bulges with a minimum of voids. After a gabion has been filled, the lid shall then be secured to the sides, ends and diaphragms with the wireties or connecting wire in the manner described above for assembling.

Gabions will be measured and paid for by the cubic yard, complete in place, as shown on the plans or as directed by the Engineer.

The contract price paid per cubic yard for gabion shall include full compensation for furnishing all labor, materials (including anchor stakes), tools, equipment and incidentals, and for doing all the work involved in gabion, complete in place, including structure excavation, structure backfill and disposing of excess material, as shown on the plans, as specified in the Standard Specifications and these special provisions, and as directed by the Engineer.

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APPENDIX B

Wire Comparison Data

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Data Table Key

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                 Location A
                 |
Location,        NA2B ----------------------Blazed damage
                 | |Row 2
              northwall
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Condition, P = Plain; B = Blazed; C = Cut; G = Galvanized

A - STR, strength of wire A

B - STR, strength of wire B

Avg - STR, strength average $\frac{(A\text{-}STR)+(B\text{-}STR)}{2}$

Wt - A, weight of wire A

Wt - B, weight of wire B

Avg - Wt weight average $\frac{(wt\text{-}A)+(wt\text{-}B)}{2}$

Dia - A, Diameter of wire A

Dia - B, Diameter of wire B

DATE, Date sampled

DELTA/STRENGTH, average strength change since previous sample

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LOCATION	CONDITION	A-STR	B-STR	AVG-STR	WT-A	WT-B	AVG-WT
NA2	P	640	650	645	4.38	4.27	4.325
NA2	P	676	694	685	4.19	4.30	4.245
NA2	P	667	697	682	4.30	4.29	4.295
NA2B	B	667	660	663	4.27	4.22	4.245
NA2B	B	680	679	679	4.29	4.24	4.265
NA2B	B	664	689	676	4.23	4.23	4.230
NA2C	C	715	608	661	4.31	4.39	4.350
NA2C	C	683	616	649	4.27	4.29	4.280
NA2C	C	614	678	646	4.24	4.26	4.250
NA4	P	680	663	671	4.26	4.33	4.295
NA4	P	676	668	672	4.26	4.35	4.305
NA4	P	673	653	663	4.25	4.35	4.300
NA4B	B	654	678	666	4.27	4.27	4.270
NA4B	B	668	677	672	4.22	4.21	4.215
NA4B	B	666	661	663	4.19	4.18	4.185
NA4C	C	666	612	639	4.28	4.31	4.295
NA4C	C	620	723	671	4.37	4.27	4.320
NA4C	C	616	724	670	4.32	4.25	4.285
NB2	P	654	637	645	4.19	4.34	4.265
NB2	P	673	638	655	4.21	4.33	4.270
NB2	P	639	679	659	4.33	4.21	4.270
NB2B	B	603	695	649	4.35	4.22	4.285
NB2B	B	718	616	667	4.20	4.36	4.280
NB2B	B	615	678	646	4.34	4.18	4.260
NB2C	C	711	667	689	4.22	4.38	4.300
NB2C	C	656	691	673	4.28	4.29	4.285
NB2C	C	687	719	703	4.34	4.16	4.250
NB4	P	693	681	687	4.24	4.37	4.305
NB4	P	717	762	739	4.22	4.34	4.280
NB4	P	697	696	696	4.36	4.20	4.280
NB4B	B	650	658	654	4.22	4.28	4.250
NB4B	B	670	675	672	4.21	4.24	4.225
NB4B	B	696	663	679	4.19	4.19	4.190
NB4C	C	646	657	651	4.27	4.24	4.255
NB4C	C	663	664	663	4.30	4.27	4.285
NB4C	C	655	656	655	4.27	4.15	4.210
NBG	G	704	853	778	5.45	5.66	5.555
NBG	G	722	857	789	5.42	5.52	5.470
NBG	G	713	844	778	5.12	5.31	5.215
NC2	P	699	629	664	4.31	4.21	4.260
NC2	P	718	659	688	4.30	4.21	4.255
NC2	P	656	717	686	4.20	4.29	4.245
NC2B	B	613	609	611	4.19	4.42	4.305
NC2B	B	622	633	627	4.40	4.17	4.285
NC2B	B	617	612	614	4.13	4.35	4.240
NC2C	C	633	724	678	4.35	4.33	4.340
NC2C	C	646	704	675	4.33	4.28	4.305
NC2C	C	640	686	663	4.31	4.21	4.260
NC4	P	683	635	659	4.29	4.35	4.320
NC4	P	701	644	672	4.27	4.33	4.300
NC4	P	699	643	671	4.26	4.34	4.300
NC4B	B	669	665	667	4.28	4.19	4.235
NC4B	B	669	673	671	4.25	4.18	4.215

Gabion Data

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LOCATION	DIA-A	DIA-B	DATE	DELTA/STRENGTH
NA2	0.104	0.104	28-Oct-86	
NA2	0.104	0.104	19-May-87	40
NA2	0.105	0.104	05-May-88	-3
NA2B	0.104	0.103	28-Oct-86	0
NA2B	0.105	0.104	19-May-87	16
NA2B	0.102	0.102	05-May-88	-3
NA2C	0.104	0.105	28-Oct-86	0
NA2C	0.104	0.105	19-May-87	-12
NA2C	0.103	0.102	05-May-88	-3.5
NA4	0.103	0.104	28-Oct-86	0
NA4	0.104	0.105	19-May-87	0.5
NA4	0.104	0.104	05-May-88	-9
NA4B	0.104	0.104	28-Oct-86	0
NA4B	0.103	0.104	19-May-87	6.5
NA4B	0.102	0.102	05-May-88	-9
NA4C	0.104	0.104	28-Oct-86	0
NA4C	0.106	0.104	19-May-87	32.5
NA4C	0.103	0.103	05-May-88	-1.5
NB2	0.103	0.104	28-Oct-86	0
NB2	0.104	0.105	19-May-87	10
NB2	0.105	0.104	05-May-88	3.5
NB2B	0.104	0.103	28-Oct-86	0
NB2B	0.103	0.106	19-May-87	18
NB2B	0.102	0.101	05-May-88	-20.5
NB2C	0.104	0.105	28-Oct-86	0
NB2C	0.105	0.104	19-May-87	-15.5
NB2C	0.103	0.103	05-May-88	29.5
NB4	0.103	0.105	28-Oct-86	0
NB4	0.104	0.105	19-May-87	52.5
NB4	0.105	0.104	05-May-88	-43
NB4B	0.102	0.103	28-Oct-86	0
NB4B	0.104	0.105	19-May-87	18.5
NB4B	0.101	0.103	05-May-88	7
NB4C	0.104	0.103	28-Oct-86	0
NB4C	0.105	0.104	19-May-87	12
NB4C	0.103	0.102	05-May-88	-8
NBG	0.117	0.119	28-Oct-86	0
NBG	0.119	0.118	19-May-87	11
NBG	0.115	0.116	05-May-88	-11
NC2	0.105	0.103	28-Oct-86	0
NC2	0.103	0.103	19-May-87	24.5
NC2	0.103	0.104	05-May-88	-2
NC2B	0.102	0.106	28-Oct-86	0
NC2B	0.106	0.103	19-May-87	16.5
NC2B	0.102	0.104	05-May-88	-13
NC2C	0.105	0.104	28-Oct-86	0
NC2C	0.106	0.104	19-May-87	-3.5
NC2C	0.104	0.102	05-May-88	-12
NC4	0.103	0.104	28-Oct-86	0
NC4	0.104	0.105	19-May-87	13.5
NC4	0.104	0.105	05-May-88	-1.5
NC4B	0.103	0.103	28-Oct-86	0
NC4B	0.105	0.103	19-May-87	4

Gabion Data

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LOCATION	CONDITION	A-STR	B-STR	AVG-STR	WT-A	WT-B	AVG-WT
NC4B	B	668	664	666	4.19	4.12	4.155
NC4C	C	700	623	661	4.24	4.30	4.270
NC4C	C	721	636	678	4.26	4.31	4.285
NC4C	C	704	638	671	4.23	4.28	4.255
NCG	G	727	828	777	5.50	5.51	5.505
NCG	G	752	841	796	5.44	5.43	5.435
NCG	G	805	746	775	5.26	5.20	5.230
ND2	P	617	650	633	4.31	4.36	4.335
ND2	P	664	631	647	4.32	4.30	4.310
ND2	P	676	629	652	4.22	4.35	4.285
ND2B	B	654	689	671	4.31	4.28	4.295
ND2B	B	690	664	677	4.26	4.30	4.280
ND2B	B	656	689	672	4.25	4.21	4.230
ND2C	C	713	602	657	4.32	4.35	4.335
ND2C	C	715	607	661	4.31	4.35	4.330
ND2C	C	614	631	622	4.10	4.08	4.090
ND4	P	664	624	644	4.21	4.37	4.290
ND4	P	685	632	658	4.24	4.35	4.290
ND4	P	631	657	644	4.29	4.26	4.275
ND4B	B	649	707	678	4.27	4.22	4.245
ND4B	B	724	676	700	4.24	4.28	4.260
ND4B	B	654	714	684	4.19	4.16	4.175
ND4C	C	608	621	614	4.24	4.16	4.200
ND4C	C	645	628	636	4.15	4.18	4.165
ND4C	C	609	715	662	4.33	4.30	4.315
NE2	P	644	667	655	4.23	4.28	4.255
NE2	P	681	704	692	4.24	4.25	4.245
NE2	P	654	676	665	4.23	4.27	4.250
NE2B	B	625	691	658	4.30	4.26	4.280
NE2B	B	640	678	659	4.22	4.29	4.255
NE2B	B	630	702	666	4.29	4.20	4.245
NE2C	C	637	654	645	4.30	4.24	4.270
NE2C	C	655	657	656	4.19	4.33	4.260
NE2C	C	671	655	663	4.12	4.24	4.180
NE4	P	697	641	669	4.23	4.32	4.275
NE4	P	650	714	682	4.34	4.22	4.280
NE4	P	706	644	675	4.20	4.34	4.270
NE4B	B	593	687	640	4.24	4.24	4.240
NE4B	B	612	717	664	4.25	4.22	4.235
NE4B	B	710	606	658	4.21	4.21	4.210
NE4C	C	668	652	660	4.33	4.19	4.260
NE4C	C	679	672	675	4.29	4.19	4.240
NE4C	C	652	686	669	4.10	4.27	4.185
NEG	G	739	830	784	5.44	5.51	5.475
NEG	G	752	846	799	5.40	5.43	5.415
NEG	G	818	737	777	5.28	5.16	5.220
NF2	P	729	605	667	4.33	4.28	4.305
NF2	P	614	748	681	4.35	4.32	4.335
NF2	P	609	742	675	4.33	4.30	4.315
NF2B	B	682	664	673	4.36	4.25	4.305
NF2B	B	688	696	692	4.33	4.26	4.295
NF2B	B	696	688	692	4.21	4.32	4.265
NF2C	C	673	640	656	4.26	4.34	4.300

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LOCATION	DIA-A	DIA-B	DATE	DELTA/STRENGTH
NC4B	0.103	0.102	05-May-88	-5
NC4C	0.104	0.104	28-Oct-86	0
NC4C	0.105	0.105	19-May-87	17
NC4C	0.103	0.104	05-May-88	-7.5
NCG	0.118	0.118	28-Oct-86	0
NCG	0.123	0.117	19-May-87	19
NCG	0.115	0.115	05-May-88	-21
ND2	0.104	0.105	28-Oct-86	0
ND2	0.104	0.104	19-May-87	14
ND2	0.104	0.106	05-May-88	5
ND2B	0.104	0.104	28-Oct-86	0
ND2B	0.105	0.105	19-May-87	5.5
ND2B	0.103	0.103	05-May-88	-4.5
ND2C	0.105	0.105	28-Oct-86	0
ND2C	0.108	0.105	19-May-87	3.5
ND2C	0.101	0.101	05-May-88	-38.5
ND4	0.104	0.106	28-Oct-86	0
ND4	0.102	0.106	19-May-87	14.5
ND4	0.104	0.105	05-May-88	-14.5
ND4B	0.103	0.103	28-Oct-86	0
ND4B	0.104	0.104	19-May-87	22
ND4B	0.102	0.101	05-May-88	-16
ND4C	0.103	0.103	28-Oct-86	0
ND4C	0.103	0.103	19-May-87	22
ND4C	0.104	0.104	05-May-88	25.5
NE2	0.103	0.103	28-Oct-86	0
NE2	0.103	0.104	19-May-87	37
NE2	0.103	0.104	05-May-88	-27.5
NE2B	0.104	0.103	28-Oct-86	0
NE2B	0.104	0.104	19-May-87	1
NE2B	0.104	0.101	05-May-88	7
NE2C	0.104	0.104	28-Oct-86	0
NE2C	0.105	0.105	19-May-87	10.5
NE2C	0.101	0.103	05-May-88	7
NE4	0.103	0.104	28-Oct-86	0
NE4	0.105	0.103	19-May-87	13
NE4	0.104	0.105	05-May-88	-7
NE4B	0.104	0.102	28-Oct-86	0
NE4B	0.104	0.103	19-May-87	24.5
NE4B	0.101	0.102	05-May-88	-6.5
NE4C	0.104	0.103	28-Oct-86	0
NE4C	0.104	0.104	19-May-87	15.5
NE4C	0.101	0.103	05-May-88	-6.5
NEG	0.118	0.117	28-Oct-86	0
NEG	0.117	0.119	19-May-87	14.5
NEG	0.116	0.114	05-May-88	-21.5
NF2	0.104	0.105	28-Oct-86	0
NF2	0.104	0.104	19-May-87	14
NF2	0.105	0.105	05-May-88	-5.5
NF2B	0.104	0.104	28-Oct-86	0
NF2B	0.104	0.104	19-May-87	19
NF2B	0.103	0.102	05-May-88	0
NF2C	0.103	0.105	28-Oct-86	0

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LOCATION	CONDITION	A-STR	B-STR	AVG-STR	WT-A	WT-B	AVG-WT
NF2C	C	663	693	678	4.30	4.22	4.260
NF2C	C	681	651	666	4.21	4.29	4.250
NF4	P	654	670	662	4.29	4.31	4.300
NF4	P	678	665	671	4.31	4.29	4.300
NF4	P	675	666	670	4.31	4.31	4.310
NF4B	B	680	639	659	4.31	4.28	4.295
NF4B	B	701	719	710	4.36	4.25	4.305
NF4B	B	684	643	663	4.26	4.19	4.225
NF4C	C	630	708	669	4.33	4.22	4.275
NF4C	C	716	645	680	4.19	4.34	4.265
NF4C	C	645	710	677	4.32	4.15	4.235
NG2	P	660	630	645	4.25	4.26	4.255
NG2	P	645	678	661	4.25	4.26	4.255
NG2	P	636	669	652	4.24	4.29	4.265
NG2B	B	612	647	629	4.19	4.22	4.205
NG2B	B	671	629	650	4.21	4.18	4.195
NG2B	B	641	627	634	4.17	4.20	4.185
NG2C	C	639	700	669	4.26	4.34	4.300
NG2C	C	701	665	683	4.25	4.27	4.260
NG2C	C	660	702	681	4.23	4.26	4.245
NG4	P	645	682	663	4.27	4.26	4.265
NG4	P	662	697	679	4.27	4.27	4.270
NG4	P	705	654	679	4.27	4.27	4.270
NG4B	B	635	657	646	4.40	4.23	4.315
NG4B	B	663	676	669	4.31	4.19	4.250
NG4B	B	674	660	667	4.17	4.34	4.255
NG4C	C	665	628	646	4.28	4.41	4.345
NG4C	C	678	653	665	4.26	4.36	4.310
NG4C	C	636	668	652	4.40	4.23	4.315
NGG	G	701	730	715	5.51	5.57	5.540
NGG	G	751	717	734	5.55	5.54	5.545
NGG	G	712	727	719	5.16	5.20	5.180
NH2	P	614	666	640	4.14	4.25	4.195
NH2	P	682	631	656	4.24	4.16	4.200
NH2	P	680	662	671	4.26	4.15	4.205
NH2B	B	649	639	644	4.22	4.31	4.265
NH2B	B	660	672	666	4.29	4.22	4.255
NH2B	B	648	658	653	4.28	4.18	4.230
NH2C	C	694	615	654	4.27	4.26	4.265
NH2C	C	638	697	667	4.28	4.26	4.270
NH2C	C	631	693	662	4.22	4.22	4.220
NH4	P	653	653	653	4.32	4.22	4.270
NH4	P	675	662	668	4.23	4.32	4.275
NH4	P	655	653	654	4.33	4.23	4.280
NH4B	B	649	689	669	4.28	4.22	4.250
NH4B	B	663	713	688	4.24	4.23	4.235
NH4B	B	705	657	681	4.21	4.20	4.205
NH4C	C	635	658	646	4.37	4.25	4.310
NH4C	C	682	651	666	4.22	4.39	4.305
NH4C	C	675	639	657	4.18	4.33	4.255
NI2	P	672	634	653	4.27	4.37	4.320
NI2	P	699	659	679	4.26	4.41	4.335
NI2	P	687	647	667	4.26	4.38	4.320

Gabion Data

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LOCATION	DIA-A	DIA-B	DATE	DELTA/STRENGTH
NF2C	0.105	0.105	19-May-87	21.5
NF2C	0.103	0.101	05-May-88	-12
NF4	0.104	0.105	28-Oct-86	0
NF4	0.104	0.104	19-May-87	9.5
NF4	0.105	0.104	05-May-88	-1
NF4B	0.104	0.104	28-Oct-86	0
NF4B	0.105	0.103	19-May-87	50.5
NF4B	0.102	0.102	05-May-88	-46.5
NF4C	0.104	0.102	28-Oct-86	0
NF4C	0.103	0.105	19-May-87	11.5
NF4C	0.103	0.102	05-May-88	-3
NG2	0.102	0.105	28-Oct-86	0
NG2	0.103	0.104	19-May-87	16.5
NG2	0.104	0.105	05-May-88	-9
NG2B	0.103	0.103	28-Oct-86	0
NG2B	0.104	0.103	19-May-87	20.5
NG2B	0.102	0.102	05-May-88	-16
NG2C	0.103	0.105	28-Oct-86	0
NG2C	0.105	0.105	19-May-87	13.5
NG2C	0.102	0.105	05-May-88	-2
NG4	0.103	0.103	28-Oct-86	0
NG4	0.104	0.104	19-May-87	16
NG4	0.104	0.104	05-May-88	0
NG4B	0.104	0.103	28-Oct-86	0
NG4B	0.106	0.103	19-May-87	23.5
NG4B	0.101	0.104	05-May-88	-2.5
NG4C	0.104	0.105	28-Oct-86	0
NG4C	0.105	0.106	19-May-87	19
NG4C	0.105	0.102	05-May-88	-13.5
NGG	0.118	0.118	28-Oct-86	0
NGG	0.119	0.120	19-May-87	18.5
NGG	0.114	0.115	05-May-88	-14.5
NH2	0.102	0.103	28-Oct-86	0
NH2	0.104	0.103	19-May-87	16.5
NH2	0.104	0.103	05-May-88	14.5
NH2B	0.103	0.104	28-Oct-86	0
NH2B	0.105	0.103	19-May-87	22
NH2B	0.103	0.102	05-May-88	-13
NH2C	0.103	0.103	28-Oct-86	0
NH2C	0.104	0.105	19-May-87	13
NH2C	0.103	0.102	05-May-88	-5.5
NH4	0.105	0.103	28-Oct-86	0
NH4	0.102	0.104	19-May-87	15.5
NH4	0.105	0.104	05-May-88	-14.5
NH4B	0.103	0.103	28-Oct-86	0
NH4B	0.104	0.104	19-May-87	19
NH4B	0.102	0.102	05-May-88	-7
NH4C	0.105	0.103	28-Oct-86	0
NH4C	0.104	0.105	19-May-87	20
NH4C	0.103	0.104	05-May-88	-9.5
NI2	0.104	0.105	28-Oct-86	0
NI2	0.103	0.106	19-May-87	26
NI2	0.104	0.106	05-May-88	-12

Gabion Data

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LOCATION	CONDITION	A-STR	B-STR	AVG-STR	WT-A	WT-B	AVG-WT
NI2B	B	665	724	694	4.25	4.47	4.360
NI2B	B	682	736	709	4.24	4.46	4.350
NI2B	B	658	739	698	4.21	4.45	4.330
NI2C	C	702	651	676	4.23	4.27	4.250
NI2C	C	713	675	694	4.24	4.28	4.260
NI2C	C	655	708	681	4.22	4.26	4.240
NI4	P	622	649	635	4.30	4.31	4.305
NI4	P	640	669	654	4.31	4.32	4.315
NI4	P	664	634	649	4.30	4.31	4.305
NI4B	B	681	644	662	4.26	4.30	4.280
NI4B	B	673	692	682	4.31	4.28	4.295
NI4B	B	697	655	676	4.27	4.30	4.285
NI4C	C	623	677	650	4.26	4.25	4.255
NI4C	C	697	644	670	4.24	4.27	4.255
NI4C	C	632	688	660	4.23	4.19	4.210
NIG	G	850	703	776	5.53	5.58	5.555
NIG	G	700	856	778	5.52	5.50	5.510
NIG	G	830	694	762	5.22	5.16	5.190
SA2	P	613	669	641	4.16	4.25	4.205
SA2	P	688	647	667	4.21	4.17	4.190
SA2	P	687	624	655	4.25	4.15	4.200
SA2B	B	649	705	677	4.27	4.25	4.260
SA2B	B	710	662	686	4.26	4.29	4.275
SA2B	B	641	702	671	4.03	4.18	4.105
SA2C	C	647	711	679	4.32	4.23	4.275
SA2C	C	716	656	686	4.23	4.33	4.280
SA2C	C	715	650	682	4.16	4.33	4.245
SA5	P	653	640	646	4.21	4.37	4.290
SA5	P	655	682	668	4.39	4.24	4.315
SA5	P	678	648	663	4.21	4.37	4.290
SA5B	B	660	691	675	4.30	4.39	4.345
SA5B	B	641	681	661	4.36	4.28	4.320
SA5B	B	670	617	643	4.22	4.28	4.250
SA5C	C	632	699	665	4.26	4.21	4.235
SA5C	C	719	646	682	4.23	4.23	4.230
SA5C	C	712	637	674	3.97	4.24	4.105
SB2	P	713	653	683	4.21	4.32	4.265
SB2	P	735	654	694	4.19	4.30	4.245
SB2	P	723	645	684	4.21	4.33	4.270
SB2B	B	699	726	712	4.20	4.46	4.330
SB2B	B	720	731	725	4.18	4.48	4.330
SB2B	B	714	705	709	4.38	4.09	4.235
SB2C	C	665	638	651	4.19	4.36	4.275
SB2C	C	665	681	673	4.36	4.24	4.300
SB2C	C	632	676	654	4.31	4.20	4.255
SB4	P	648	691	669	4.31	4.25	4.280
SB4	P	654	689	671	4.32	4.25	4.285
SB4	P	644	697	670	4.32	4.29	4.305
SB4B	B	671	684	677	4.22	4.37	4.295
SB4B	B	679	720	699	4.22	4.36	4.290
SB4B	B	673	672	672	4.24	4.12	4.180
SB4C	C	646	670	658	4.21	4.23	4.220
SB4C	C	682	657	669	4.21	4.24	4.225

Gabion Data

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LOCATION	DIA-A	DIA-B	DATE	DELTA/STRENGTH
NI2B	0.103	0.105	28-Oct-86	0
NI2B	0.106	0.106	19-May-87	14.5
NI2B	0.103	0.106	05-May-88	-10.5
NI2C	0.104	0.103	28-Oct-86	0
NI2C	0.105	0.104	19-May-87	17.5
NI2C	0.102	0.102	05-May-88	-12.5
NI4	0.104	0.104	28-Oct-86	0
NI4	0.104	0.105	19-May-87	19
NI4	0.104	0.104	05-May-88	-5.5
NI4B	0.104	0.104	28-Oct-86	0
NI4B	0.105	0.105	19-May-87	20
NI4B	0.103	0.102	05-May-88	-6.5
NI4C	0.104	0.103	28-Oct-86	0
NI4C	0.105	0.105	19-May-87	20.5
NI4C	0.103	0.102	05-May-88	-10.5
NIG	0.118	0.118	28-Oct-86	0
NIG	0.117	0.118	19-May-87	1.5
NIG	0.115	0.114	05-May-88	-16
SA2	0.103	0.103	28-Oct-86	0
SA2	0.103	0.103	19-May-87	26.5
SA2	0.103	0.103	05-May-88	-12
SA2B	0.104	0.105	28-Oct-86	0
SA2B	0.104	0.105	19-May-87	9
SA2B	0.100	0.101	05-May-88	-14.5
SA2C	0.105	0.103	28-Oct-86	0
SA2C	0.104	0.105	19-May-87	7
SA2C	0.100	0.105	05-May-88	-3.5
SA5	0.104	0.105	28-Oct-86	0
SA5	0.105	0.103	19-May-87	22
SA5	0.104	0.105	05-May-88	-5.5
SA5B	0.105	0.106	28-Oct-86	0
SA5B	0.105	0.105	19-May-87	-14.5
SA5B	0.101	0.102	05-May-88	-17.5
SA5C	0.104	0.104	28-Oct-86	0
SA5C	0.103	0.103	19-May-87	17
SA5C	0.100	0.104	05-May-88	-8
SB2	0.103	0.105	28-Oct-86	0
SB2	0.103	0.104	19-May-87	11.5
SB2	0.103	0.104	05-May-88	-10.5
SB2B	0.103	0.106	28-Oct-86	0
SB2B	0.104	0.106	19-May-87	13
SB2B	0.106	0.099	05-May-88	-16
SB2C	0.104	0.105	28-Oct-86	0
SB2C	0.105	0.106	19-May-87	21.5
SB2C	0.103	0.103	05-May-88	-19
SB4	0.105	0.104	28-Oct-86	0
SB4	0.104	0.104	19-May-87	2
SB4	0.105	0.104	05-May-88	-1
SB4B	0.104	0.105	28-Oct-86	0
SB4B	0.104	0.105	19-May-87	22
SB4B	0.102	0.100	05-May-88	-27
SB4C	0.103	0.103	28-Oct-86	0
SB4C	0.102	0.104	19-May-87	11.5

Gabion Data

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LOCATION	CONDITION	A-STR	B-STR	AVG-STR	WT-A	WT-B	AVG-WT
SB4C	C	664	665	664	4.11	4.22	4.165
SBG	G	847	696	771	5.54	5.54	5.540
SBG	G	715	856	785	5.54	5.50	5.520
SBG	G	699	833	766	5.35	5.31	5.330
SC2	P	689	662	675	4.23	4.18	4.205
SC2	P	679	703	691	4.21	4.24	4.225
SC2	P	614	698	656	4.33	4.23	4.280
SC2B	B	653	676	664	4.25	4.27	4.260
SC2B	B	661	681	671	4.23	4.27	4.250
SC2B	B	661	650	655	4.20	4.07	4.135
SC2C	C	721	599	660	4.23	4.26	4.245
SC2C	C	715	616	665	4.24	4.27	4.255
SC2C	C	709	597	653	4.17	4.21	4.190
SC4	P	690	644	667	4.21	4.23	4.220
SC4	P	702	663	682	4.26	4.18	4.220
SC4	P	630	695	662	4.20	4.24	4.220
SC4B	B	655	664	659	4.32	4.18	4.250
SC4B	B	659	660	659	4.13	4.29	4.210
SC4B	B	658	647	652	4.08	4.29	4.185
SC4C	C	687	688	687	4.31	4.27	4.290
SC4C	C	713	679	696	4.28	4.22	4.250
SC4C	C	678	672	675	4.18	4.19	4.185
SCG	G	818	726	772	5.34	5.44	5.390
SCG	G	840	747	793	5.33	5.43	5.380
SCG	G	727	807	767	5.27	5.15	5.210
SD2	P	613	702	657	4.35	4.20	4.275
SD2	P	726	620	673	4.20	4.34	4.270
SD2	P	716	615	665	4.19	4.35	4.270
SD2B	B	667	648	657	4.21	4.26	4.235
SD2B	B	665	666	665	4.35	4.22	4.285
SD2B	B	628	657	642	4.26	4.15	4.205
SD2C	C	689	704	696	4.35	4.20	4.275
SD2C	C	725	689	707	4.23	4.36	4.295
SD2C	C	708	668	688	4.17	4.25	4.210
SD4	P	688	612	650	4.21	4.36	4.285
SD4	P	698	648	673	4.23	4.35	4.290
SD4	P	614	698	656	4.33	4.23	4.280
SD4B	B	702	668	685	4.22	4.36	4.290
SD4B	B	676	707	691	4.32	4.24	4.280
SD4B	B	667	693	680	4.19	4.09	4.140
SD4C	C	661	647	654	4.17	4.39	4.280
SD4C	C	650	661	655	4.37	4.21	4.290
SD4C	C	646	660	653	4.36	4.14	4.250
SDG	G	710	793	751	5.44	5.30	5.370
SDG	G	743	802	772	5.44	5.32	5.380
SDG	G	751	776	763	5.21	5.08	5.145
SE2	P	646	666	656	4.34	4.23	4.285
SE2	P	677	660	668	4.20	4.36	4.280
SE2	P	648	672	660	4.36	4.23	4.295
SE2B	B	665	684	674	4.22	4.34	4.280
SE2B	B	695	698	696	4.37	4.23	4.300
SE2B	B	665	671	668	4.19	4.12	4.155
SE2C	C	732	613	672	4.24	4.34	4.290

Gabion Data

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LOCATION	DIA-A	DIA-B	DATE	DELTA/STRENGTH
SB4C	0.100	0.103	05-May-88	-5
SBG	0.118	0.118	28-Oct-86	0
SBG	0.119	0.119	19-May-87	14
SBG	0.117	0.116	05-May-88	-19.5
SC2	0.103	0.103	28-Oct-86	0
SC2	0.103	0.103	19-May-87	15.5
SC2	0.105	0.104	05-May-88	-35
SC2B	0.103	0.103	28-Oct-86	0
SC2B	0.104	0.105	19-May-87	6.5
SC2B	0.100	0.100	05-May-88	-15.5
SC2C	0.103	0.104	28-Oct-86	0
SC2C	0.103	0.104	19-May-87	5.5
SC2C	0.102	0.100	05-May-88	-12.5
SC4	0.103	0.104	28-Oct-86	0
SC4	0.104	0.103	19-May-87	15.5
SC4	0.104	0.103	05-May-88	-20
SC4B	0.105	0.104	28-Oct-86	0
SC4B	0.103	0.105	19-May-87	0
SC4B	0.099	0.103	05-May-88	-7
SC4C	0.104	0.105	28-Oct-86	0
SC4C	0.104	0.104	19-May-87	8.5
SC4C	0.102	0.101	05-May-88	-21
SCG	0.116	0.117	28-Oct-86	0
SCG	0.118	0.120	19-May-87	21.5
SCG	0.116	0.113	05-May-88	-26.5
SD2	0.105	0.103	28-Oct-86	0
SD2	0.103	0.105	19-May-87	15.5
SD2	0.103	0.105	05-May-88	-7.5
SD2B	0.103	0.105	28-Oct-86	0
SD2B	0.105	0.104	19-May-87	8
SD2B	0.101	0.101	05-May-88	-23
SD2C	0.105	0.103	28-Oct-86	0
SD2C	0.103	0.105	19-May-87	10.5
SD2C	0.101	0.102	05-May-88	-19
SD4	0.104	0.105	28-Oct-86	0
SD4	0.102	0.105	19-May-87	23
SD4	0.105	0.104	05-May-88	-17
SD4B	0.104	0.107	28-Oct-86	0
SD4B	0.104	0.104	19-May-87	6.5
SD4B	0.101	0.101	05-May-88	-11.5
SD4C	0.103	0.105	28-Oct-86	0
SD4C	0.106	0.104	19-May-87	1.5
SD4C	0.105	0.101	05-May-88	-2.5
SDG	0.118	0.116	28-Oct-86	0
SDG	0.121	0.116	19-May-87	21
SDG	0.115	0.113	05-May-88	-9
SE2	0.105	0.104	28-Oct-86	0
SE2	0.106	0.105	19-May-87	12.5
SE2	0.105	0.104	05-May-88	-8.5
SE2B	0.104	0.105	28-Oct-86	0
SE2B	0.105	0.104	19-May-87	22
SE2B	0.102	0.100	05-May-88	-28.5
SE2C	0.104	0.105	28-Oct-86	0

Gabion Data

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LOCATION	CONDITION	A-STR	B-STR	AVG-STR	WT-A	WT-B	AVG-WT
SE2C	C	754	617	685	4.27	4.36	4.315
SE2C	C	595	724	659	4.22	4.17	4.195
SE4	P	638	717	677	4.35	4.24	4.295
SE4	P	728	662	695	4.23	4.36	4.295
SE4	P	709	645	677	4.23	4.35	4.290
SE4B	B	673	640	656	4.28	4.32	4.300
SE4B	B	666	682	674	4.29	4.27	4.280
SE4B	B	634	674	654	4.09	4.20	4.145
SE4C	C	665	633	649	4.23	4.30	4.265
SE4C	C	636	643	639	4.26	4.22	4.240
SE4C	C	619	642	630	4.29	4.22	4.255
SEG	G	736	734	735	5.46	5.62	5.540
SEG	G	723	740	731	5.49	5.55	5.520
SEG	G	699	722	710	5.27	5.25	5.260
SF2	P	633	632	632	4.38	4.13	4.255
SF2	P	648	648	648	4.42	4.10	4.260
SF2	P	637	624	630	4.37	4.09	4.230
SF2B	B	640	658	649	4.30	4.19	4.245
SF2B	B	674	666	670	4.21	4.29	4.250
SF2B	B	634	650	642	4.10	4.14	4.120
SF2C	C	727	645	686	4.44	4.19	4.315
SF2C	C	749	659	704	4.46	4.21	4.335
SF2C	C	726	640	683	4.48	4.00	4.240
SF4	P	690	634	662	4.22	4.29	4.255
SF4	P	653	726	689	4.33	4.19	4.260
SF4	P	690	647	668	4.20	4.30	4.250
SF4B	B	661	641	651	4.22	4.38	4.300
SF4B	B	658	687	672	4.34	4.24	4.290
SF4B	B	639	655	647	4.29	4.17	4.230
SF4C	C	631	708	669	4.23	4.22	4.225
SF4C	C	657	722	689	4.24	4.20	4.220
SF4C	C	707	635	671	4.20	4.17	4.185
SFG	G	841	708	774	5.54	5.54	5.540
SFG	G	728	880	804	5.57	5.52	5.545
SFG	G	837	708	772	5.22	5.15	5.185
SG2	P	683	660	671	4.26	4.32	4.290
SG2	P	664	699	681	4.32	4.29	4.305
SG2	P	681	671	676	4.26	4.32	4.290
SG2B	B	645	700	672	4.21	4.31	4.260
SG2B	B	715	655	685	4.29	4.22	4.255
SG2B	B	639	707	673	4.10	4.22	4.160
SG2C	C	622	625	623	4.17	4.39	4.280
SG2C	C	628	624	626	4.41	4.16	4.285
SG2C	C	611	610	610	4.13	4.39	4.260
SG4	P	637	701	669	4.34	4.17	4.255
SG4	P	649	729	689	4.36	4.20	4.280
SG4	P	696	627	661	4.21	4.25	4.230
SG4B	B	663	648	655	4.29	4.22	4.255
SG4B	B	655	683	669	4.22	4.23	4.225
SG4B	B	635	653	644	4.20	4.20	4.200
SG4C	C	672	625	648	4.35	4.24	4.295
SG4C	C	651	697	674	4.27	4.22	4.245
SG4C	C	621	676	648	4.23	4.22	4.225

Gabion Data

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LOCATION	DIA-A	DIA-B	DATE	DELTA/STRENGTH
SE2C	0.104	0.105	19-May-87	13
SE2C	0.103	0.101	05-May-88	-26
SE4	0.105	0.103	28-Oct-86	0
SE4	0.103	0.105	19-May-87	17.5
SE4	0.104	0.105	05-May-88	-18
SE4B	0.104	0.104	28-Oct-86	0
SE4B	0.104	0.104	19-May-87	17.5
SE4B	0.101	0.102	05-May-88	-20
SE4C	0.104	0.104	28-Oct-86	0
SE4C	0.103	0.104	19-May-87	-9.5
SE4C	0.110	0.105	05-May-88	-9
SEG	0.118	0.120	28-Oct-86	0
SEG	0.120	0.119	19-May-87	-3.5
SEG	0.117	0.115	05-May-88	-21
SF2	0.105	0.104	28-Oct-86	0
SF2	0.106	0.103	19-May-87	15.5
SF2	0.105	0.102	05-May-88	-17.5
SF2B	0.104	0.103	28-Oct-86	0
SF2B	0.104	0.105	19-May-87	21
SF2B	0.101	0.101	05-May-88	-28
SF2C	0.105	0.103	28-Oct-86	0
SF2C	0.107	0.104	19-May-87	18
SF2C	0.108	0.100	05-May-88	-21
SF4	0.103	0.104	28-Oct-86	0
SF4	0.105	0.104	19-May-87	27.5
SF4	0.103	0.104	05-May-88	-21
SF4B	0.103	0.105	28-Oct-86	0
SF4B	0.107	0.104	19-May-87	21.5
SF4B	0.102	0.103	05-May-88	-25.5
SF4C	0.103	0.104	28-Oct-86	0
SF4C	0.104	0.104	19-May-87	20
SF4C	0.101	0.101	05-May-88	-18.5
SFG	0.118	0.119	28-Oct-86	0
SFG	0.120	0.118	19-May-87	29.5
SFG	0.115	0.114	05-May-88	-31.5
SG2	0.104	0.104	28-Oct-86	0
SG2	0.108	0.104	19-May-87	10
SG2	0.104	0.104	05-May-88	-5.5
SG2B	0.103	0.104	28-Oct-86	0
SG2B	0.106	0.103	19-May-87	12.5
SG2B	0.100	0.101	05-May-88	-12
SG2C	0.103	0.105	28-Oct-86	0
SG2C	0.106	0.103	19-May-87	2.5
SG2C	0.106	0.109	05-May-88	-15.5
SG4	0.105	0.103	28-Oct-86	0
SG4	0.106	0.103	19-May-87	20
SG4	0.104	0.103	05-May-88	-27.5
SG4B	0.105	0.103	28-Oct-86	0
SG4B	0.104	0.104	19-May-87	13.5
SG4B	0.106	0.103	05-May-88	-25
SG4C	0.105	0.103	28-Oct-86	0
SG4C	0.104	0.104	19-May-87	25.5
SG4C	0.107	0.107	05-May-88	-25.5

Gabion Data

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LOCATION	CONDITION	A-STR	B-STR	AVG-STR	WT-A	WT-B	AVG-WT
SH2	P	678	619	648	4.27	4.16	4.215
SH2	P	680	629	654	4.24	4.14	4.190
SH2	P	624	674	649	4.16	4.26	4.210
SH2B	B	713	625	669	4.23	4.25	4.240
SH2B	B	730	657	693	4.21	4.25	4.230
SH2B	B	632	704	668	4.21	4.18	4.195
SH2C	C	637	706	671	4.35	4.23	4.290
SH2C	C	663	703	683	4.32	4.21	4.265
SH2C	C	630	694	662	4.13	4.14	4.135
SH4	P	666	655	660	4.27	4.19	4.230
SH4	P	687	668	677	4.26	4.19	4.225
SH4	P	654	668	661	4.21	4.26	4.235
SH4B	B	685	649	667	4.24	4.31	4.275
SH4B	B	683	701	692	4.34	4.26	4.300
SH4B	B	651	687	669	4.30	4.23	4.265
SH4C	C	614	608	611	4.41	4.16	4.285
SH4C	C	630	626	628	4.17	4.41	4.290
SH4C	C	614	599	606	4.17	4.16	4.165
SI2	P	632	709	670	4.36	4.22	4.290
SI2	P	651	725	688	4.38	4.20	4.290
SI2	P	640	715	677	4.34	4.20	4.270
SI2B	B	603	715	659	4.28	4.23	4.255
SI2B	B	727	620	673	4.22	4.26	4.240
SI2B	B	717	607	662	4.22	4.24	4.230
SI2C	C	669	655	662	4.21	4.27	4.240
SI2C	C	679	666	672	4.15	4.22	4.185
SI2C	C	645	646	645	4.20	4.10	4.150
SI4	P	624	751	687	4.32	4.32	4.320
SI4	P	644	718	681	4.30	4.26	4.280
SI4	P	627	695	661	4.30	4.27	4.285
SI4B	B	717	606	661	4.22	4.36	4.290
SI4B	B	612	737	674	4.34	4.23	4.285
SI4B	B	595	709	652	4.31	4.18	4.245
SI4C	C	648	667	657	4.29	4.30	4.295
SI4C	C	661	671	666	4.31	4.29	4.300
SI4C	C	650	629	639	4.18	4.05	4.115

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LOCATION	DIA-A	DIA-B	DATE	DELTA/STRENGTH
SH2	0.104	0.103	28-Oct-86	0
SH2	0.103	0.103	19-May-87	6
SH2	0.103	0.104	05-May-88	-5.5
SH2B	0.104	0.104	28-Oct-86	0
SH2B	0.106	0.104	19-May-87	24.5
SH2B	0.101	0.101	05-May-88	-25.5
SH2C	0.104	0.103	28-Oct-86	0
SH2C	0.105	0.103	19-May-87	11.5
SH2C	0.101	0.100	05-May-88	-21
SH4	0.105	0.103	28-Oct-86	0
SH4	0.106	0.103	19-May-87	17
SH4	0.103	0.104	05-May-88	-16.5
SH4B	0.104	0.105	28-Oct-86	0
SH4B	0.105	0.104	19-May-87	25
SH4B	0.107	0.106	05-May-88	-23
SH4C	0.105	0.103	28-Oct-86	0
SH4C	0.103	0.106	19-May-87	17
SH4C	0.108	0.102	05-May-88	-21.5
SI2	0.105	0.103	28-Oct-86	0
SI2	0.106	0.102	19-May-87	17.5
SI2	0.105	0.104	05-May-88	-10.5
SI2B	0.103	0.103	28-Oct-86	0
SI2B	0.107	0.105	19-May-87	14.5
SI2B	0.102	0.103	05-May-88	-11.5
SI2C	0.104	0.104	28-Oct-86	0
SI2C	0.104	0.104	19-May-87	10.5
SI2C	0.102	0.102	05-May-88	-27
SI4	0.104	0.104	28-Oct-86	0
SI4	0.104	0.104	19-May-87	-6.5
SI4	0.104	0.104	05-May-88	-20
SI4B	0.105	0.103	28-Oct-86	0
SI4B	0.106	0.104	19-May-87	13
SI4B	0.102	0.101	05-May-88	-22.5
SI4C	0.104	0.104	28-Oct-86	0
SI4C	0.106	0.105	19-May-87	8.5
SI4C	0.102	0.101	05-May-88	-26.5

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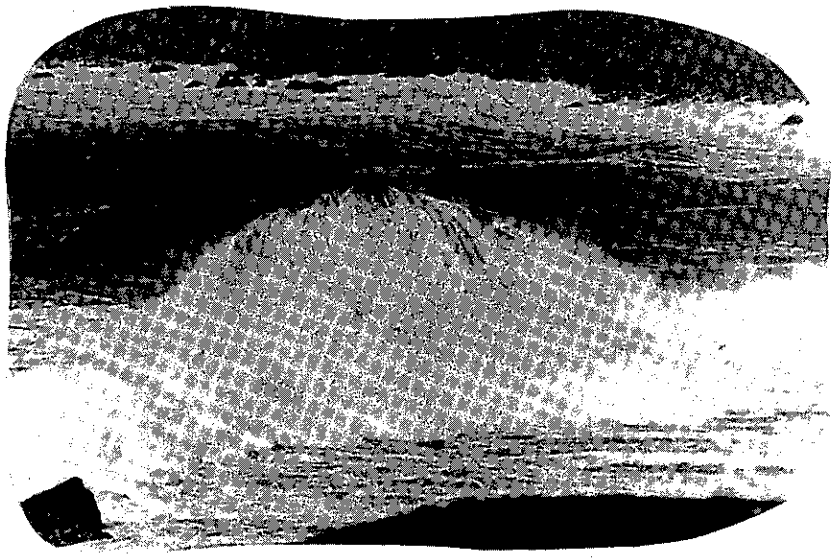

APPENDIX C

Comparative Photos

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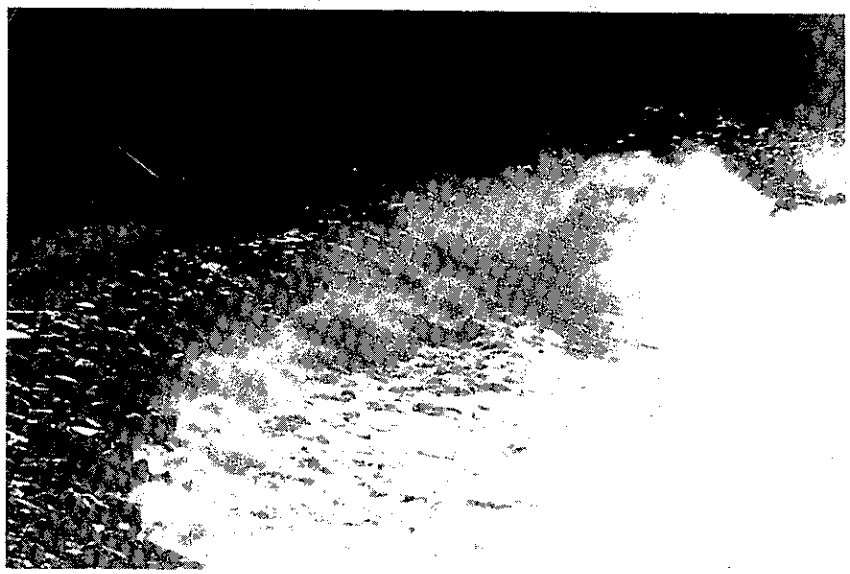
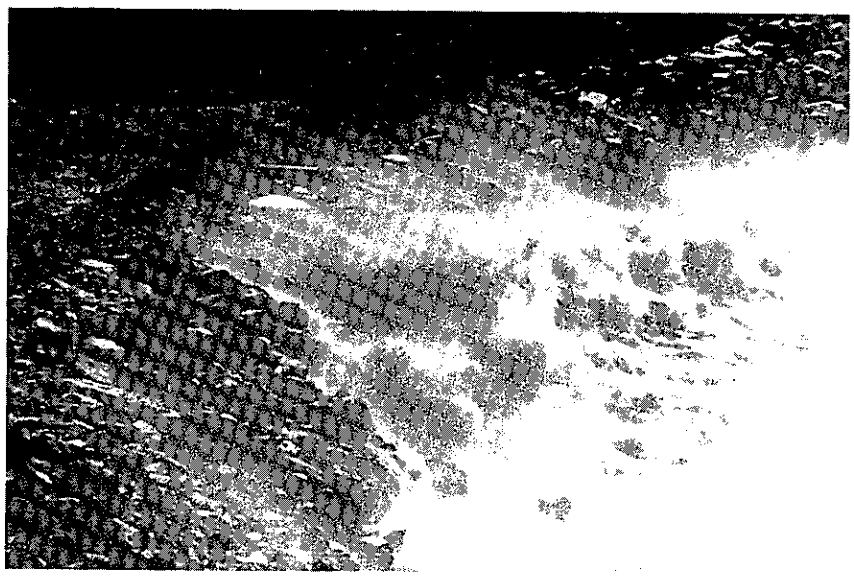


Site 1 Wave Breaking



Site 1 Wave run up

Wave Attack at Mattress Installations

FIGURE C1

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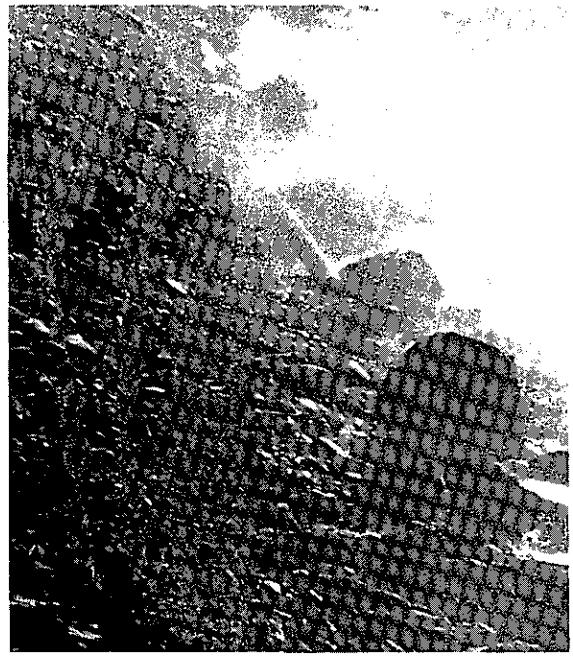
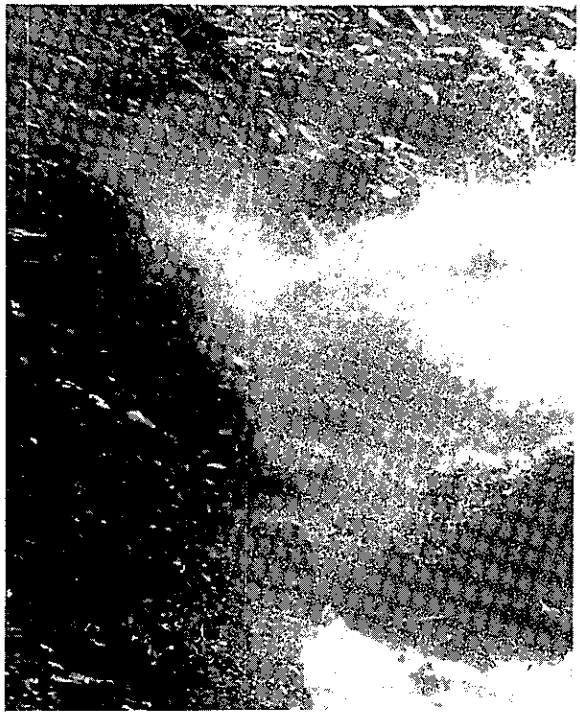


Wave out

Wave incoming



Wave Peak Attack

Wave Attack at Wall Installations

Figure C2

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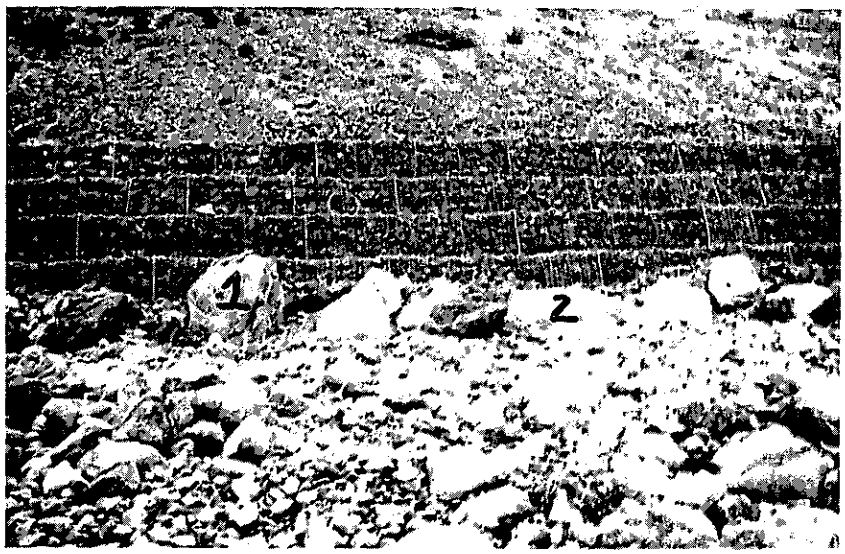
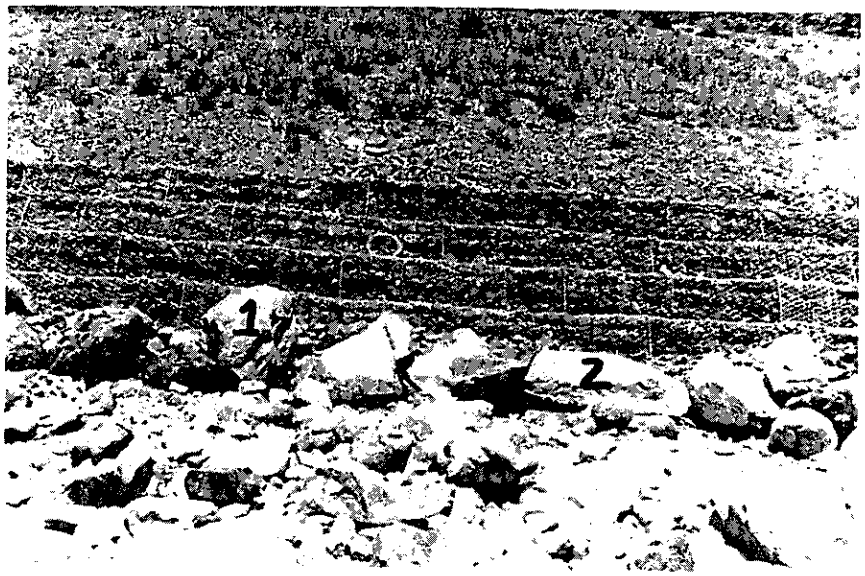
ClibPDF - www.fastio.com



Overview Site
May 3, 19878

Same View,
May 1988
Note increased
scour exposing
more of rocks 1 & 2



Wave Action Effects

Figure C3

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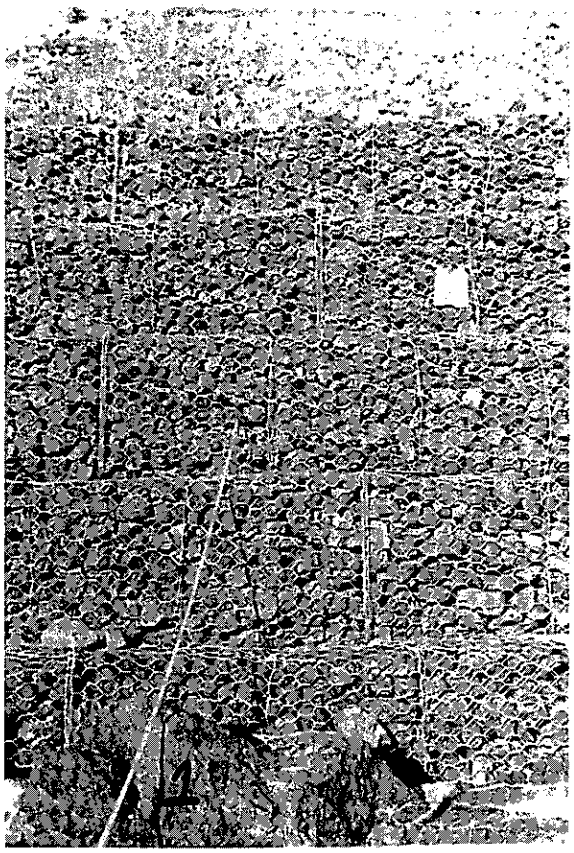
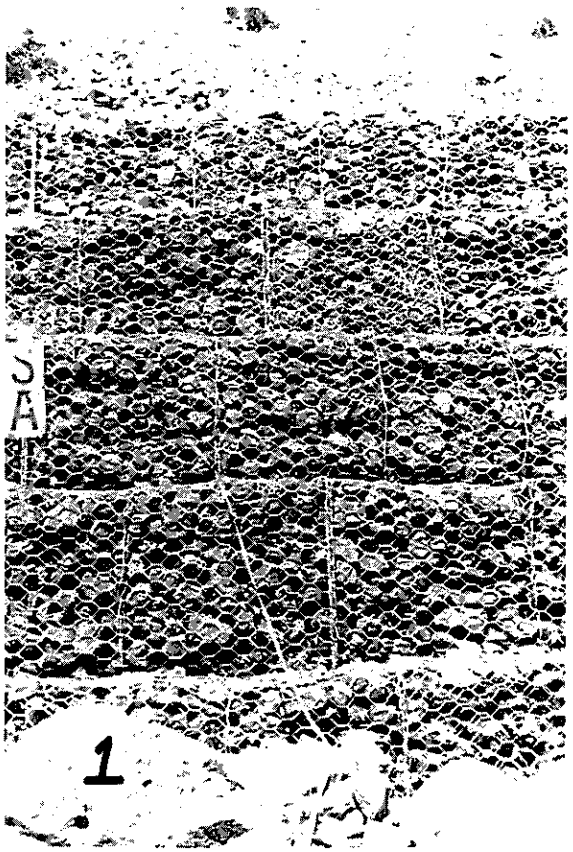


Site 3
Photo Point SA
October 1986- Long
perspective.
Tape attached to
permanent wire marker.



Site 3
Photo Point SA
May 1988 - Long
perspective.
Tape at same wire
marker, new "ID"
letters.

Example of Long Perspective Photo Points

Figure C4

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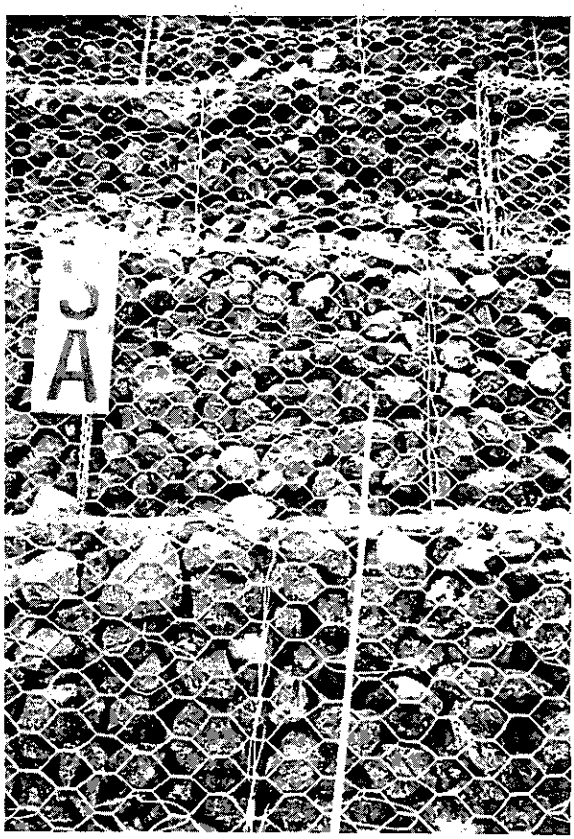
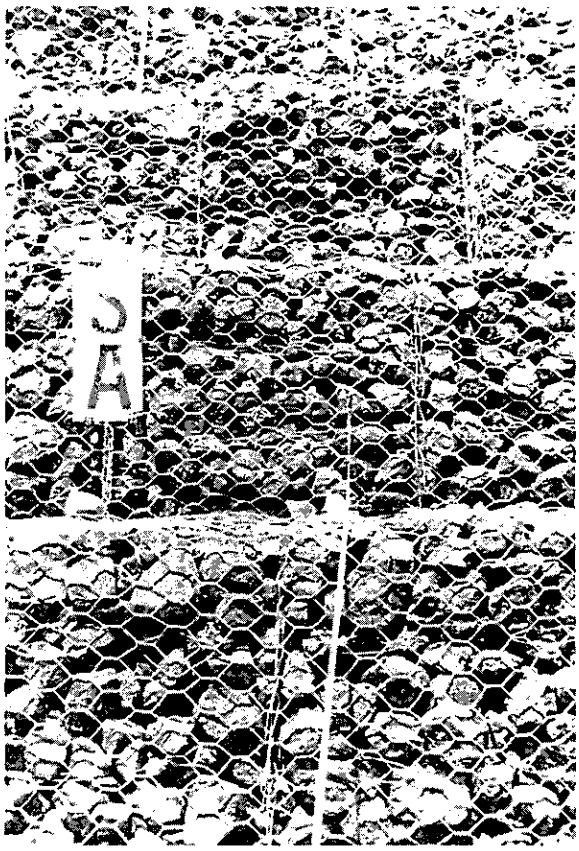


Site 3 Photo Point
SA- Close perspective
May 1987

Site 3 Photo Point
SA- Close perspective
May 1988



Example of Close Perspective Photo Points

Figure C5

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ClibPDF - www.fastio.com

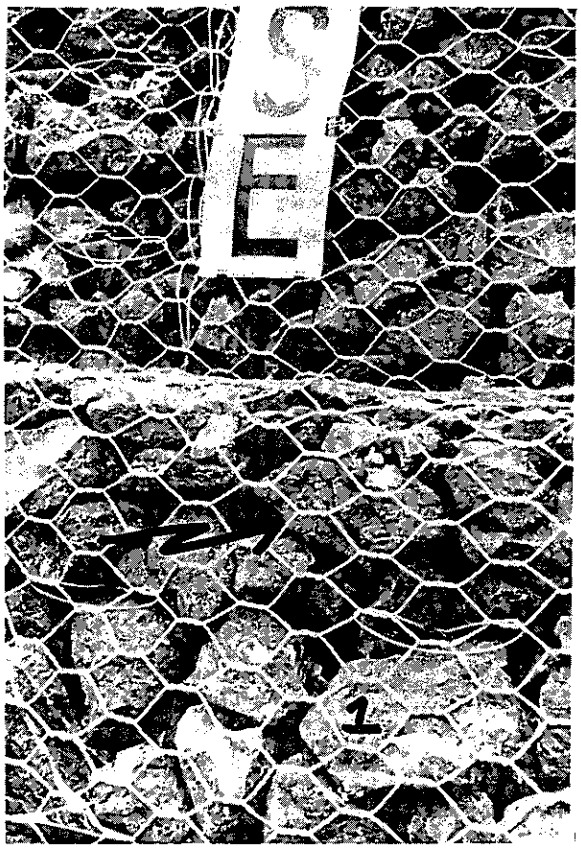
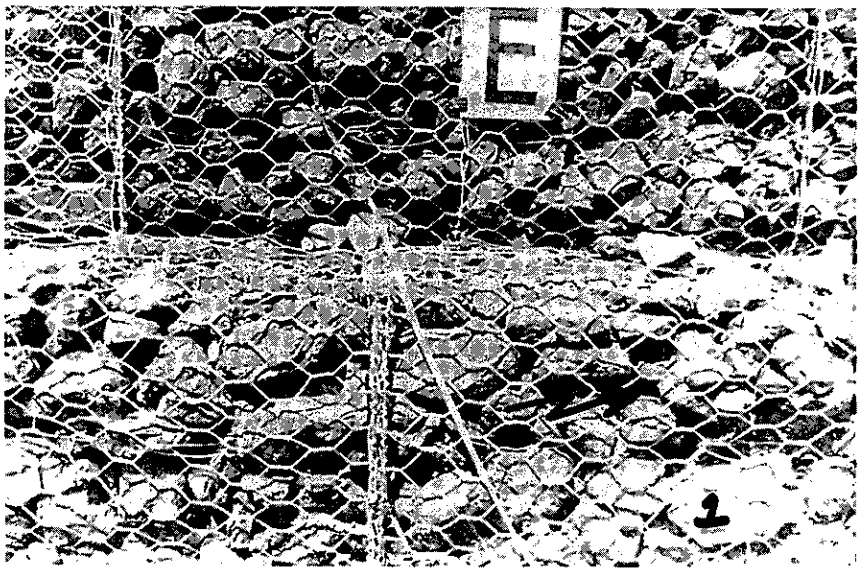


Photo Point SE
Rock condition
May 1987

Photo Point SE
Rock condition
May 1988. Note
rock deterioration,
arrows in both
pictures are in
same wire cell.



Rock Survivability Monitoring, Also See Figure C7

Figure C6

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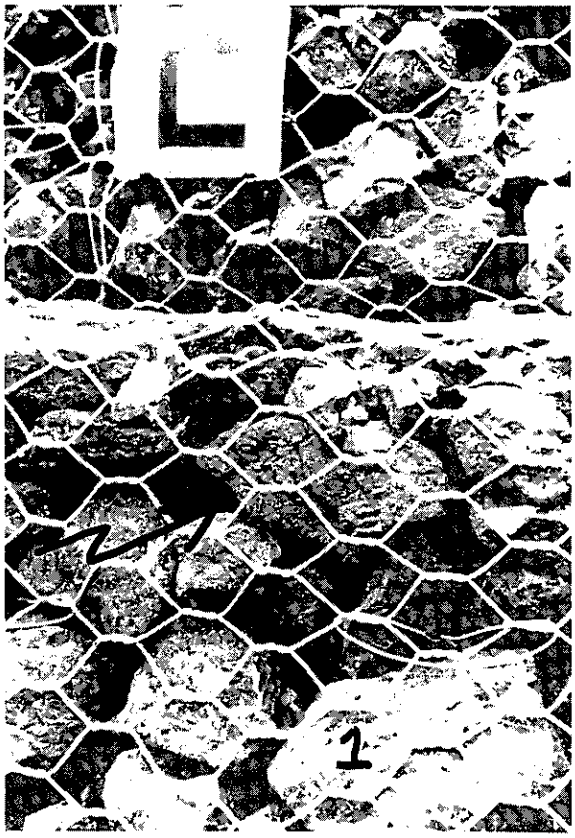

Photo Point SE
close up of Rock
condition - May 1987

Photo Point SE
Close up of
Rock condition
May 1988

Rock Survivability Monitoring, Alse see Figure C6

Figure C7

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ClibPDF - www.fastio.com

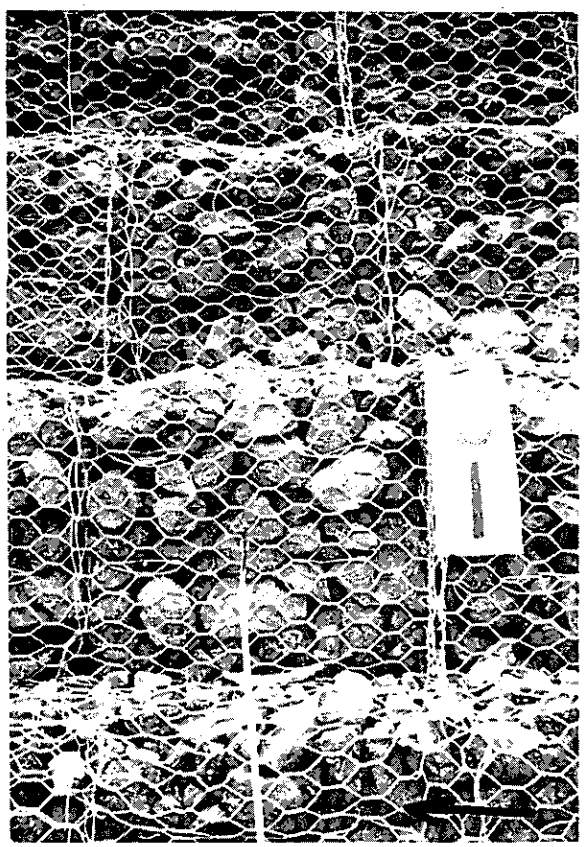


Photo Point SI wire configuration, durability monitoring May 1987. Note bulge from impact.

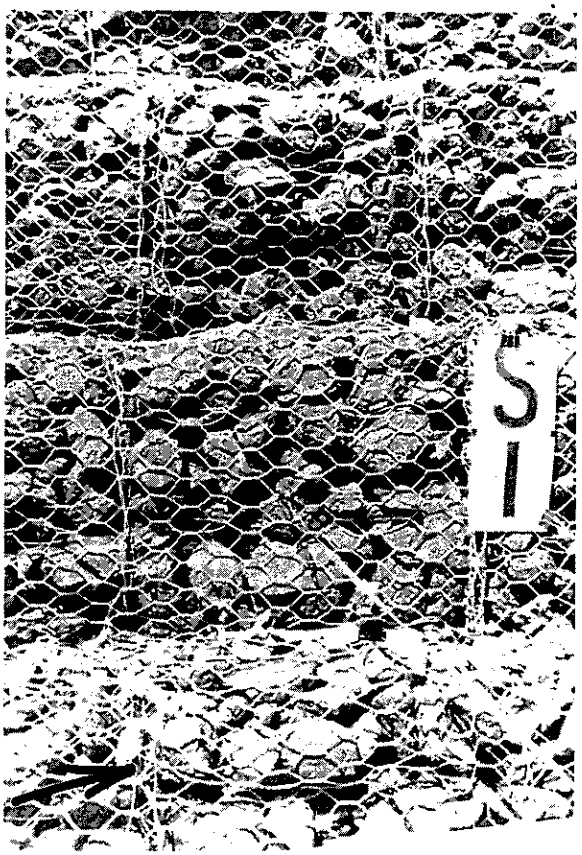


Photo Point SI wire configuration, durability monitoring May 1988. Note bulge from impact.

Wire Bulging from Impact

Figure C8

ClibPDF - www.fastio.com

ClibPDF - www.fastio.com

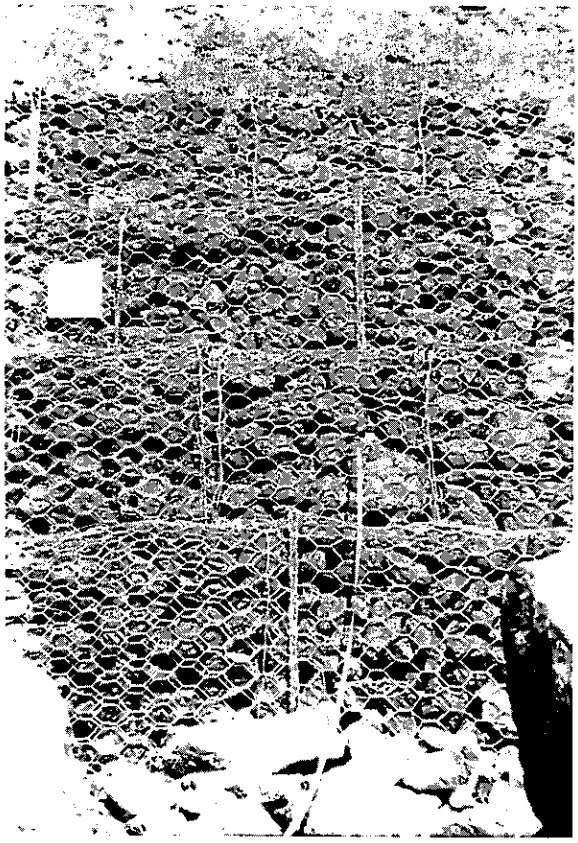
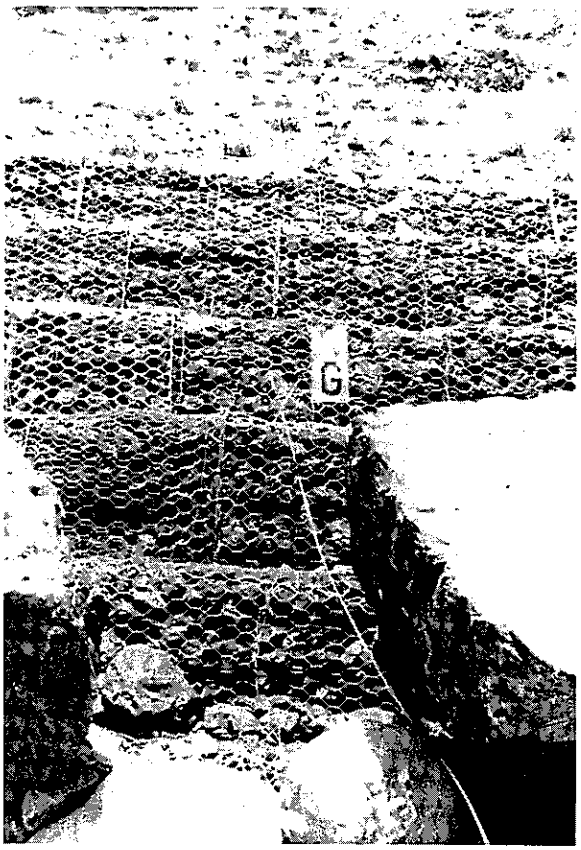


Photo Point NG
Long perspective
October 1986, note
debris at toe.

Photo Point NG
Long perspective
October 1988.
Notescour of debris
shown in 86 photo
above.



Debris movement at Wall Toe

Figure C9

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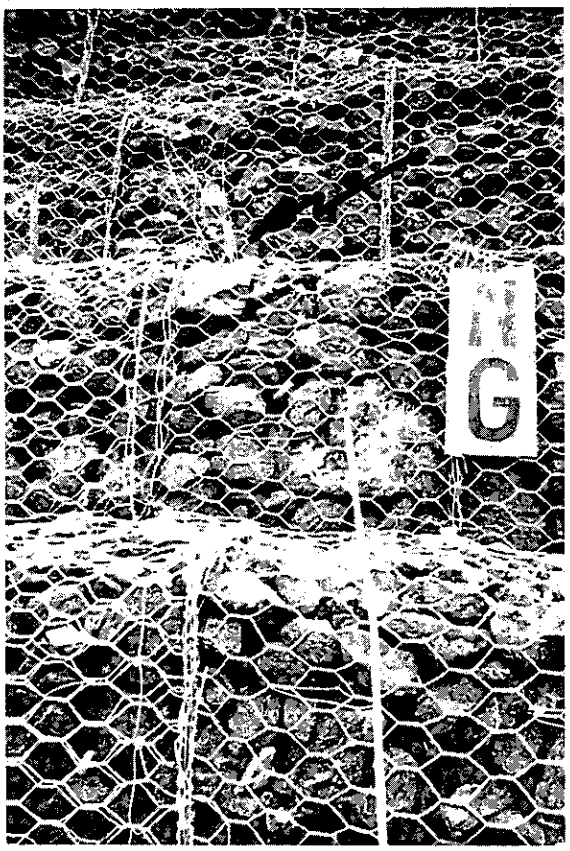

Photo Point NG
May 1987
Close perspective,
note weeds.

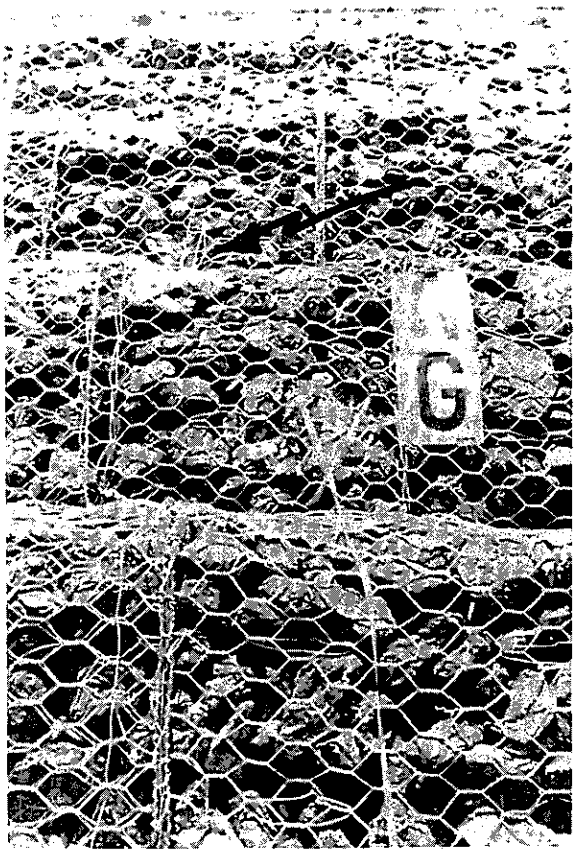

Photo Point NG
Close perspective
May 1988, note
weeds are still
barely visible.

Some Growth in Upper Wall Levels

Figure C10

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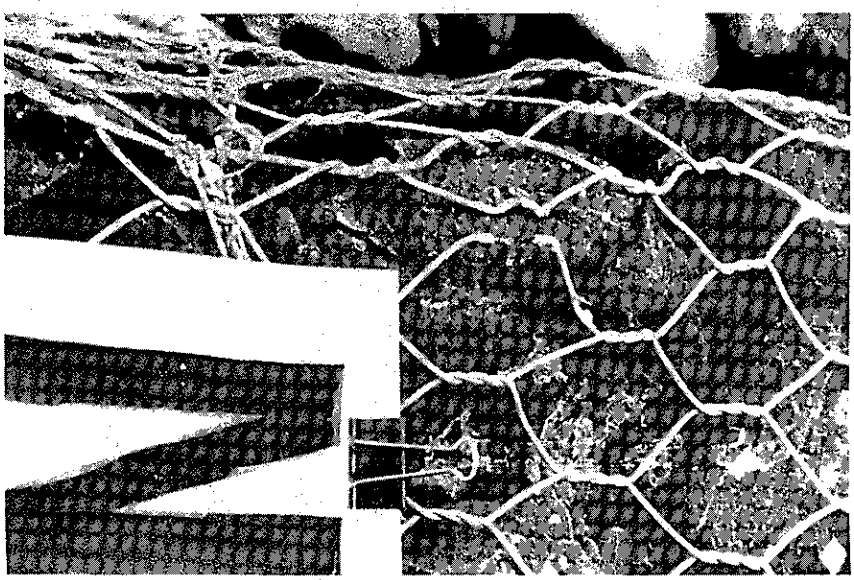
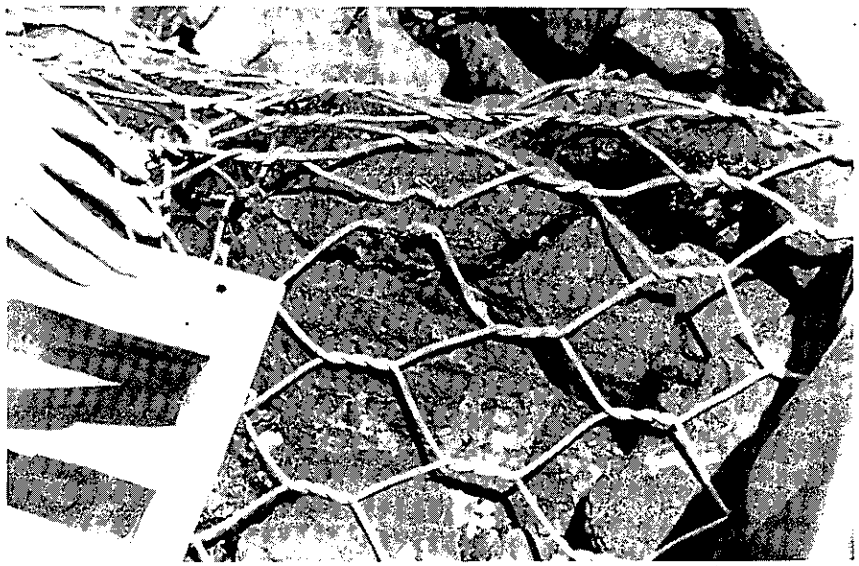


Construction damage to wire May 1987

Same damage as of May 1988.



Construction Damage to Staple

Figure C11

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Relative rock position
monitoring- base photo
October 1986

Rock position
monitoring photo
May 1988

Rock Position Monitoring with Little Movement

Figure C12

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Rock position
monitoring May 1987
Note culvert.

Rock position
monitoring May 1988
Slightly lower
perspective due to
movement of
available camera
point, rocks
moved.

Movement of Camera Location for Photos

Figure C13

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Rock position
monitoring May 1987

Rock position
Monitoring May 1988
Translation/
Rotation of 1 and
Rotation of 2.

Rock Position Monitoring with Movement

Figure C14

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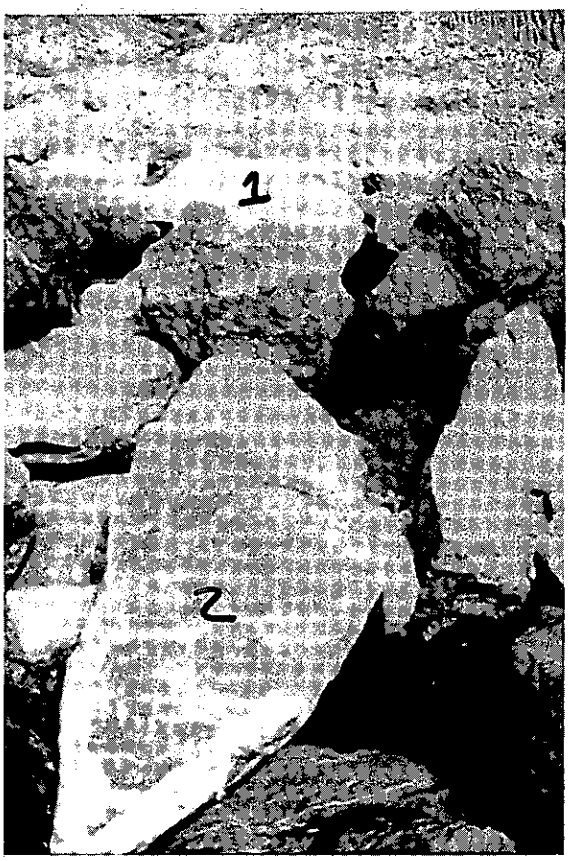
ClibPDF - www.fastio.com



Rock position monitoring
October 1986

Rock position
Monitoring May 1988
with relative shift
of 1 and 2

Rock Translations from Wave Attack

Figure C15

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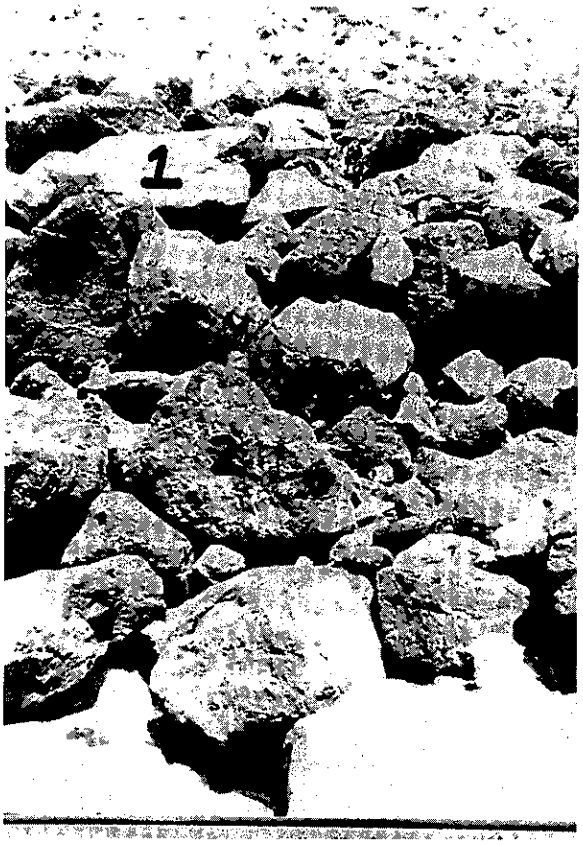
ClibPDF - www.fastio.com

Rock position
monitoring October 1986



Rock position monitoring
May 1988.
Note rock 3 is gone, and
2 has shifted
relative to rock 1.

Relative Rock Movement from Wave Action

Figure C16

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ClibPDF - www.fastio.com