# SCRAP TIRE SHORE PROTECTION STRUCTURES


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## INTRODUCTION

The physical indestructibility of today's tires, a vexing problem when trying to dispose of them, has been utilized to the utmost in this innovative approach to solving one of our nation's most stubborn solid waste problems. "What to do with old worn out automobile tires."

Researchers with The Goodyear Tire & Rubber Company believe that the scrap tire shore protection mats will not only help solve a pollution problem, but will have the added benefit of improving our marine habitat and saving energy via the reuse effort.

For years our marine designers have indicated that they could solve many of the world's shore protection problems if someone would come up with a relatively thin mat that could absorb, without being destroyed, large amounts of energy, and that was unlimited in its breadth and length dimensions, and that could be made to either float or sink.

The proposed Goodyear scrap tire shore protection structures have great potential and they come at a price that anyone can afford to pay.

The general consensus of all the individuals knowledgeable of the latest Goodyear 18 tire modular construction system is that this unique construction technology is indeed a major break-through in the design of shore protection structures, and that the resulting tire structures have an excellent chance of helping to manage our nation's marine environment in the future.

These structures when properly constructed and installed will be useful as floating breakwaters, on-shore beach erosion mats, sand dune stabilization mats, marshland protection mats, river and stream bank erosion mats, and floating artificial reefs.

Construction

The proposed mat designs rely on a modular construction concept where a relatively few tires are secured together to form a small easily assembled, portable building unit which serves as the basic building block for constructing very large structures.

The construction procedure is quite simple. First, the modular unit is constructed. This is done by securing 18 individual tires together to form a 7' x 6 1/2' x 2 1/2' tightly interlocked bundle of scrap tires.

The basic method used to construct the tire modules is to stack the tires flat, but vertically, in a 3-2-3-2-3-2-3 combination - as shown in sketch #1 - weaving the tying material through as you go. The increasing weight of the tire stack and the physical compression of the tires by hand will compress the tires sufficiently to allow easy fastening of the typing material, and form a tightly secured bundle.

Once the modules have been constructed they can easily be transported to the assembly site.

Interconnecting modular sections require only a slight alteration in tire position and the addition of two tires per module. First, the four corner tires of each module are rotated approximately

100°, as shown in sketch #2. Next, the two additional tires are added and interlocked to form the desired shaped protective structure as shown in Sketch #3.

The resulting mat shown in sketch number 4, has excellent strength characteristics (as high as 55,000 lbs breaking strength on a 6 1/2 ft spaced longitudinal and transverse grid), and has the ability to absorb great amounts of energy by yielding and deforming when overloaded (elongation of more than 30% are possible in both directions).

It should be noted that these maximum elongations only occur under extremely high loading conditions, and that the modules do return to their normal shape under no load conditions with no permanent deformation resulting.

Scrap Tire Sources:

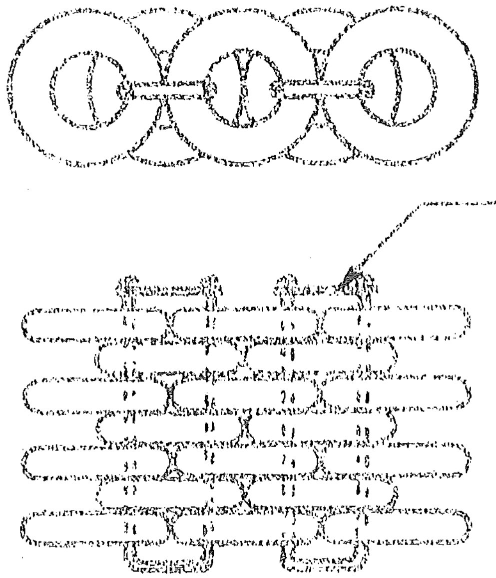
Obtaining the worn-out tires to build a scrap tire marine mat should be no problem in any area of reasonable population density. Recapping shops, service stations, and tire dealers are always looking for ways to dispose of scrap tires. Also, municipal and private waste haulers must find ways to dispose of tires which they collect.

Used tires may also be purchased. Normal charges range from $10 to $20 per ton (approximately 100 tires) delivered to your construction site. Often publicizing the need for scrap tires and providing a convenient drop off or collecting station will produce an over abundance of tires. Standard 14" and 15" passenger tires work best for marine mat applications.

## TYPICAL ASSEMBLY DETAILS OF THE PROPOSED GOODYEAR SCRAP TIRE SHORE PROTECTION MAT

(Side View)

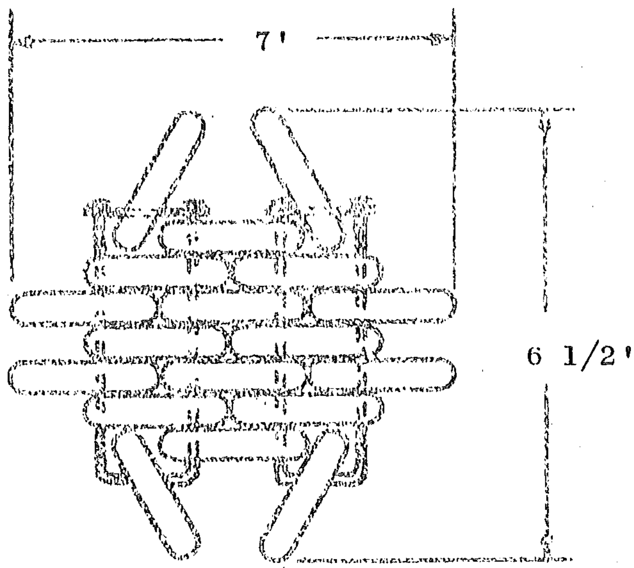
(Top View)



Interlocking devices may be special corrosion resistant steel hardware as shown or chain, rope, cable, or strap with proper fasteners.

Modular Building Unit Shown as Constructed

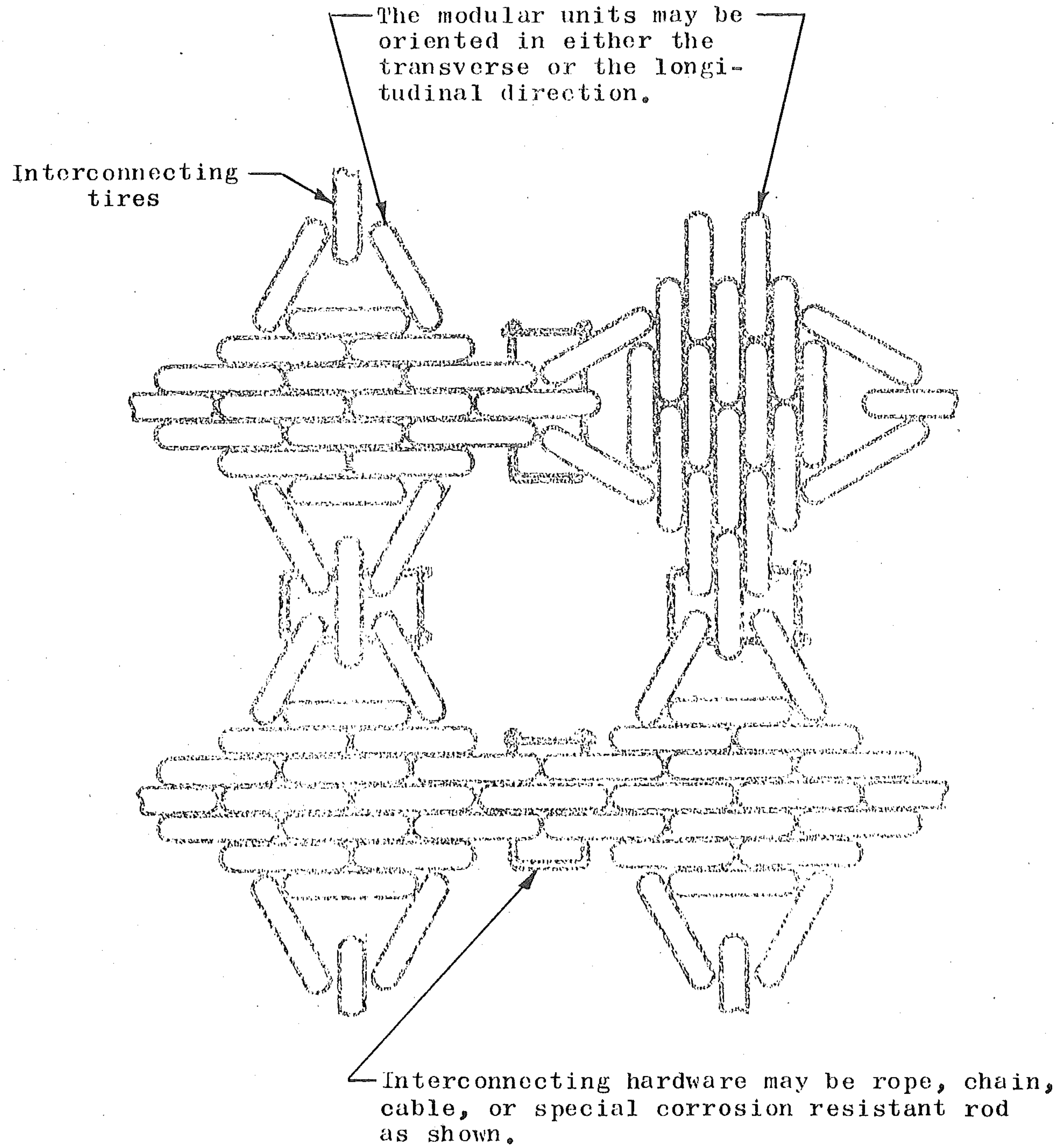
Sketch No 1




Modular Building Unit Shown as Installed

Sketch No 2

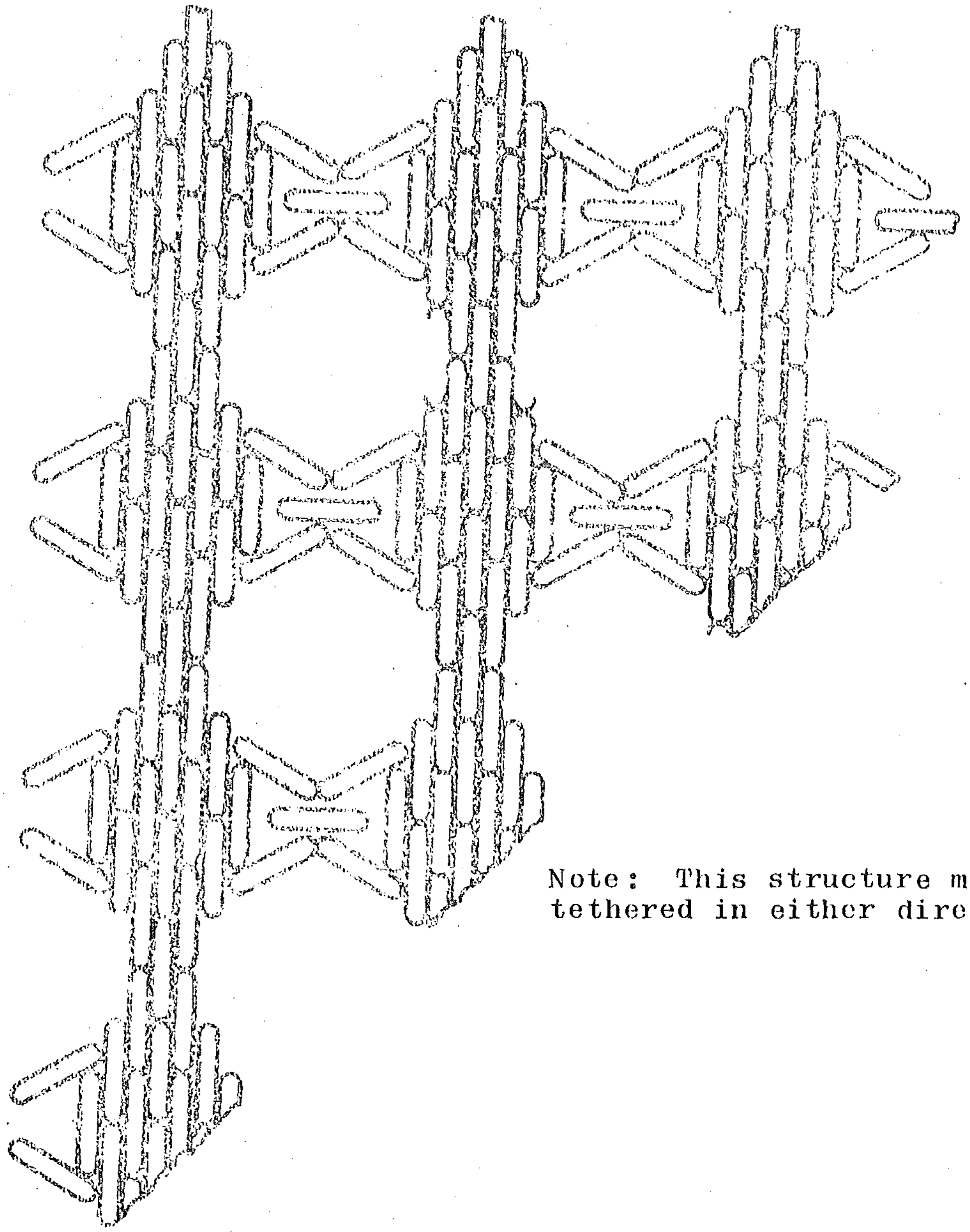
# TYPICAL ASSEMBLY DETAILS OF THE PROPOSED GOODYEAR SCRAP TIRE SHORE PROTECTION MAT




Sketch No 3

# THE PROPOSED GOODYEAR SCRAP TIRE

# SHORE PROTECTION MAT



Note: This structure may be tethered in either direction.

Sketch No 4

Selecting the Interlocking Hardware:

The type of interlocking hardware which is used in the construction of the Goodyear Scrap Tire Shore Protection Structures will be dependent upon the desired strength and expected service life of the installation. The estimated breaking strength of each interlocked tire module is about 56,000 pounds in both the longitudinal and transverse directions. This figure is calculated by using the tire bead breaking strength. An equivalent strength in the interlocking hardware would provide an optimum performance, but may not be necessary for all applications.

The interlocking hardware will represent approximately 1/3 to 1/2 the total cost of the breakwater, with labor and the mooring system composing the remaining costs. The temptation, therefore, is to economize on tying materials as much as possible. This kind of economizing should be avoided, since the interlocking material is the "weak link" in the system.

The ideal interlocking material must be able to hold together for 20 years in fresh or seawater subject to corrosion, crevacing, fatiguing, and abrasion.

Various types and sizes of chain, synthetic rope, steel cable, and plastic strap are currently being evaluated in field tests.

Of the interlocking materials currently being investigated, specially manufactured 1/2" unwelded, open link chain has to date proven to be best suited for the construction of scrap tire floating breakwaters and on-shore beach erosion mats. The open link chain has adequate strength, is easily handled, and has a long life expectancy in water. Also, it can be easily interconnected with the use of simple hand tools which eliminated the need for expensive connecting links.

While materials-testing still continues, the following has become clear: Avoid contact between dissimilar metals. The thicker the individual strands in steel cable, the longer it will last and the lower the purchase price. When wire rope is joined with oval compression sleeves, use the manufacturer's recommended number of crimps.

<u>Flotation</u>:

The basic 18 tire units as assembled weigh approximately 400 lbs; when placed in the water they weigh only about 20% of 400 lbs or 80 pounds.

An old auto tire when placed in the water vertically traps air in the crown portion of the torus shaped carcass. This trapped air provides a buoyant force sufficient to support the weight of the immersed tire, plus 10 additional pounds.

Our full scale floating breakwater testing program has demonstrated that this trapped air does provide more than adequate uniform buoyance for the basic modular construction units. But yearly maintenance will be required to replenish the trapped air supply for it is only a matter of about 2 years time before the trapped air will be dissolved into the water. Therefore, to provide maintenance free uniform flotation it is necessary that permanent flotation material be placed in each tire. Typical flotation materials are about 1/2 pounds of rigid urethane or polystyrene foams, closed cell flexible foams or air tight enclosures such as plastic bags of air, blow molded polyethylene floats, two 1/2 gallon plastic bottles, etc. Materials with a buoyancy equivalent to the trapped air volume and positioned in the same crown position will do the job nicely.

The completely uniform flotation provided by this technique is aesthetically pleasing, and will facilitate interconnecting the units in the water. The independent flotation of each unit provides a very stable installation, and the interconnecting hardware is utilized with maximum efficiency.

## Floating Breakwater Mats

Presently, scrap tire shore protection mats are being extensively investigated as low cost, mobile floating breakwaters for protection of our nation's bays, harbors, and marinas. Our preliminary research has indicated that the modular bundles of scrap tires, properly secured together, do form easily installed, readily adaptable floating breakwater barriers.

The construction procedures for the floating breakwater are identical to the basic shore protection mats with the exception of a small amount of buoyancy material being added to the crown section of each tire. Once the flotation material has been added to the scrap tires, the modular units are constructed as previously described. The modules can then be interconnected, usually in the water, to form a breakwater of the required length and width dimensions. All that is left to do is tow the breakwater into position and anchor it in place.

The floating scrap tire mat constructions are excellent examples of maximum optimization in utilizing the tires in their "as is" condition, and, therefore, result in very economical structures which are very rugged and long lasting. They are also capable of being constructed with simple hand tools, and require no special handling equipment.

Actual field tests performed by the University of Rhode Island have proven the utility of the tire mats as conventional type floating breakwater structures in lakes and sheltered ocean waters.

Due largely to the tremendous success of the URI projects, and the excellent dissemination of the results of this work, at least seven full scale, saltwater evaluations of the new 18 tire modular constructed floating breakwater mats are now underway in the Narragansett Bay area.

To demonstrate the effectiveness of these structures on small fresh water lakes, a three section 550 feet long experimental tire breakwater has been installed at the Wingfoot Lake Marina, Akron, Ohio.

A 760 feet long tire breakwater has been installed on Lake Erie at Dunkirk Harbor, New York, to evaluate the effectiveness of these structures in the Great Lake environment.

Actual on site construction experience has shown that the floating scrap tire breakwaters may be built and installed using unskilled labor and light duty mechanical equipment.

Floating breakwaters constructed with scrap tires are now a reality. Their overall performance has been documented as excellent by at least twelve full scale marine installations. Investigations of other marine applications utilizing the tire mats should now be undertaken.

Shore or Beach Stabilization Mats:

Great sums are spent annually in the United States by federal, state, and municipal governments, and by private owners for structures designed to prevent shore and beach erosion. Many of the existing traditional means of shore defenses have failed, or they have deteriorated through lack of maintenance. All of which testifies to the urgent need for the development of additional augmenting structures and associated technology for combating this problem.

The scrap tire mats properly constructed and installed have an excellent chance of helping to manage or solve this problem.

The shore or beach scrap tire mats are proposed as submerged bottom stabilizing structures. The mats will be installed on an eroding bank or beach starting at the high water mark and extending submerged well out into the water to stabilize the unconsolidated bottom materials.

The construction and installation of a large submerged tire mat will be more difficult than the floating tire mats, but alternates to simplify the handling difficulties have been conceived.

The University of Michigan is currently investigating shore and beach stabilization structures which utilize the tire mats. Plans for the installation of two such mats are now underway. One installation will be in Lake Huron at Rogers City, Michigan. This mat will be 55 feet wide and cover about 200 linear feet of shore in front of the city's waste water treatment plant. Available information indicates that as much as 40 feet of land has already been lost to eroding lake waters in this area. The second installation will be at Michiana, Michigan. This mat will be 280 feet long. It will start at the base of a 30 ft high bluff, lie partially exposed for about 10 ft, and then continue out into the lake for about 45 ft.

Permits have been applied for by Rogers City. Michiana has received approval on all permits, and the installation is now approximately one half complete. Results to date are encouraging.

The University of Michigan will publish the results of their investigations in an annual report titled "Shore Erosion Engineering Demonstration Projects".

At this point the writer would like to emphasize that this proposed usage must be documented, and proven successful in actual use, before it can be exalted as the solution to beach erosion.

Marshland Stabilization Mats:

The floating tire mat structures should work very well as marshland erosion stabilization mats. The floating structures can be constructed at easily accessible locations and then towed to the marshland problem areas.

The previous maze of tires will prevent erosion and stabilize the marsh-sea interface without seriously altering natural conditions. Tidal currents, overwash, and sea water flooding are all necessary natural fluctuating water flows which must be preserved if a viable marshland is to be maintained.

North Carolina State University is currently investigating a floating scrap tire marshland stabilization mat. The mat is on the New River estuary and protects a newly vegetated shore area. The mat was installed more than a year ago. The results to-date are encouraging.

Sand Dune Stabilization Mats:

Vegetation stabilized dunes rely on the underground parts of the plants to bind the sand material together for erosion control. At best a fragile system requiring careful management and protection, the utilization of a tire mat 30 inches thick with a maze of openings and surfaces should help the plants bind the sand material together.

The tire mats will tolerate and persist even under the most adverse conditions, and the root system, the Achille's heel of natural plants, will be afforded maximum protection to allow them to perform their excellent job of stabilizing, while the plant's foliage performs the additional, much needed function of providing a natural, aesthetically pleasing cover for the tire mats.

Natural restoration and enhancement will have an excellent opportunity of occurring, because the tire structures have a very long life.

Plans are now underway to evaluate the mats as sand dune stabilization structures at several sites on the Outer Banks of the East Coast.

Present dune stabilization systems are undependable, endangered, and expensive to maintain. Hopefully, the scrap tire modular constructed mats will augment the existing erosion control structures, and provide an alternative that is more dependable. We are presently cooperating with North Carolina State University and the Skidaway Institute of Oceanography, at Savannah, Georgia, on this project.

The tire dune stabilization mats can be furnished and installed for as little as 30¢ per sq ft, that is about $13,000 per acre.

River and Stream Bank Erosion Mats:

Researchers with the U S Army Corps of Engineers, at the Waterways Experimental Station in Vicksburg, Mississippi, are planning to investigate the new modular construction technique for preparing tire mats for erosion control on river and stream banks. Erosion of our river and stream banks is a major concern and millions of dollars are spent yearly to combat this problem.

Floating Artificial Reefs:

The floating scrap tire breakwater structures will attract and concentrate marine life and provide an ideal habitat for propagation, possibly better than bottom reefs at some sites. These structures, therefore, may be considered as floating artificial reefs. This provides yet another opportunity for investigation.

Design and Cost Considerations for 3-Foot High Waves:

Many full scale field tests have been performed by the Sea Grant Engineers at the University of Rhode Island to substantiate the performance of the scrap tire floating breakwaters. They report up to 80% efficiencies with structure widths of 20 and 26 feet in waters with 3 to 4 foot wave climates.

Therefore, it is recommended that a structure 26 feet wide by one unit deep be considered for attenuating 3-foot high waves.

A 26 feet wide scrap tire floating breakwater can be constructed and installed for $15 to $40 per linear foot of breakwater depending upon the desired service life. Long life connecting hardwares and flotation mediums are more expensive. The following cost tables may be used to calculate more exact costs for select groups of designs.

Design and Cost Considerations for 6-Foot High Waves:

Researchers with the U S Army Corps of Engineers, at the Waterways Experimental Station in Vicksburg, Mississippi, after studying the University of Rhode Island's reports and their own laboratory report on a similar geometric shaped tire structure, concluded that a tire structure with a 105 feet sea to shore width would minimize storm damage to a construction site in the open sea off the Florida coast.

Therefore, it is recommended that a structure 105 feet wide by one unit deep be considered for attenuating 6-foot high waves. This recommendation is based on laboratory tests, theoretical calculations and field tests of maximum wave heights of 3 to 4 feet only, and therefore should be considered questionable.

A 105 feet wide scrap tire floating breakwater can be constructed and installed for $60 to $160 per linear foot of breakwater depending upon the materials used and the desired service life.

More exact cost breakdowns on both the 26 feet and 105 feet wide tire breakwater installations are given in the following tables.

## TABLE OF COSTS FOR A 26 FT x 600 FT TIRE BREAKWATER

| | Item | Quantity | Unit Cost | Total Cost | Cost/ft of BW |
|---|---|---|---|---|---|
| 1) | Scrap Tires | 6700 | $.15 | $ 1005 | $ 1.68 |
| 2) | Urethane Foam (hand mixing) | 3,350 lbs | .70 | 2345 | 3.90 |
| 3) | 1/2" Open Link Special Chain | 10,320 ft | .65 | 6,605 | 11.01 |
| 4) | Handmade 500 lb concrete anchors | 14 | 30.00 | 420 | .70 |
| 5) | Handmade 250 lb concrete anchors | 14 | 15.00 | 210 | .35 |
| 6) | Mooring Chain 1/2" open link | 2,800 ft | .65 | 1820 | 3.04 |
| 7) | Labor Estimate 2 hrs/bundle-build & install @ $5.50/hr | 688 hrs | 5.50/hr | 3784 | 6.31 |
| | | | Total | $16,189 | $26.99 |

## TABLE OF COSTS FOR A 105 FT x 600 FT TIRE BREAKWATER

| | Item | Quantity | Unit Cost | Total Cost | Cost/ft of BW |
|---|---|---|---|---|---|
| 1) | Scrap Tires | 27,316 | .15 | $ 4,098 | $ 6.83 |
| 2) | Urethane Foam (hand mixing) | 13,658 lbs | .70 | 9,561 | 15.94 |
| 3) | 1/2" Open Link Special Chain | 41,280 ft | .65 | 26,832 | 44.72 |
| 4) | Handmade 500 lb concrete anchors | 28 | 30.00 | 840 | 1.40 |
| 5) | Handmade 250 lb concrete anchors | 28 | 15.00 | 420 | .70 |

| | | | | | |
|---|---|---|---|---|---|
| 6) | Mooring Chain<br>1/2 open link | 2800 ft | .65 | 1,820 | 3.04 |
| 7) | Labor Estimate<br>2 hrs/bundle-Build &<br>Install @ $5.50/hr | 2752 hrs | 5.50/hr | 15,136 | 25.23 |
| | | Total | | $58,707 | $97.90 |

Other possible materials which might be considered for insertion into the tires to provide flotation include the following:

| | Item | Cost | Cost/Ft 26' Wide BW | Cost/Ft 104' Wide BW |
|---|---|---|---|---|
| 1) | Rigid Urethane Foam (as above) with auto-mixing & dispensing unit | $2.42/lb | 13.51 | $54.04 |
| 2) | Ethafoam Rod<br>5" dia x 12" long | 1.11/ft | 12.40 | 49.58 |
| 3) | 1/2 gal Plastic Jugs (two per tire) and caps | .26 ea | 2.91 | 11.62 |
| 4) | Trapped Air - for prototype testing | free | free | free |

Other possible connecting materials which might be considered for building and interconnecting the tire bundles include the following:

| | Item | Unit Cost | Cost/Ft 26' Wide BW | Cost/ft 104' Wide BW |
|---|---|---|---|---|
| 1) | 3/8" Proof Coil Steel Chain - and<br>Quick Link Connectors | $ .90/ft<br>.82 ea | $17.36 | $69.44 |
| 2) | 3/8" Galv Arcft Cable and Crosby Cable Clips | $ .40/ft<br>.88 ea | $ 8.90 | $35.60 |
| 3) | 1/4" SS Arcft Cable and Crosby Cable Clips | $ .73/ft<br>.73 ea | $14.24 | $56.96 |
| 4) | 1/2" dia Nylon Rope<br>And Al Crimped Sleeves<br>Crimping Tool & Die | $ .22/ft<br>.38 ea<br>642.00 | $ 5.73 | $22.92 |

Conclusions:

The search for total ecological balance with the seas is an unobtainable quest.

Ever since man has arrived on the scene, he has had to continually adapt to an ever changing environment. The seas have been one of the major contributors to this changing environment.

These environmental changes, like aging, have a way of progressing at varying rates and are subject to unpredictable catastrophic happenings at any time. They present mankind one of his more formidable challenges.

The general consensus of all the individuals knowledgeable of the latest Goodyear 18 tire modular construction system is that this unique construction technology (building block) is indeed a major break-through in the design of shore protection structures, and that the resulting tire structures have an excellent chance of helping to manage our nation's marine environment in the future. The modular blocks have excellent strength and energy absorbing characteristics, and could provide the ocean engineer with a tool which can reduce erosion rates sufficiently to allow mankind to economically utilize the highly enticing environment of our sea shores.

The projected service life of the tire mats could be better than conventional floating type breakwater structures due to the elastic nature of the tires. Field experience indicates that sudden unpredictable overloads are a major problem with conventional floating structures. The tire structures have the ability to withstand these overloads by deflecting and then recovering without failure. The furnished and installed costs of the proposed designs are only 1/10 of the cost of existing comparable structures. If they are built on a do-it-yourself basis, the out of the pocket cost to the building can be reduced another 1/3.

It is not our intent to design shore protection structures. Our objective is to inform the designers of these structures that if they use scrap tires instead of the materials they are now using, they will produce a better product, at a reduced cost, and with a potentially longer service life.

To this end, The Goodyear Tire & Rubber Company is dedicated and working toward, with all benefits to be received being turned over to the public.

The Goodyear Legal Department asks that I caution and inform you that the use of any of the scrap tire structures described in this paper or in any of our published reports shall be at the sole risk and responsibility of the user with no liability of any nature whatsoever on the part of The Goodyear Tire and Rubber Co.

# REFERENCES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# LIST OF PARTICIPATING INSTITUTIONS AND FIELD LOCATIONS OF THEIR ASSOCIATE SCRAP TIRE SHORE PROTECTION PROJECTS

I. Tadeusz Kowalski, PhD, Assoc Prof
Neil W Ross, Marine Recreation Specialist
Marine Advisory Service
Univ of Rhode Island
Narragansett, R I 02882
401-792-6211

## Project - Floating Tire Breakwaters (Field Tests)

1. Tadeusz Kowalski
Principal Investigator
University of Rhode Island
Narragansett Bay Campus
Butler Building
Narragansett, R I 02882

Dr Kowalski performed full instrumented field tests with three floating scrap tire breakwater structures in the West Passage of Narragansett Bay at the University's Bay Campus. The results of the first test are published in the "1974 Floating Breakwater Conference Papers", Marine Technical Report Series Number 24, University of Rhode Island. The second test is covered in a URI report "Evaluation of Scrap Tire Floating Breakwaters", April 1975.

## Project - Floating Tire Breakwater (Field Locations)

1. Dr Henry Childers
Edgewood Yacht Club
Shaw Ave
Cranston, R I 02910

This breakwater is 20 feet wide x 500 feet long. It protects The Edgewood Yacht Club Marina in Upper Narragansett Bay.

2. Ronald F Courville, Pres
Boston Harbor Marina, Inc
542 East Squantum St
Squantum, MA 02171

This breakwater is 20 feet wide x 100 feet long and provides protection for the Boston Harbor Marina in Dorchester Bay, MA. Plans are underway to add 407 feet of additional breakwater at this site.

3. Thomas W Kingman
Cataumet Marina
Cataumet, MA 02534

This experimental breakwater is 20 feet wide x 70 feet long. If all goes well this Cape Cod Breakwater will be enlarged in the future.

4. Mike Cuddy, Coordinator
Rhode Island Yacht Club
Ocean Avenue
Cranston, R I

This prototype breakwater is 20 feet wide x 90 feet long and is located in Narragansett Bay.

5. William Parent, Manager
Parent's Marina
1 Washington Ave
Providence, R I 02903

This 20 feet wide x 90 feet long experimental breakwater was towed 25 miles from URI's Bay Campus to Parent's Marina in Providence where it continues to do a good job of calming the stormy waters of Narragansett Bay. Additional experimental sections have been added.

6. Paul Dodson, President
Newport Int Sailboat Show
431 Thames St
Newport, R I 02840

This 26 feet wide x 500 feet long floating tire breakwater was used this past Fall to protect the show boats at the International Sailboat Show, Fort Adams, Newport, R I. The structure is located in Newport Harbor.

7. Don Dube, Manager
Don's Marina
3797 Riverside Ave
Somerset, Mass

A 20 feet wide x 350 feet long structure is planned for early '76. Permits have been applied for.

8. Carl Koch
438 Lewis Wharf
Boston, Mass 02110

A major tire breakwater (33 feet wide x 800 feet long) is being designed for this Boston Harbor, salt water site. URI is consulting on this project.

9. Carl C Crosen, Gen Manager
Great Bay Marina, Inc
Fox Point Rd
Newington, NH 03801

A 20 feet wide x 300 feet long tire breakwater has been proposed for this Great Bay, NH marina. The area has a 6 knot current. Spring 1976 is the projected construction date.

10. Richard Trexler, Manager
Moultonboro Marine, Inc
Moultonboro Neck
Moultonboro, N H 03226

A modified design tire breakwater is proposed for under dock construction in Lake Winnipesaukee. This fresh water structure has not been installed to date.

11. John Zinck
Public Works of Canada
P O Box 7350
St Johns, New Brunswick
Canada, E2L4J4

Construction has started on this 20 feet wide x 420 feet long tire breakwater for use on the Lower Caraquet, New Brunswick. This structure is to be installed before March '76.

II. Robert B Patten, Regional Marine Specialist
Sea Grant Advisory Service
State University of New York
375 Mason Hall Addition
Fredonia, N Y 14063
716-673-3413

Project - Floating Tire Breakwaters (Field Locations)

1. William Larson, Jr
City Engineer, Department of Engineering
Dunkirk Harbor
Dunkirk, N Y 14048

This breakwater is 26 feet wide x 760 feet long. It is expected to be 1000 feet long when completed. The structure protects several marinas in Dunkirk Harbor, Lake Erie.

2. Walter A Cronin, Pres
Dock & Coal Marina
1 Dock Street
Plattsburgh, N Y 12901

This breakwater is now being constructed. Plans are to build a structure 26 feet wide x 250 feet long to protect the Dock & Coal Marina on Lake Champlain.

3. George Hays, Commodore
Mentor Harbor Yacht Club
5330 Cornado Dr
Mentor-on-the-Lake, Ohio 44060

This breakwater is now being constructed. When completed it will be 26 feet wide x 210 feet long. It will be used to provide protection to sail boats entering and leaving the Yacht Club's inland marina, Lake Erie.

III. Richard D Candle, Sec Hd
William J Fischer, Design Engineer
The Goodyear Tire & Rubber Company
Research Division
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Project - Tire Shore Protection Structures (Reports)

1. Richard D Candle, PE
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142 Goodyear Blvd
Akron, OH 44316

Researchers with The Goodyear Tire & Rubber Company have written the following reports on scrap tire structures for use in the marine environment:

"The Proposed Goodyear Scrap Tire Floating Breakwater", 1973.

"The Proposed Goodyear Scrap Tire Full-Depth Breakwater, Bulkhead, Seawall, or Revetment", 1973.

"Goodyear Scrap Tire Floating Breakwater Concepts", 1974.

"The Proposed Goodyear Sinking Scrap Tire Marine Mat", 1974.

"The Proposed Goodyear Modular Mat Type Scrap Tire Floating Breakwater", 1974.

"Scrap Tire Shore Protection Structures", 1975.

Project - Floating Tire Breakwater (Field Location)

1. Frank Balint, Mgr
Wingfoot Lake Recreational Park
993 Goodyear Park Blvd
Mogadore, OH 44260

This experimental breakwater is 26 feet wide x 550 feet long. This research structure contains experimental flotation materials and interconnecting hardwares, which will be evaluated for performance and life. This project is expected to require 10 years for completion. The breakwater protects the Wingfoot Lake Marina on an inland fresh water lake located in Goodyear's recreational park.

Project - Floating Tire Fishing Reef (Field Location)

1. Frank Balint, Mgr
Wingfoot Lake Recreational Park
993 Goodyear Park Blvd
Mogadore, OH 44260

This experimental fishing reef is the first of four such structures which will be installed in this small fresh water lake to provide improved recreational fishing. The structures are approximately 35 feet in diameter.

IV. Robert C Summerfelt, Dr, Professor of Zoology
School of Biological Sciences
Oklahoma State University
Stillwater, Oklahoma 74074
405-372-6211

Project - Floating Tire Breakwater (Field Location)

1. Oklahoma Fisheries Service
Department of Wildlife Conservation
Stillwater, Oklahoma 74074

This breakwater will be 26 feet wide x 500 feet long, and is now under construction. When completed it will be installed in a local municipal water supply reservoir to reduce shoreline erosion, provide a sheltered area for the reproduction of large mouth bass, and to generally improve the fish habitat.

V. Dr John M Armstrong, Director
Michael R McGill, Research Associate
The University of Michigan
Great Lakes Resource Management Program
Coastal Zone Laboratory
1101 North University Building
Ann Arbor, Michigan 48104
313-763-1377

<u>Project</u> - <u>On-Shore Tire Beach Mats (Field Locations)</u>

1. Robert Dixon
Lake Erosion Chairman
Village of Michiana
4000 Cherokee Drive
New Buffalo, Mich 49117

This on-shore beach mat is to be 56 feet wide x 260 feet long when completed. It is now 1/2 finished and the performance is already encouraging. It will protect a 30 feet high bluff on Lake Michigan.

2. Mike Holt, Engineer
City of Rogers City
193 East Michigan Avenue
Rogers City, Mich 49779

This on-shore beach mat will be 56 feet wide x 200 feet long. It will protect an area of shore immediately in front of the city's waste water treatment plant. Available information indicates that as much as 40 feet of land has already been lost to the eroding waves of Lake Huron at this site.

All permits have now been obtained and construction is scheduled to start as soon as the weather is suitable for working outdoors.

VI. Dr William W Woodhouse, Jr, Professor
Steve W Broome, Assistant
Department of Soil Science
North Carolina State University
Raleigh, North Carolina 27607
919-737-2657

<u>Project</u> - <u>Floating Tire Marsh Mat (Field Location)</u>

1. Steve Broome, Project Leader
North Carolina State University
188 Williams Hall
Raleigh, North Carolina 27607

A floating marsh mat 20 feet wide x 90 feet long has been constructed using vertical and horizontal floating scrap tires. The structure is located on the New River Estuary and protects a newly vegetated marsh area. This project is more than a year old and the results to date are excellent.

<u>Project</u> - <u>Tire Sand Dune Stabilization Mat (Field Test)</u>

1. Ted Mew, Park Ecologist
National Park Service
Cape Hatteras National Sea Shore
Fort Raleigh, RR #1, Box 675
Manteo, North Carolina 27954

Researchers with the Department of Soil, Science, North Carolina State University have requested permission from the National Park Service, to install test scrap tire sand dune stabilization mats at several endangered, blow out areas in the dunes on Cape Hatteras National Sea Shore.

VII. Robert W Whalin, PhD
Chief, Wave Dynamics Div
U S Army Corps Engineers
Waterways Experiment Station
P O Box 631
Vicksburg, Miss 39180
601-636-3111 Ext 3418

<u>Project</u> - <u>Floating Tire Breakwater (Laboratory Tests)</u>

1. D D Davidson, Project Engineer
U S Army Corps Engineers
Waterway Experiment Station
P O Box 631
Vicksburg, Miss 39180

A report has been written by Mr Davidson on the laboratory testing of a similar shaped tire breakwater. It is titled "Hydraulic Characteristics of Mobile Breakwaters Composed of Tires or Spheres". Technical Report H-68-2, June 1968.

<u>Project</u> - <u>Floating Tire Breakwater (Report)</u>

1. Robert W Whalin, PhD
Consultant
11 Lake Boulevard
Lake Park Estates, RR#1
Vicksburg, Mississippi 39180

Dr Whalin has prepared a private consultant report for EBASCO Services, Inc, Jensen Beach, Florida, titled "Design of Floating Scrap Tire Breakwater for Expediting Intake Structure Construction: Hutchinson Island Nuclear Power Plant, Florida Power and Light Company."

This report proposes that a floating tire structure be used for protecting an off-shore construction site from adverse wave actions. EBASCO Services Inc did not build this proposed breakwater.

VIII. Eugene P Richey, Prof of Civil Engr
313 Harris Hydraulics Laboratory
Univ of Washington
Seattle, Washington 98195
2-6-543-2100

Project - Floating Tire Breakwaters (Laboratory Tests)

1. Theoretical analysis only to date.

IX. Dr George Oertel, Marine Sedimentologist
Skidaway Institute of Oceanography
P O Box 13687
Savannah, Ga 31406
912-352-1631

Project - Sand Dune Tire Stabilization Mats (Field Test)

1. Proposal Stage Only.

Project - Inland River Bank Tire Stabilization Mats (Field Test)

1. Private land owner (proposal only)

X. Dr Bob Byrne, Dept of Geological Oceanography
Vir Institute of Marine Science
Gloucester Point, Vir 23062
804-642-2111

Project - Marshland Tire Stabilization Mat (Field Test)

1. Proposal Stage Only.

A state task force group has been appointed to investigate various methods of preventing the erosion of the protective marshland areas on Tangier Island. Dr Byrne plans to include the tire stabilization mats as a low cost solution to this problem.

XI. Fred B Givens, Jr
Shoreline Erosion Control Engineer
U S Dept of Agriculture
Soil Conservation Service
P O Box 171
Warsaw, Va 22572
804-333-6931

Project - Marshland Tire Stabilization Mat (Field Test)

1. Tangier Island Task Force - proposal only.

XII. Dr William E Odum, Dept of Environmental Sc
University of Virginia
Books Halls
Charlottesville, Vir 22903
804-924-0311

Project - On-Shore Tire Beach Erosion & Nourishment Mats (Field Tests)

1. Talking stages only.

XIII. Richard B Stone, Oceanographer
National Marine Fisheries Service
Atlantic Estuarine Fisheries Center
Pivers Island
Beaufort, N C 28516
919-728-4595

Project - Artificial Tire Reefs (Saltwater Habitat) (Field Tests)

1. Bottom Type Artificial Tire Reefs Only.

Mr Stone has written many reports on the artificial tire fishing reefs. More than 100 artificial reefs have been established off the Eastern Coast of our Nation. Many other nations have built the tire fishing reefs. His latest report is "Scrap Tires as Artificial Reefs", publication SW-119, National Marine Fisheries Service, 1974.

XIV. Eric D Prince, PhD Research Assistant
Fisheries Science
Department of Fisheries
Vir Polytechnic Institute & State University
Blacksburg, Virginia 24061
703-951-5481

Project - Artificial Tire Reefs (Fresh Water Habitat) (Field Tests)

1. Bottom Type Aritifical Tire Reefs Only.

Dr Prince is doing research on artificial tire reefs for improving fresh water fish habitat. He has written many reports on this successful project. The latest is titled "Progress of the Smith Mountain Reservoir Artificial Reef Project", published in the proceedings of the First International Conference on Artificial Reefs, held in Houston, Texas, March 19-22, 1974.

## DISTRIBUTORS OF SPECIAL HARDWARE FOR THE SCRAP TIRE SHORE PROTECTION STRUCTURES

Specifications: Special 1/2" open link chain, 2.65 pitch, 2,500 lbs breaking strength, 1010 steel, wt approx 2 lbs/ft, cost $.72/ft.

(1) Bob Adamson, Director of Marketing
Campbell Chain Company
3990 E Market St
York, Pa 17402 Ph 717-755-2921

## DISTRIBUTORS OF TWO COMPONENT RIGID URETHANE FOAMS

Specifications: Density: 2.0 to 2.4 lbs/ft$^3$ closed cell rigid urethane foam.
Price: $.75/lb for foam and foaming agent
Ratio: 1 to 1 by weight (foam to foaming agent)
This foam can be hand mixed and poured.

(1) General Latex Corp
66 Main Street
Cambridge, Mass
Ph 617-864-7750

Vultafoam - Catalog #: 16F-1402

(2) PPG Industries, Inc
151 Colfax St
P O Box 127
Springdale, Pa

Selectrofoam - Catalog #: 67040

## DISTRIBUTORS OF INSTA-FOAM TYPE RIGID URETHANE FOAM

Specifications: Insta Foam Products, Inc will supply the #2200 refill Froth Pack Kit which provides automatic mixing and dispensing, consisting of 2 tanks, a high pressure regulator, 300 pounds of chemical $2.29/#, gun hose assembly 30', and NP nozzles.

The cost breakdown of this unit is as follows:

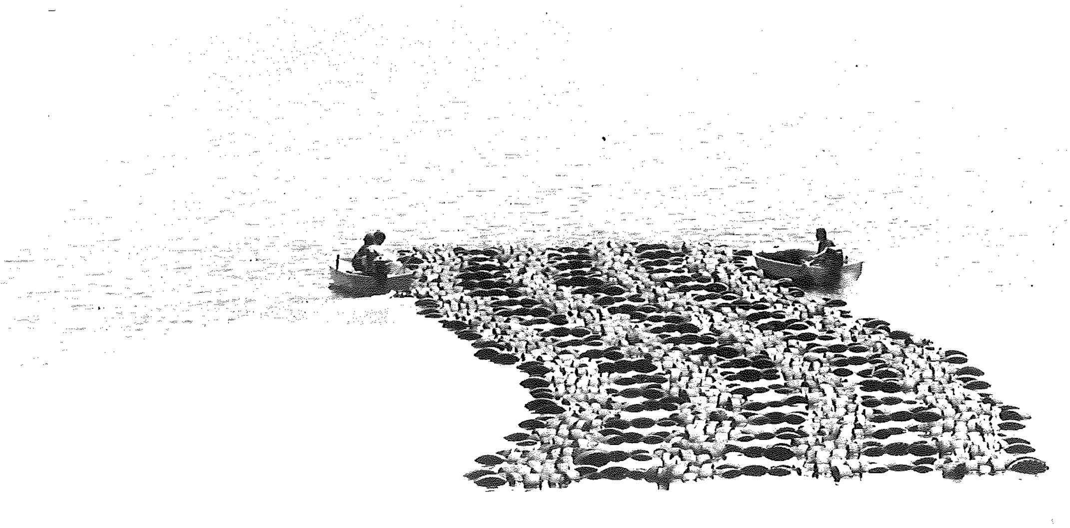
1st Cost - Approx $5.00/lb of foam
Refill Cost - Approx $2.29/lb of foam
Note: Approx 1/2 lb of foam is required per tire.

(1) Insta-Foam Products, Inc
2050 No Broadway
Joliet, Illinois 60435

THE MODULAR UNITS ARE EASILY ASSEMBLED


HEAVY STEEL CHAIN INTERLOCKING PROVIDES LONG LIFE

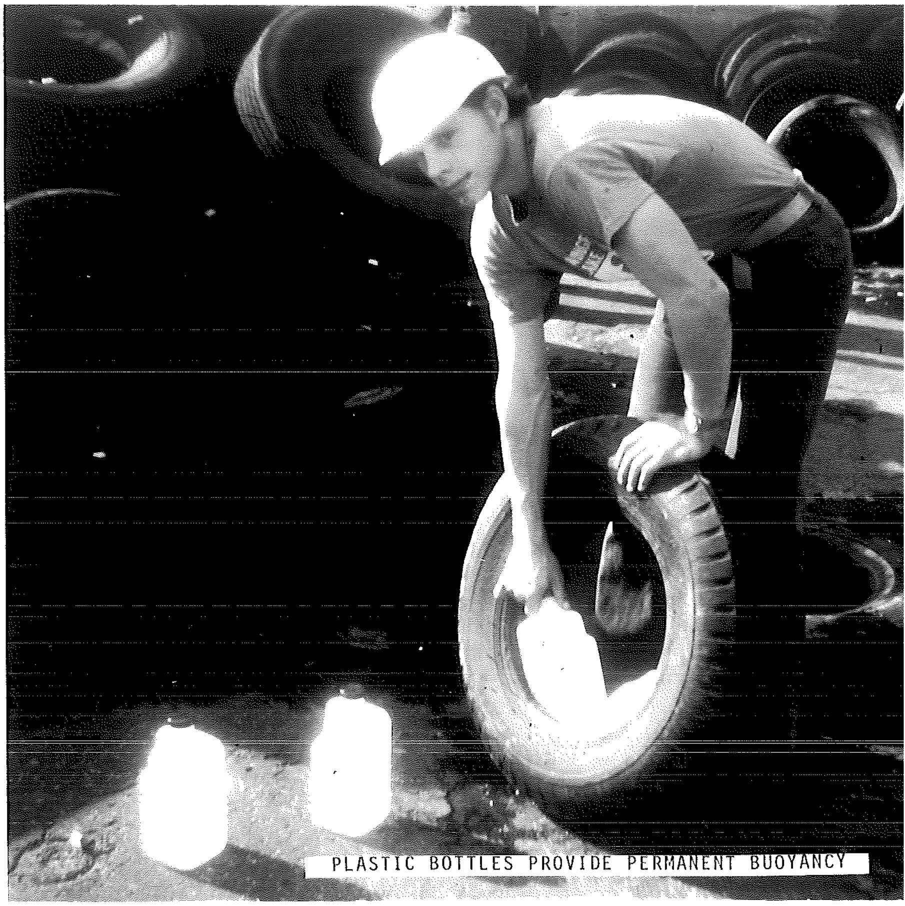
LIGHT DUTY EQUIPMENT TRANSPORTS THE UNITS ON LAND



LARGE MATS ARE TRANSPORTED WITH EASE IN THE WATER

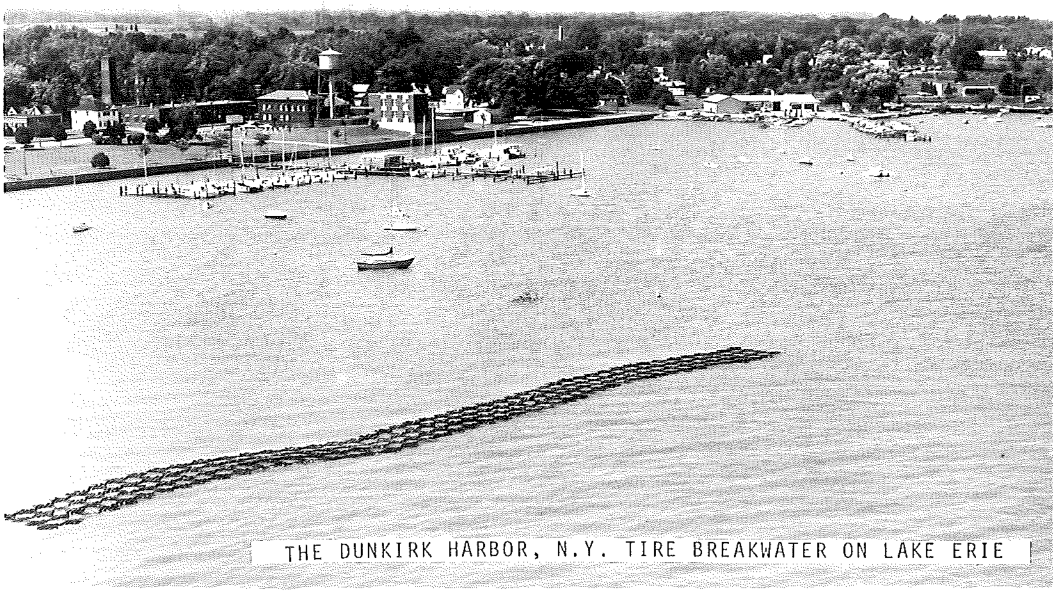
EXPERIMENTAL TIRE BREAKWATER, GOODYEAR WINGFOOT LAKE MARINA,

CHAIN, ROPE, CABLE, AND STRAP CAPABILITIES ARE BEING INVESTIGA



PLASTIC BOTTLES PROVIDE PERMANENT BUOYANCY

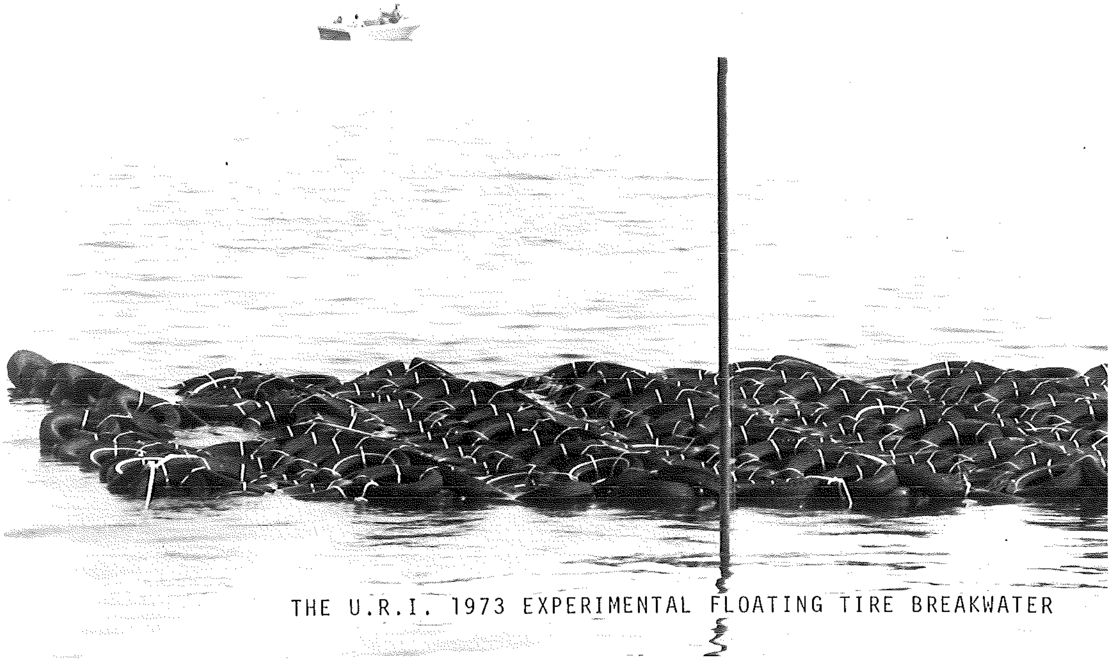
AIR CURING FOAM PROVIDES PERMANENT BUOYANCY


THE DUNKIRK HARBOR, N.Y. TIRE BREAKWATER ON LAKE ERIE

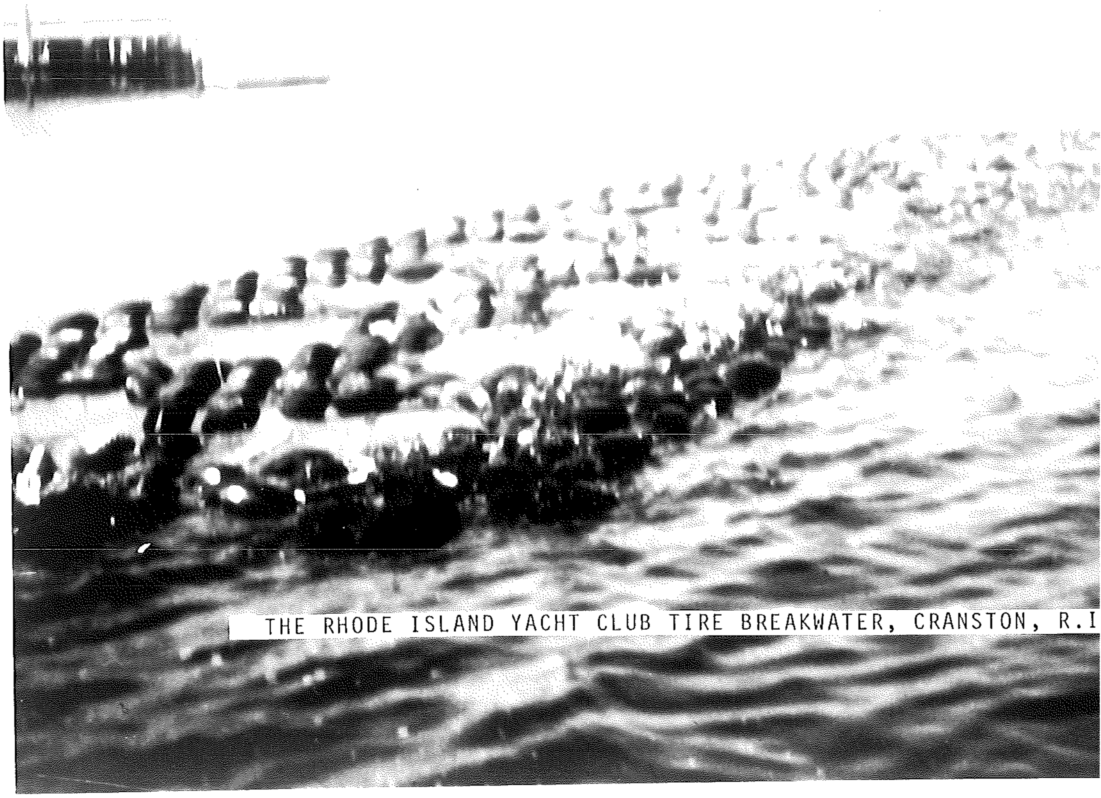

THE DUNKIRK HARBOR TIRE BREAKWATER IN ACTION

THE MICHIANA, MICH. TIRE REVET-MAT PROTECTS A HIGH BLUFF

A FLOATING TIRE FISHING REEF AT WINGFOOT LAKE, AKRON, OHIO

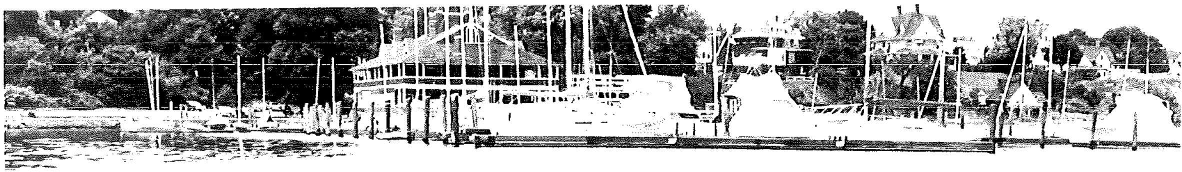


THE U.R.I. 1973 EXPERIMENTAL FLOATING TIRE BREAKWATER



THE RHODE ISLAND YACHT CLUB TIRE BREAKWATER, CRANSTON, R.I

THE EDGEWOOD YACHT CLUB TIRE BREAKWATER, CRANSTON, R. I.

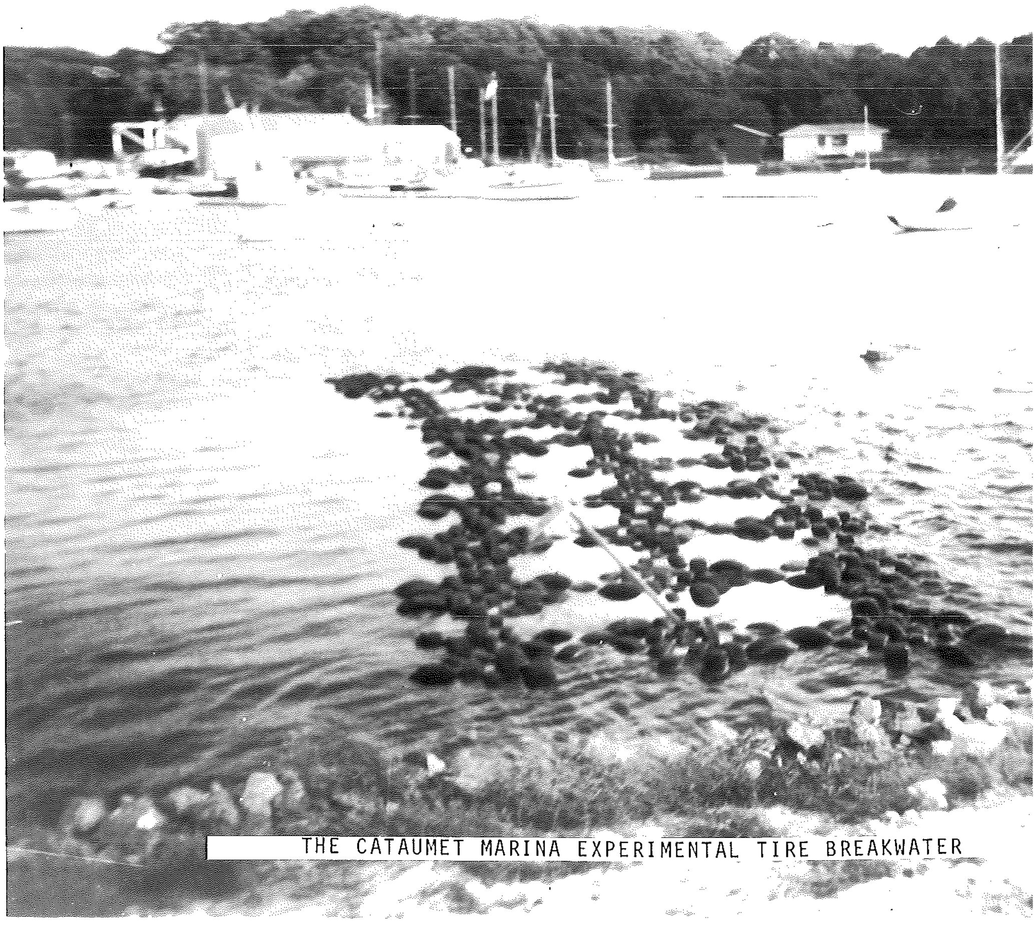


THE EDGEWOOD YACHT CLUB BREAKWATER CLOSE UP


THE INTERNATIONAL SAILBOAT SHOW TIRE BREAKWATER, NEWPORT,

ASSEMBLY OF MODULAR UNITS, SAILBOAT SHOW BREAKWA

THE CATAUMET MARINA, CATAUMET, MASS.



THE CATAUMET MARINA EXPERIMENTAL TIRE BREAKWATER