Understanding the Stresses Incurred By a Typical Lobster Trap Using Finite Element Analysis

Drew A. Domnarski

Professor Satya S. Shivkumar, Advisor

April 27, 2011

A Major Qualifying Project Report
submitted to the Faculty of
WORCESTER POLYTECHNIC INSTITUTE
in partial fulfillment of the requirements for the
Degree of Bachelor of Science

Abstract

Lost and improperly disposed of lobster traps are a problem because they hinder conservation efforts, pollute the marine environment, risk the lives of mariners, and endanger civilians. Information regarding current lobster trap materials and industry practices was gathered and a solid model of a typical lobster trap was created using computer aided design software. This model was then used to perform finite element analysis and will ultimately lead to the development of new lobster trap technology.

Table of Contents

List of Figures

List of Tables

INTRODUCTION

As a recreational lobsterman the loss and disposal of lobster traps is a continuous problem. Unfortunately, this issue is widespread throughout the industry and it leads to the phenomena of ghost gear (see Figure 1) and marine debris (see Figure 2). According to the Food and Agriculture Organization (FAO) of the United Nations, ghost gear is “lost or abandoned fishing gear that continues to catch fish.”[1] While the National Oceanic and Atmospheric Administration (NOAA) defines marine debris as “any persistent solid material that is…intentionally or unintentionally, disposed of or abandoned into the marine environment or the Great Lakes.”[2] The loss and disposal of traditional lobstering gear is a problem because it hinders conservation efforts, pollutes the marine environment, risks the lives of mariners, and endangers civilians.

While my Interactive Qualifying Project (IQP) examined the prevalence of these phenomena, my Major Qualifying Project (MQP) is attempting to solve the problem by designing an environmentally lobster trap. This process involved visiting various industry manufacturers to learn about the materials and techniques used in the lobster trap industry, creating a computer aided design three dimensional model of a lobster trap, and testing that model with typical industry stresses using finite element analysis software. By understanding the typical industry stresses using finite element analysis new materials and designs can be explored in order to make a lobster trap which biodegrades after being left underwater for a certain period of time.

This is a difficult problem to solve because lobster traps are not engineered but rather built through tradition and old fashioned ingenuity. Also, lobster traps are not all the same as each particular lobsterman has a preference on its design. Some lobstermen believe that certain designs, devices, and its assembly have an effect on the catching of

---

[1] FAO. © 2005-2010. Fisheries Issues. Ghost fishing. Text by Andrew Smith. In: *FAO Fisheries and Aquaculture Department* [online]. Rome. Updated 27 May 2005. [Cited 8 April 2010]. http://www.fao.org/fishery/topic/14798/en

[2] "Marine Debris Program - Marine Debris Information." *NOAA Marine Debris Program - Welcome*. 17 Nov. 2010. Web. 21 Feb. 2011. <http://marinedebris.noaa.gov/info/welcome.html>.

lobsters. However, this tradition or established equipment and techniques must be able to accept the implementation of the biodegradable lobster trap as changes are expensive and unwelcomed within the lobster fishery.

LOBSTER TRAP HISTORY

The lobster trap originated in France approximately four hundred years ago. Known as a crille and made out of wood it had its pitfalls. To fix these, fishermen in Britain, Ireland, and Scotland improved its design.[3] However, it was Jim Knott around 1956 that created the first wire mesh lobster trap. He did this because wooden traps weighed about one hundred pounds when wet and are very buoyant. While a wire mesh trap is approximately one half the weight of a wooden trap and is more negatively buoyant. A wire mesh lobster trap has a service life of one to over ten years and according to Jim Knott, "If the trap is [left alone] the PVC can protect it indefinitely, but if it's used in a rocky place the PVC eventually gets scrubbed off. When that happens the zinc eventually goes and the wire will rust." Also, "Knott estimates that 90% of all lobster traps used in the U.S. are made from wire."[4]

Lobster Trap Functionality

A lobster trap is a very simple device and while each trap differs with each lobsterman due to preference, it works in the following way:

1) The lobster is attracted to the trap by the bait which is either bagged or hung within the trap.
2) The lobster crawls into the kitchen through either one of the two head openings (see Figure 3).
3) The lobster feeds on the bait until no longer interested.
4) After feeding, the lobster attempts to crawl out of the trap using the parlor head. However, the parlor head does not lead to the seafloor but into the parlor.

[3] Pekar, P. M. *How to Build a Lobster Trap*. Nyack, NY: Rockcom Pub., 1986. 5-14. Print.
[4] Marselli, Mark. "End Use; Wire as a Dinner Invitation." *Wire Journal International* 29.11 (1996): 104. Print.

5) If the lobster is big enough it will not be able to fit through the required escape vent designed to allow undersized lobsters back into the environment. The only way out is when the lobsterman hauls the trap and removes them manually.
6) Once aboard the lobsterman's boat, the lobster is measured and if undersized, as defined by regulations, it is thrown back into the ocean. If not, it is rubber banded to keep the caught lobsters from fighting and protect the handlers and brought back to land for sale.

While the way a trap catches lobsters is not complicated, it is a very effective piece of fishing equipment which is why its overall design should not be changed dramatically. However, due to the current lobster fishery it is a misconception that a lobster trap is hauled up filled with lobsters which creates stress on the trap. Unfortunately, there are not enough lobsters to fill the trap and a lobsterman is lucky to find more than one in the trap when it is hauled. For that reason, this scenario was not looked at during this project.

OBJECTIVES

- To evaluate the characteristics of lobster traps
- To understand the usage and storage of lobster traps
- To evaluate the stress distributions in lobster traps

METHODOLOGY

My MQP was based around the methodology of learning, doing, and reviewing. For example, I visited three manufacturers within the lobster trap industry to evaluate the characteristics of lobster traps prior to making my solid model. Also, I walked the Stonington Town Docks, homeport of the few remaining commercial lobstermen in Connecticut, to understand the usage and storage of lobster traps prior to evaluating the stress distributions in my solid model using finite element analysis. Once that process was completed, I reviewed my results in order to see if they made sense and could be seen in the real world.

Manufacturers Visits

In order to learn more about the materials and techniques used in building wire lobster traps I visited three different manufacturers: Northeast Trap LLC, Ketcham Supply Corp, and Riverdale Mills Corporation. The first visit was to Northeast Trapp LLC in Douglas, MA. Northeast Trap LLC is a lobster trap manufacturer and distributer of Cavatorta's Seaplax™ wire mesh (see Figure 4, Figure 5, Figure 6, Figure 7). During the visit I learned how a lobster trap was made and about the lobster trap industry. Surprisingly, all lobster traps are made from hand through tradition and that the customization of each particular lobsterman's traps is not able to be accomplished by a machine. A lobster tap begins as a roll of wire mesh, in this case Seaplax™, and is cut then bent into the trap parts. Each part is secured to each other using a clip put on using a pneumatic tool. Finally, the handmade net heads, wire mesh top, and bungee cord latch are secured. An interesting fact is that a Massachusetts lobsterman, who is allowed to fish 800 traps, will cycle the gear by replacing 100 traps a year. Also, a typical wire mesh lobster trap costs between $55 and $80 depending on its design.[5]

The second visit was to Ketcham Supply Corp in New Bedford, MA on November 15, 2010. During this visit I was able to take many photographs of different lobster traps in the company's storage yard (see Figure 8, Figure 9).

The third visit was to Riverdale Mills Corporation in Northbridge, MA where I was welcomed by the President and Founder Jim Knott, Sr. who, as mentioned previously, is the inventor of the wire mesh lobster trap. While Riverdale Mills Corporation is not a lobster trap manufacturer, they are the leader in the manufacture of the wire mesh which is used to build lobster traps (see Figure 10). I was fortunate to be able to see how this wire mesh is made:

1) The wire arrives at Riverdale Mills Corporation in giant spools of varying thickness. Depending on what gauge wire mesh is being produced, the corresponding wire is loaded into the process.
2) Then the raw wire is unwound and cut into lengths.

[5] Christian, Mike, and Peter Christian. Personal Interview by Drew Domnarski. 24 Sep. 2010.

3) The lengths of raw wire are loaded into an automatic welder which welds the perpendicular intersections of the raw wire forming the wire mesh.
4) The weld wire mesh is galvanized.
5) After galvanizing the wire mesh, it is submerged into PVC dust which is then baked on to form the protective coating.

This process runs nonstop and was the idea of Jim Knott himself.[6]

Solid Model

After visiting those manufacturers I felt I had a good understanding of the materials and techniques used in building wire lobster traps and I was ready to start working on my solid model. To create the solid model I decided to use SolidWorks 2010 Education Edition installed on my laptop (see Table 1).

Beginning from the most basic design and progressing to the more complicated, I first designed a cube. While starting with a cube might seem trivial, it was even used in the finite element analysis to make sure my model was working. This was done by putting a distributed load of 2.76 psi on top of the cube, with the bottom being fixed representing the trap bottom resting on a solid surface such as in storage. The results of this test were then compared to the following tests in which the properties of the materials were changed. The following material properties were changed: 0.5 mass density, 2 mass density, 0.5 elastic modulus, 2 elastic modulus, 0.5 yield strength, and 2 yield strength. After each time a material property was changed the test was run again and the results recorded (see Table 2). It was proven that the model was working because the stress and deformation changed with the property change.

Once the cube confirmed that my model was working I hollowed it out, to a thickness of the diameter of the wire mesh, to create a shell. Again, even this model was used, with the same process as before; in the finite element analysis to make sure my model was working (see Table 2).

[6] Knott, Sr., Jim. Personal Interview by Drew Domnarski. 17 Feb. 2011.

Finally, once the model was proved to be working the entire typical wire lobster trap was designed in SolidWorks. To begin, I sketched a square in the Front Plane and Extruded it back to the depth of the trap and hollowed out the interior to the thickness of the wire mesh using the Shell tool. Next, I created a model of the wire mesh by creating three sketches of patterned squares, one on each software plane, and Extruded Cut them. To create the bridge I sketched a square in the Front Plane and created the wire mesh using the same process I did previously. Finally, I Extruded Cut the head and escape vent openings from two sketches. The finished solid model can be seen in a drawing in the appendix (see Figure 11).

Industry Stresses

A lobster trap has to endure some of the worst environments known to man – submerged under many feet of water for long periods of time too stacked many tall on a dock baking in the sun. It is also not handled with care as they are thrown around the deck of a lobster boat and hauled from the depths using winches. With that said, it would be extremely difficult to model these industry stresses. However, there are some scenarios that can be modeled, such as during storage and hauling.

For example, when lobster traps are not being fished they are often stored on land stacked many tall. To learn more about their storage I visited the Stonington Town Dock which is the homeport of the few remaining commercial lobstermen in Connecticut. At this site I took numerous photographs which I used to figure out the average number of traps that are stacked on top of the bottom trap. That is because in this scenario the bottom trap incurs the most stress.

Another scenario that can be modeled is when the traps are being hauled onto the deck of a lobster boat to get the caught lobsters. While each lobsterman has his own preference as to how he wants to attach his traps together for hauling, I have given some examples in the photographs in the appendix (see Figure 12). In this scenario a point load will be directed to the attachment point of the hauling bridle.

Most Realistic Scenario

As mentioned previously, the worst stresses a lobster trap endures are during fishing operations; however they are extremely difficult to model. For that reason, I have developed what I call the *Most Realistic Scenario* to use when performing finite element analysis on the solid model. What the *Most Realistic Scenario* represents is a bottom trap during storage with multiple traps stacked above it. I assume that the bottom lobster trap has to withstand a distributed load caused by the wire mesh of the lobster traps stacked on top of it and point loads caused by the multiple ballast bricks inside of those lobster traps.

To begin this scenario information about the trap was gathered. For example, a typical lobster trap with its heads and ballast bricks removed was weighed in order to know how much the wire mesh weighs by its self.

$$Empty\ Lobster\ Trap\ Weight = 12\ lbs$$

With that information gathered, the weight of the total number of traps stacked on top of the bottom trap must be calculated. However before that occurs, the average number of traps stacked on top of the bottom trap during typical storage must be figured out. This was done by looking at the photographs of the lobster trap stacks taken at the Stonington Town Dock and counting the number of traps on top of the bottom trap in each stack. This was then put into a table to find the average number of traps stacked on top of the bottom trap during typical storage (see Table 3).

$$Stack\ Weight = 5\ (traps) x\ 12\ lbs = 60\ lbs$$

Next, the model trap dimensions were gathered in order to calculate the area of the top of the trap. Also, the number of mesh squares was counted in order to calculate the mesh area subtraction as only the wire mesh contact area supports the load.

$$Trap\ Top\ Area = 38.38\ in\ (lengthwise) x\ 19.24\ in\ (widthwise) = 738.43\ in^2$$

$$\#\ of\ Mesh\ Squares = 24\ (lengthwise) x\ 12\ (widthwise) = 288$$

$$1\ Mesh\ Square\ Area = 1.5\ in\ (lengthwise) x\ 1.5\ in\ (widthwise) = 2.25\ in^2$$

$$Total\ Mesh\ Area = 288\ x\ 2.25\ in^2 = 648\ in^2$$

$$Mesh\ Area\ Subtraction = 738.43\ in^2 - 648\ in^2 = 90.43\ in^2$$

Finally, the distributed loaded must be calculated in order to be implemented in the scenario.

$$Distributed\ Load = 60\ lbs/90.43\ \ in^2 = 0.663\ psi$$

After calculating the distributed load it is implemented into SolidWorks SimulationXpress, a finite element analysis software package in SolidWorks, in order to understand the stress and deformation of a trap during this scenario. The results of the scenario are shown in the appendix as screenshots of the printout from Solidworks SimulationXpress (see Figure 13, Figure 14, Figure 15, Figure 17, Figure 18). Figure 13 explains how the scenario was set up, meaning what part of the model was fixed (unable to deform) and where the load was applied. Figure 14 tells the value of maximum and minimum stresses incurred by the model and where they occur on the model. Please refer to Figure 17 for a better view of the stress distribution graphic. Figure 15 tells the value of the maximum and minimum deformation of the model and where they occur on the model. Please refer to Figure 18 for a better view of the deformation graphic. Figure 16 describes the material that was used; in this case detailed information about the actual wire mesh material was unable to be secured from the manufacturers so generic galvanized steel was used.

RESULTS & DISCUSSION

Upon completion of the finite element analysis of the trap I was able to understand the stress distributions in a lobster trap. These results are sensible, can be seen in the real world, and are acceptable. For example, the maximum deformation occurs in the areas of the top which are unsupported and the value is an acceptable 0.35 cm. Also, by looking at the screen shot of the trap's deformation results it is able to be seen that the trap deforms outward or bows. Using the results of that analysis I will be able to narrow down my options for a new trap material.

As mentioned previously, the idea of an environmentally friendly lobster trap is one which is designed to degrade within the ocean after a certain period of time. This period of time has to be short enough to decrease the amount of marine life that is caught in a trap once it is lost but long enough to be comparable with the service life of a typical wire mesh lobster trap. While the service life of a typical wire mesh lobster trap varies with its use, my model will be able to predict this by using corrosion and simple fatigue information.

Corrosion fatigue is the weakening of the wire mesh used to make the lobster trap due the ocean. While my model has not yet been used with corrosion fatigue, I have been able to see what the ocean does to a trap during my IQP. That is because each trap I removed from the environment and recycled, I took a digital picture of and numbered in order to create a trap catalog. This trap catalog will be able to be used to help with corrosion fatigue as the pictures should show the typical problem areas and can be compared with the results of my model using corrosion fatigue.

However, simple fatigue requires more work as the use of the lobster trap must be broken up into cycles. One cycle could be the removal and return of a lobster trap to storage or its submergence and hauling out of the ocean. Once the definition of a cycle is determined, the amount of those cycles a trap goes through in its service lifetime must be figured out. This can be done by joining a lobsterman on a fishing trip and counting how many times trap is put into the water and hauled back up or talking to a commercial lobsterman.

Unfortunately due to time constraints this information was not able to be gathered but it must be figured out in order to move forward in the design of a new trap. Also, this process can be used to test the environmentally friendly lobster trap prior to creating a prototype. This way I understand, to some extent, how the prototype will handle during the real world tests.

CONCLUSIONS

After completing the finite analysis, the next step in the process of designing an environmentally friendly lobster trap is deciding what new material to use. Preferably, this material would be a biodegradable plastic which conforms with ASTM D7081 – 05 Standard Specification for Non-Floating Biodegradable Plastics in the Marine

Environment. A material which adheres to this document is preferable because Scope 1.3 says:

> The properties in this specification are those required to determine if products (including packaging) will biodegrade satisfactorily, including biodegrading at a rate comparable to known compostable materials. Further, the properties in the specification are required to assure that the degradation of these materials will not diminish the value or utility of the marine resources and habitat.[7]

It is important that the material or design of the biodegradable lobster trap not harm the environment as that is the problem it is trying to solve.

[7] ASTM Standard D7081, 2005, "Specification for Non-Floating Biodegradable Plastics in the Marine Environment," ASTM International, DOI: 10.1520/D7081-05, www.astm.org

REFERENCES

ASTM Standard D7081, 2005, "Specification for Non-Floating Biodegradable Plastics in the Marine Environment," ASTM International, DOI: 10.1520/D7081-05, www.astm.org

Christian, Mike, and Peter Christian. Personal Interview by Drew Domnarski. 24 09 2010.

FAO. © 2005-2010. Fisheries Issues. Ghost fishing. Text by Andrew Smith. In: *FAO Fisheries and Aquaculture Department* [online]. Rome. Updated 27 May 2005. [Cited 8 April 2010]. http://www.fao.org/fishery/topic/14798/en

Knott, Sr., Jim. Personal Interview by Drew Domnarski. 17 02 2011.

"Marine Debris Program - Marine Debris Information." *NOAA Marine Debris Program – Welcome*. 17 Nov. 2010. Web. 21 Feb. 2011. <http://marinedebris.noaa.gov/info/welcome.html>.

Marselli, Mark. "End Use; Wire as a Dinner Invitation." *Wire Journal International* 29.11 (1996): 104. Print.

Pekar, P. M. *How to Build a Lobster Trap*. Nyack, NY: Rockcom Pub., 1986. 5-14. Print.

APPENDIX

Figure 1 (Ghost Gear)
Ghost lobster trap found during my IQP, pulled from a depth of approximately 10-15'. Notice the lobster caught in the trap despite measures taken to prevent this problem.

Figure 2 (Marine Debris)
Multiple lobster traps found above the tide line at Horseneck Beach State Reservation in Westport, MA on November 15, 2010 during my IQP.

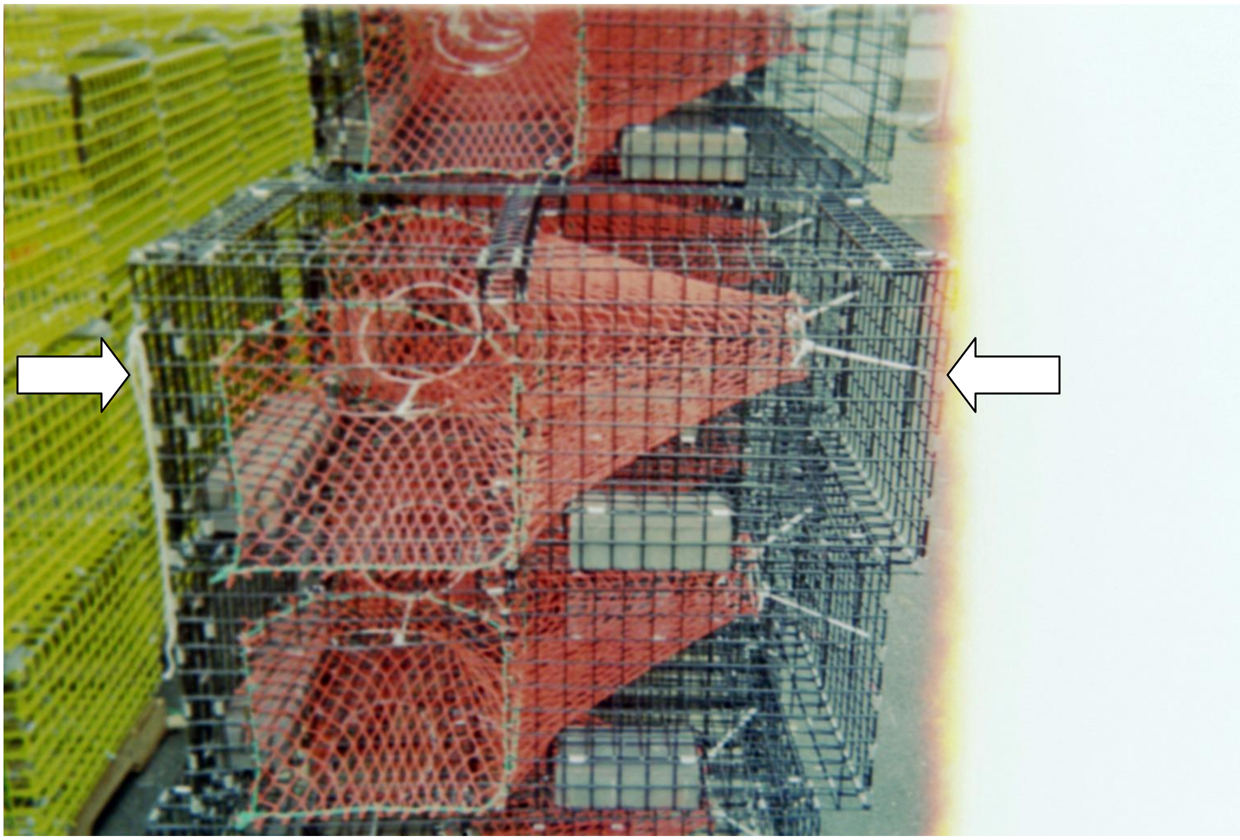


Figure 3 (Typical Lobster Trap)
Typical lobster trap. The Left arrow shows the Kitchen, the Right arrow shows the Parlor, and the Bottom Center arrow shows the ballast bricks. (Ketcham Supply Corp)

Figure 4 (Seaplax™ Brochure Cover)
Northeast Trap LLC is a distributor of Seaplax™ wire mesh (Courtesy of: Northeast Trap LLC)

SEAPLAX™

Wherever **high quality** welded-mesh rolls and panels are needed, Cavatorta's **Seaplax™ PVC coated welded wire mesh** is a tailor made solution. It is customized to outperform standard welded wire mesh products in demanding marine environments. Seaplax™ is designed and manufactured in accordance with the fishing industry's requirements and expected long-lasting service life.

SEAPLAX™ WELDED WIRE MESH DELIVERS VERIFIABLE PRODUCT VALUE:

Cavatorta's **high-tensile steel wire** provides strength, durability, and structural integrity to welded wire mesh traps, cages and structures. Products manufactured with this high-tensile steel wire can resist crushing, withstand rigorous treatment and handling.

This severe-duty wire mesh is produced from proven and specialized materials. It will have a longer life and is the most cost effective solution for harsh marine applications.

Cavatorta's **Galvafort™ heavy zinc coating** is applied using a proprietary double hot-dipped galvanizing process. The Galvafort™ heavy zinc coating supports long-term corrosion resistance in sea water. Its Cathodic protection is considerably higher than that of galvanized before welding wire mesh. The double hot-dipped Galvafort™ coating has excellent adhesion to the wire, permitting severe wire bending and forming without cracking the zinc coating, or causing fatigue cracks in the steel wire.

A **special thermo-set primer** is applied over the heavy zinc coating. The primer promotes adhesion between the PVC top-coating and the zinc substrate. This prevents water intrusion between the PVC coating and the galvanized wire and helps to preserve the wire in cases where the PVC may become abraded.

Cavatorta's **Seaplax™ is an outstanding PVC coating** that is formulated for marine service. It is applied on-top of the thermo-set primer.

Seaplax™ PVC is extremely flexible, cold crack and impact resistant at low temperatures. This marine duty coating is able to withstand continuous immersion in chemicals and salt water. Seaplax™ has superior abrasion resistance, retains its physical properties and colour during exposure to severe weather conditions, and has excellent resistance to ultraviolet sunlight.

MESH SIZE		ROLL WIDTH		WIRE DIAMETER		FINISH	ROLL LENGTH		WEIGHT x ROLL	
Imperial	Metric	Imperial	Metric	Imperial	Metric		Imperial	Metric	Imperial	Metric
In.	mm.	In.	mm.	Ga.	mm.		Ft.	M.	Lbs. appr.	Kg.appr.
1.5 x 1.5	38 x 38	66"	1,676	10.5	3.25	GAW + PVC	100'	30,5	497	225
1.5 x 1.5	38 x 38	63"	1,600	10.5	3.25	GAW + PVC	100'	30,5	458	207
1.5 x 1.5	38 x 38	60"	1,524	10.5	3.25	GAW + PVC	100'	30,5	437	198
1.5 x 1.5	38 x 38	57"	1,448	10.5	3.25	GAW + PVC	100'	30,5	415	188
1.5 x 1.5	38 x 38	54"	1,372	10.5	3.25	GAW + PVC	100'	30,5	394	178
1.5 x 1.5	38 x 38	48"	1,219	10.5	3.25	GAW + PVC	100'	30,5	350	159
1.5 x 1.5	38 x 38	43,5"	1,104	10.5	3.25	GAW + PVC	100'	30,5	318	144
1.5 x 1.5	38 x 38	36"	914	10.5	3.25	GAW + PVC	100'	30,5	264	120
1.5 x 1.5	38 x 38	34,5"	876	10.5	3.25	GAW + PVC	100'	30,5	253	115
1.5 x 1.5	38 x 38	31,5"	800	10.5	3.25	GAW + PVC	100'	30,5	231	105
1.5 x 1.5	38 x 38	25,5"	648	10.5	3.25	GAW + PVC	100'	30,5	189	88
1.5 x 1.5	38 x 38	24"	610	10.5	3.25	GAW + PVC	100'	30,5	178	81
1.5 x 1.5	38 x 38	22,5"	572	10.5	3.25	GAW + PVC	100'	30,5	167	76
1.5 x 1.5	38 x 38	21"	533	10.5	3.25	GAW + PVC	100'	30,5	156	71
1.5 x 1.5	38 x 38	19,5"	495	10.5	3.25	GAW + PVC	100'	30,5	145	66
1.5 x 1.5	38 x 38	18"	457	10.5	3.25	GAW + PVC	100'	30,5	135	61
1.5 x 1.5	38 x 38	16,5"	419	10.5	3.25	GAW + PVC	100'	30,5	124	56
1.5 x 1.5	38 x 38	15"	381	10.5	3.25	GAW + PVC	100'	30,5	113	51
1.5 x 1.5	38 x 38	13,5"	343	10.5	3.25	GAW + PVC	100'	30,5	102	46
1.5 x 1.5	38 x 38	12"	305	10.5	3.25	GAW + PVC	100'	30,5	91	41
1.5 x 1.5	38 x 38	10,5"	267	10.5	3.25	GAW + PVC	100'	30,5	81	37
1.5 x 1.5	38 x 38	6"	152	10.5	3.25	GAW + PVC	100'	30,5	48	22

Figure 5 (Seaplax™ Brochure Page 2)

This Seaplax™ brochure given to me by Northeast Trap LLC gives the details on the wire mesh that they distribute. (Courtesy of: Northeast Trap LLC)

GALVANIZED AFTER WELDING • PVC COATED WELDED WIRE MESH

Our Proven Manufacturing Expertise:
Cavatorta maintains state-of-the-art manufacturing facilities for producing high-quality steel wire products. Computer controlled precision welding is carried out with the most modern machines ensuring that the weld quality, weld ductility and ultimately the weld strength is fitting for structural, cage, and trap applications. An active quality assurance program ensures that the welded wire mesh conforms to or exceeds the industry's quality standards.
The strictest quality controls combined with the production capabilities of our modern machinery make certain of the dimensional accuracy of the wire mesh. Dimensional accuracy and exact welding aids builders and manufactures in the ease of forming and fabricating cages, traps, or structures. Precision mesh helps to speed up your mesh shearing operations and makes them easy. It promotes an efficient process for building traps, cages, and wire mesh products. Precision mesh also helps to eliminate wasted time and scrap in the forming and fabricating stages.

Our Company:
Cavatorta is a dynamic European manufacturing group that specializes in the production of galvanized and PVC coated multifunctional wire mesh products. Formed in 1961 to manufacture and supply wire products, Cavatorta is now recognized as a major supplier to the European market. Cavatorta is a team of skilled professionals who take pride in producing superior wire products and who are dedicated to excellence in their production, products and services.
Efficiency combined with comprehensive research and quick response time to customers' requests has moved Cavatorta to the forefront of the fencing and electro-welded wire mesh sectors.

APPLICATIONS FOR THIS PRODUCT INCLUDE:
Lobster traps, crab traps, fish traps, aquaculture and general marine applications. Seaplax™ products are designed especially for use in sub-sea, harsh coastal, or corrosive environments.

Other uses include:
Soil erosion control, security fencing, agricultural pens, animal housing, fences, horticultural benches, aviaries, baskets, guards, wire constructions and hobby creations.

MESH SIZE		ROLL WIDTH		WIRE DIAMETER		FINISH	ROLL LENGTH		WEIGHT x ROLL	
Imperial	Metric	Imperial	Metric	Imperial	Metric		Imperial	Metric	Imperial	Metric
In.	mm.	In.	mm.	Ga.	mm.		Ft.	M.	Lbs. appr.	Kg.appr.
1.5 x 1.5	38 x 38	66"	1,676	12.5	2.51	GAW + PVC	100'	30,5	305	138
1.5 x 1.5	38 x 38	63"	1,600	12.5	2.51	GAW + PVC	100'	30,5	276	126
1.5 x 1.5	38 x 38	60"	1,524	12.5	2.51	GAW + PVC	100'	30,5	262	120
1.5 x 1.5	38 x 38	57"	1,448	12.5	2.51	GAW + PVC	100'	30,5	250	114
1.5 x 1.5	38 x 38	54"	1,372	12.5	2.51	GAW + PVC	100'	30,5	238	108
1.5 x 1.5	38 x 38	48"	1,219	12.5	2.51	GAW + PVC	100'	30,5	212	97
1.5 x 1.5	38 x 38	43,5"	1,104	12.5	2.51	GAW + PVC	100'	30,5	192	88
1.5 x 1.5	38 x 38	36"	914	12.5	2.51	GAW + PVC	100'	30,5	159	73
1.5 x 1.5	38 x 38	34,5"	876	12.5	2.51	GAW + PVC	100'	30,5	153	70
1.5 x 1.5	38 x 38	31,5"	800	12.5	2.51	GAW + PVC	100'	30,5	139	65
1.5 x 1.5	38 x 38	24"	610	12.5	2.51	GAW + PVC	100'	30,5	108	63
1.5 x 1.5	38 x 38	22,5"	572	12.5	2.51	GAW + PVC	100'	30,5	101	46
1.5 x 1.5	38 x 38	21"	533	12.5	2.51	GAW + PVC	100'	30,5	95	43
1.5 x 1.5	38 x 38	19,5"	495	12.5	2.51	GAW + PVC	100'	30,5	88	40
1.5 x 1.5	38 x 38	18"	457	12.5	2.51	GAW + PVC	100'	30,5	82	37
1.5 x 1.5	38 x 38	16,5"	419	12.5	2.51	GAW + PVC	100'	30,5	75	34
1.5 x 1.5	38 x 38	15"	381	12.5	2.51	GAW + PVC	100'	30,5	68	31
1.5 x 1.5	38 x 38	13,5"	343	12.5	2.51	GAW + PVC	100'	30,5	62	28
1.5 x 1.5	38 x 38	12"	305	12.5	2.51	GAW + PVC	100'	30,5	56	26
1.5 x 1.5	38 x 38	10,5"	267	12.5	2.51	GAW + PVC	100'	30,5	49	23
1.5 x 1.5	38 x 38	6"	152	12.5	2.51	GAW + PVC	100'	30,5	30	14

Figure 6 (Seaplax™ Brochure Page 3)
This Seaplax™ brochure given to me by Northeast Trap LLC gives the details on the wire mesh that they distribute. (Courtesy of: Northeast Trap LLC)

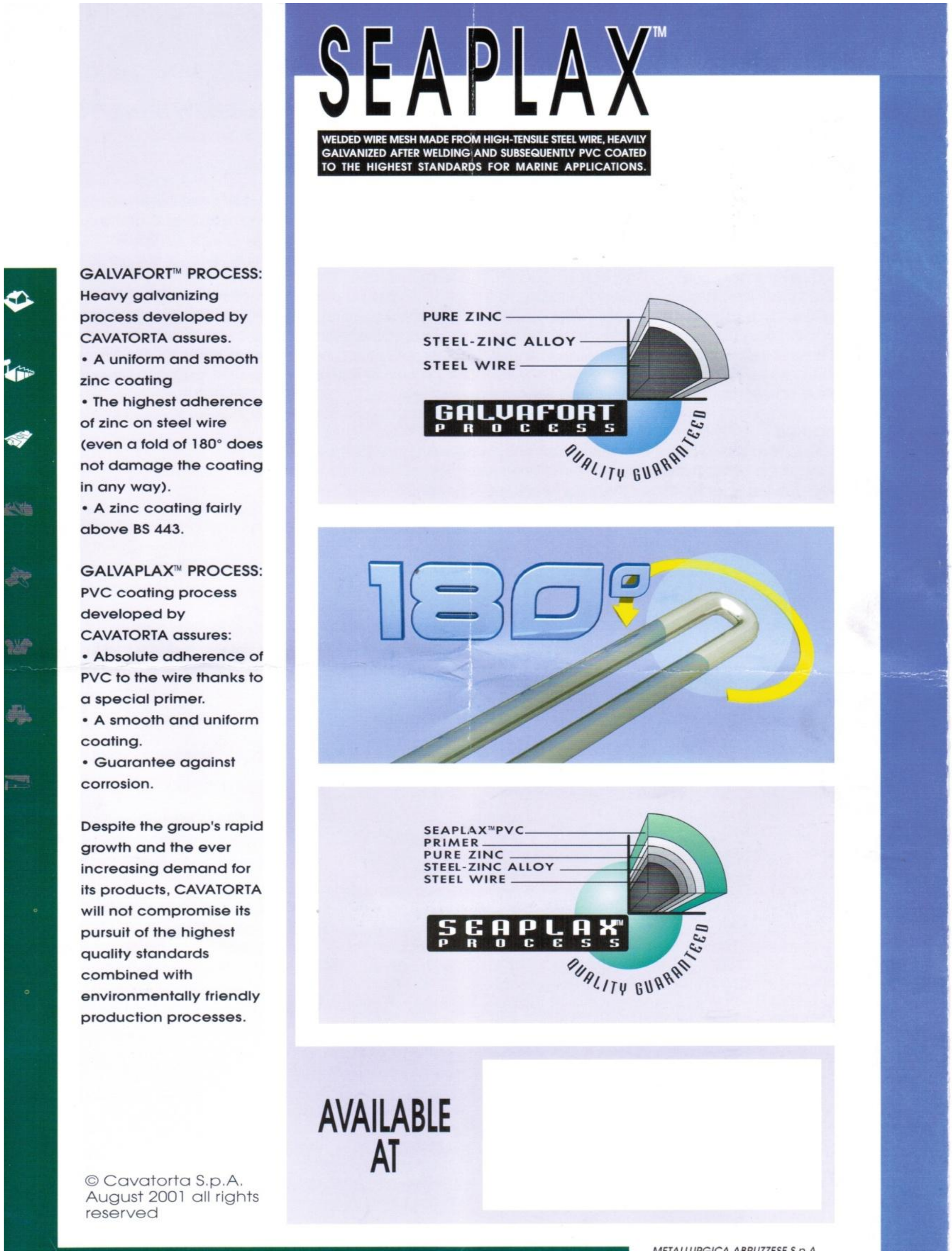


Figure 7 (Seaplax™ Brochure Page 4)
This Seaplax™ brochure given to me by Northeast Trap LLC gives the details on how the wire mesh that they distribute is made. (Courtesy of: Northeast Trap LLC)

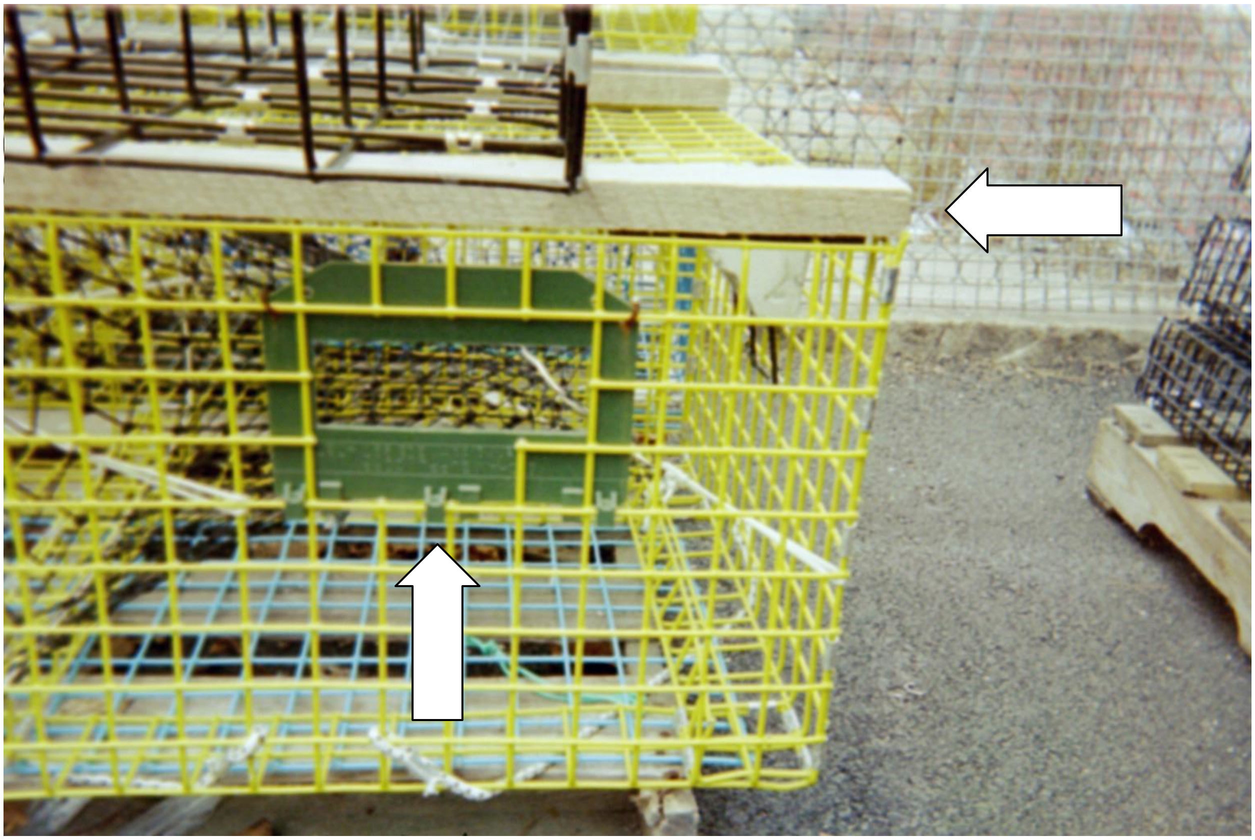


Figure 8 (Escape Vent & Runners)
Upside down lobster trap. The Center arrow shows the required escape vent; in this case it is plastic, while the Top arrow shows the wooden trap runners. (Ketcham Supply Corp)

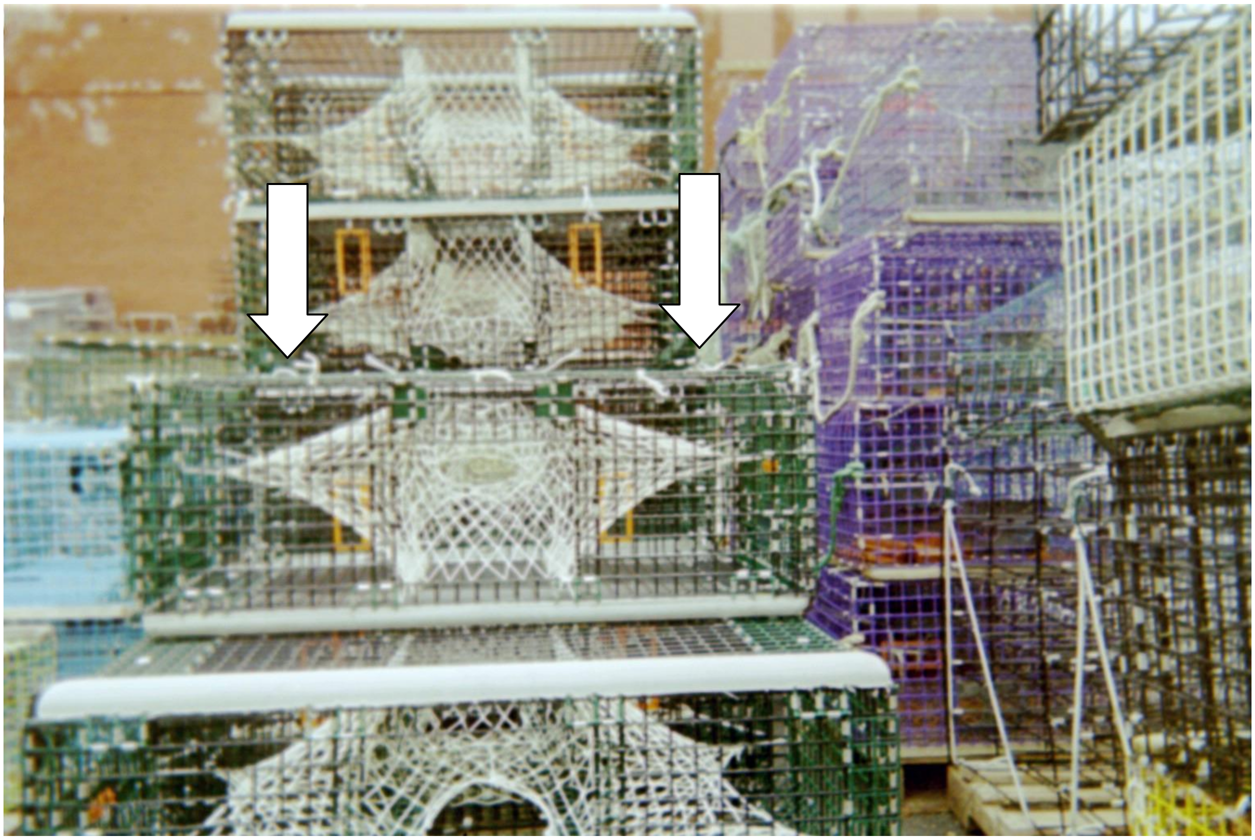
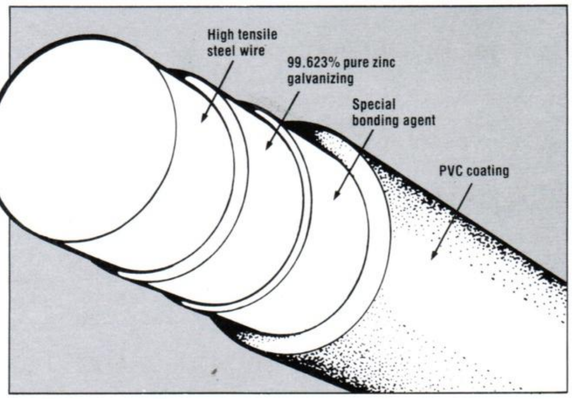


Figure 9 (Double Parlor)
Offshore double parlor lobster trap. The arrows show the two different parlors. (Ketcham Supply Corp)

The Greatest Cover-Up



What makes Riverdale wire mesh the finest you can buy?

It really starts at the beginning—at the steel mill where we select only the finest quality, high tensile steel rod. The rod is then processed at our plant, by our technicians into basic welded mesh wire. Our specifications are tough. That's why we do it ourselves.

Then, to insure that the wire is thoroughly protected, we completely cover the wire mesh with 99.623% pure zinc galvanizing. If specified we'll apply a thick coating of our own specially compounded PVC.

The cross section drawing above is graphic evidence of our unique wire construction. Notice the heavy layer of protective zinc galvanizing. And we *galvanize after welding* which completely seals the welds and adds a thick section of zinc at the wire joints.

After galvanizing we apply our vinyl compound which doesn't get brittle after years of exposure to the sun—and doesn't crack even at low temperatures.

So when you put it all together, we do cover-up better. That's why mink and fox cages made with Riverdale mesh wire will last longer than any other wire cage available.

For full information, contact your local distributor or write to Riverdale Mills Corporation, 130 Riverdale Street, Northbridge, MA 01534.

Direct Sales - 1-800-RMC-MESH
(1-800-762-6374).
Inside MA: (508) 234-8400
FAX: (508) 234-9595

RIVERDALE

RIVERDALE · MILLS · CORPORATION
130 Riverdale Street, Northbridge, MA 01534

Figure 10 (Riverdale Mills Corporation Brochure)
This brochure, given to me by Jim Knott, Sr., details how the wire mesh is made at Riverdale Mills Corporation. (Courtesy of: Jim Knott, Sr., Riverdale Mills Corporation)

COMPUTER	
Manufacturer	Acer
Windows edition	Windows 7 Home Premium
Model	Aspire 5741
Processor	Intel® Core™ i3 CPU M350 @ 2.27 GHz 2.27 GHz
Installed memory (RAM)	4.00 GB (3.68 GB usable)
System type	64-bit Operating System

SolidWorks	
Edition	2010 x64 Education
Academic Year	2010-2011 / 2010 SP4.0

Table 1 (Computer & SolidWorks)
My laptop and SolidWorks information.

MATERIAL: Galvanized Steel				
Elastic Modulus	**Poisson's Ratio**	**Mass Density**	**Tensile Strength**	**Yield Strength**
2e+011 N/m^2	0.33	7870 kg/m^3	3.569e+008 N/m^2	2.0394e-008 N/m^2

Pressure:	2.76 psi

	KISS Cube			KISS Shell 2.51			KISS Trap 2		
	Stress Min	**Stress Max**	**Deformation Max**	**Stress Min**	**Stress Max**	**Deformation Max**	**Stress Min**	**Stress Max**	**Deformation Max**
Original	8064.77 N/m^2	44134.7 N/m^2	3.70423e-005 mm	239.623 N/m^2	9.68409e+007 N/m^2	2.50596 mm	2.40628e-006 N/m^2	4.76976e+008 N/m^2	14.6011 mm
0.5 Mass Density	8064.77 N/m^2	44134.7 N/m^2	3.70423e-005 mm	224.486 N/m^2	9.68535e+007 N/m^2	5.01177 mm	2.40628e-006 N/m^2	4.76976e+008 N/m^2	14.6011 mm
2 Mass Density	8064.77 N/m^2	44134.7 N/m^2	3.70423e-005 mm	239.623 N/m^2	9.68409e+007 N/m^2	2.50596 mm	2.40628e-006 N/m^2	4.7697e+008 N/m^2	14.6011 mm
0.5 Elastic Modulus	8064.77 N/m^2	44134.7 N/m^2	7.40847e-005 mm	224.486 N/m^2	9.68535e+007 N/m^2	5.01177 mm	2.36743e-006 N/m^2	4.76977e+008 N/m^2	29.2023 mm
2 Elastic Modulus	8064.77 N/m^2	44134.7 N/m^2	1.85212e-005 mm	224.486 N/m^2	9.68535e+007 N/m^2	1.25294 mm	2.36743e-006 N/m^2	4.76977e+008 N/m^2	7.30056 mm
0.5 Yield Strength	8064.77 N/m^2	44134.7 N/m^2	3.70423e-005 mm	239.623 N/m^2	9.68409e+007 N/m^2	2.50596 mm	2.40628e-006 N/m^2	4.76976e+008 N/m^2	14.6011 mm
2 Yield Strength	8064.77 N/m^2	44134.7 N/m^2	3.70423e-005 mm	239.623 N/m^2	9.68409e+007 N/m^2	2.50596 mm	2.40628e-006 N/m^2	4.76976e+008 N/m^2	14.6011 mm

Table 2 (Model Tests)

Results of the model tests performed on the three different solid models in order to know that the model was working correctly when being used with finite element analysis.

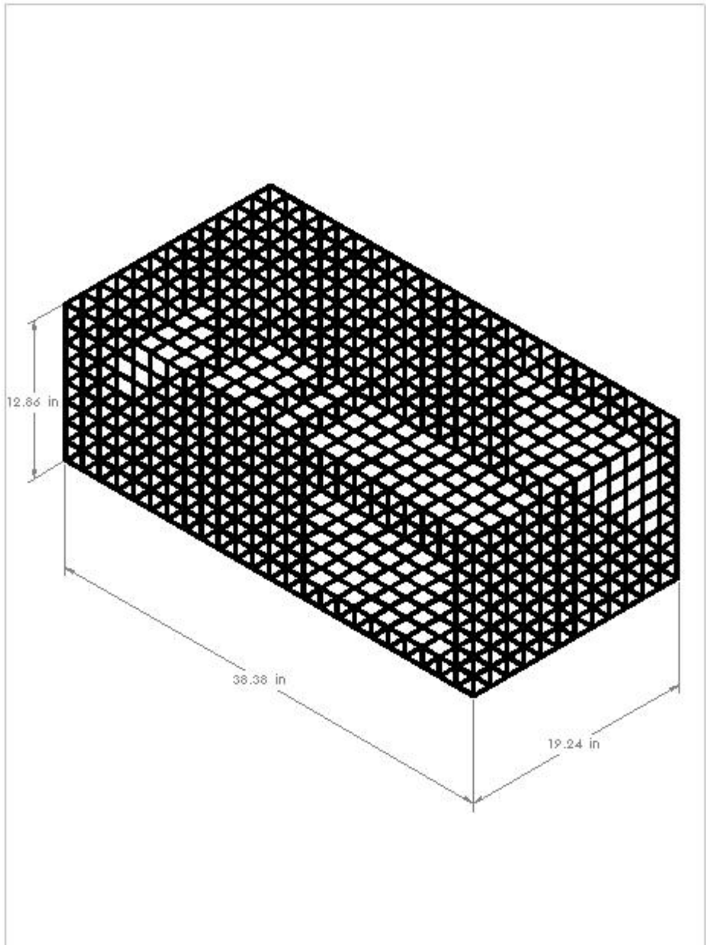


Figure 11 (Solid Model Drawing)
Drawing of the solid model of a typical lobster trap made in SolidWorks. Notice the dimensions.

Figure 12 (Attachment 1)
Single attachment hauling bridle held together with knots. The arrow shows the attachment point on the trap.

STACK #	FIGURE #	# TRAPS
1	6	6
2	6	6
3	7	4
4	7	5
5	7	6
6	8	5
7	9	4
8	10	4
9	11	4
10	12	4
	AVERAGE	**4.8**

Table 3 (Average Stack Height)

To figure out the average number of traps stacked on top of the bottom trap during typical storage, lobster trap stacks at the Stonington Town Dock were looked at and the number of traps on top of the bottom trap in each stack was counted. This was then put into the table above to find the average number of traps stacked on top of the bottom trap during typical storage.

2. Materials

No.	Body Name	Material	Mass	Volume
1	SolidBody 1(Cut-Extrude7)	Galvanized Steel	2.14649 kg	0.000545486 m^3

3. Load & Restraint Information

Fixture

Fixed-1 <KISS Trap 2>	on **1 Face(s)** fixed.	

Load

Pressure-1 <**KISS Trap 2**>	on **1 Face(s)** with Pressure **0.663 psi** along direction normal to selected face	

4. Study Property

Mesh Information

Mesh Type:	Solid Mesh
Mesher Used:	Standard mesh
Automatic Transition:	Off

Done Computer | Protected Mode: Off 100%

Figure 13 (Scenario Setup)

Explains how the scenario was setup, meaning which part of the model was fixed (unable to deform) and where the load was applied. (Source: Solidworks SimulationXpress)

5. Results

5a. Stress

Name	Type	Min	Location	Max	Location
Stress	VON: von Mises Stress	5.60997e-007 N/m^2	(679.221 mm, 0.617388 mm, -243.677 mm)	1.14578e+008 N/m^2	(528.799 mm, 307.296 mm, -405.361 mm)

KISS Trap 2-SimulationXpress Study-Stress-Stress

JPEG

VIEW

Done

Computer | Protected Mode: Off

100%

Figure 14 (Model Stress)

Tells the value of maximum and minimum stress incurred by the model and where they occur on the model. (Source: Solidworks SimulationXpress)

Name	Type	Min	Location	Max	Location
Displacement	URES: Resultant Displacement	0 mm	(772.2 mm, 2.51 mm, -324.08 mm)	3.50744 mm	(750.674 mm, 227.86 mm, -245.522 mm)

Figure 15 (Model Deformation)
Tells the value of the maximum and minimum deformation of the model and where they occur on the model. (Source: Solidworks SimulationXpress)

6. Appendix

Material name:	Galvanized Steel
Description:	0.5 Mass Density
Material Source:	
Material Model Type:	Linear Elastic Isotropic
Default Failure Criterion:	Max von Mises Stress
Application Data:	

Property Name	Value	Units
Elastic modulus	2e+011	N/m^2
Poisson's ratio	0.33	NA
Mass density	3935	kg/m^3
Tensile strength	3.569e+008	N/m^2
Yield strength	2.0394e+008	N/m^2

Note:

SolidWorks SimulationXpress design analysis results are based on linear static analysis and the material is assumed isotropic. Linear static analysis assumes that: 1) the material behavior is linear complying with Hooke's law, 2) induced displacements are adequately small to ignore changes in stiffness due to loading, and 3) loads are applied slowly in order to ignore dynamic effects.

Do not base your design decisions solely on the data presented in this report. Use this information in conjunction with experimental data and practical experience. Field testing is mandatory to validate your final design. SolidWorks SimulationXpress helps you reduce your time-to-market by reducing but not eliminating field tests.

Figure 16 (Model Material)
Describes the material that was used, in this case detailed information about the actual wire mesh material was unable to be secured from the manufacturers so a generic galvanized steel was used. (Source: Solidworks SimulationXpress)

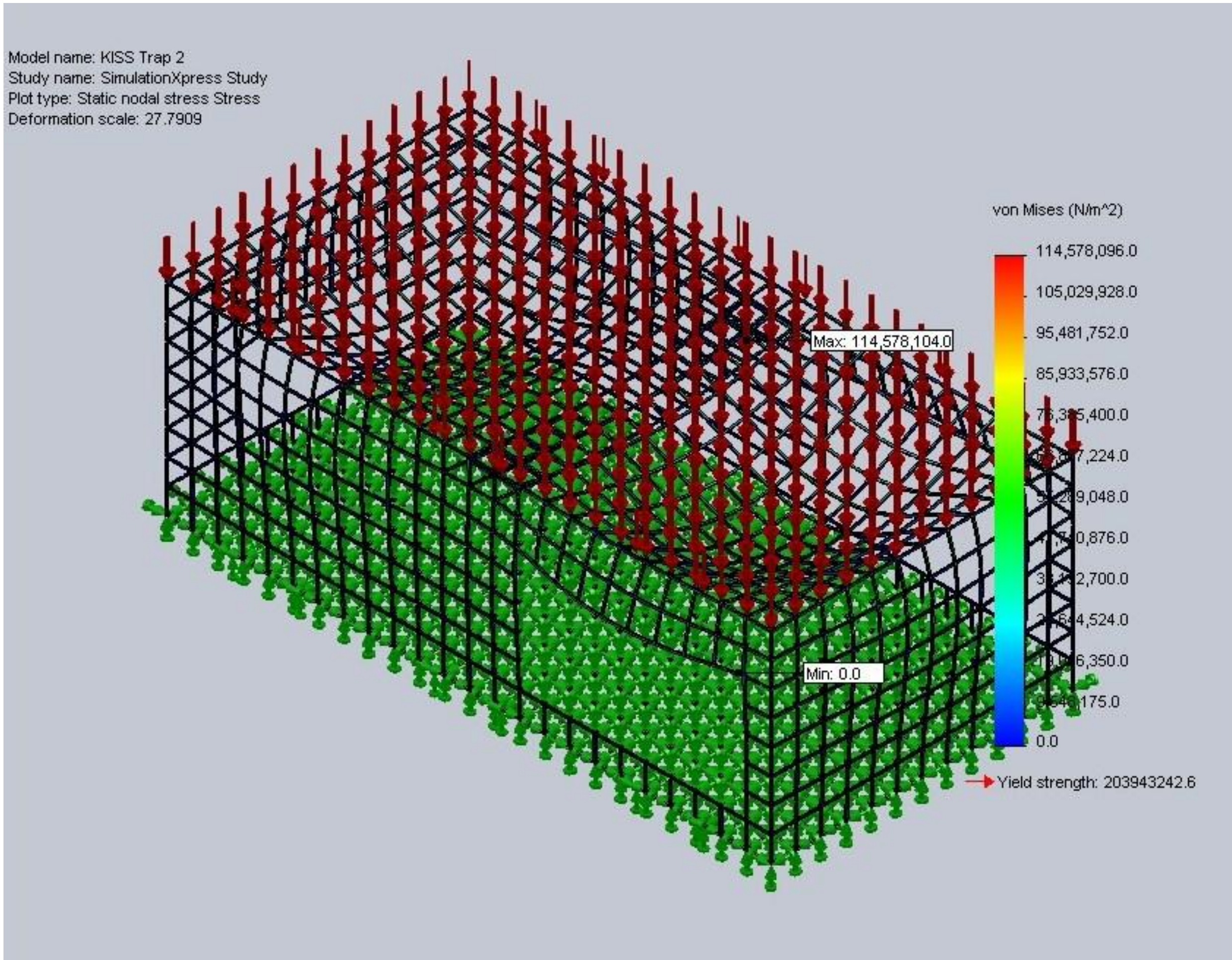


Figure 17 (Stress Distribution Graphic)
(Source: Solidworks SimulationXpress)

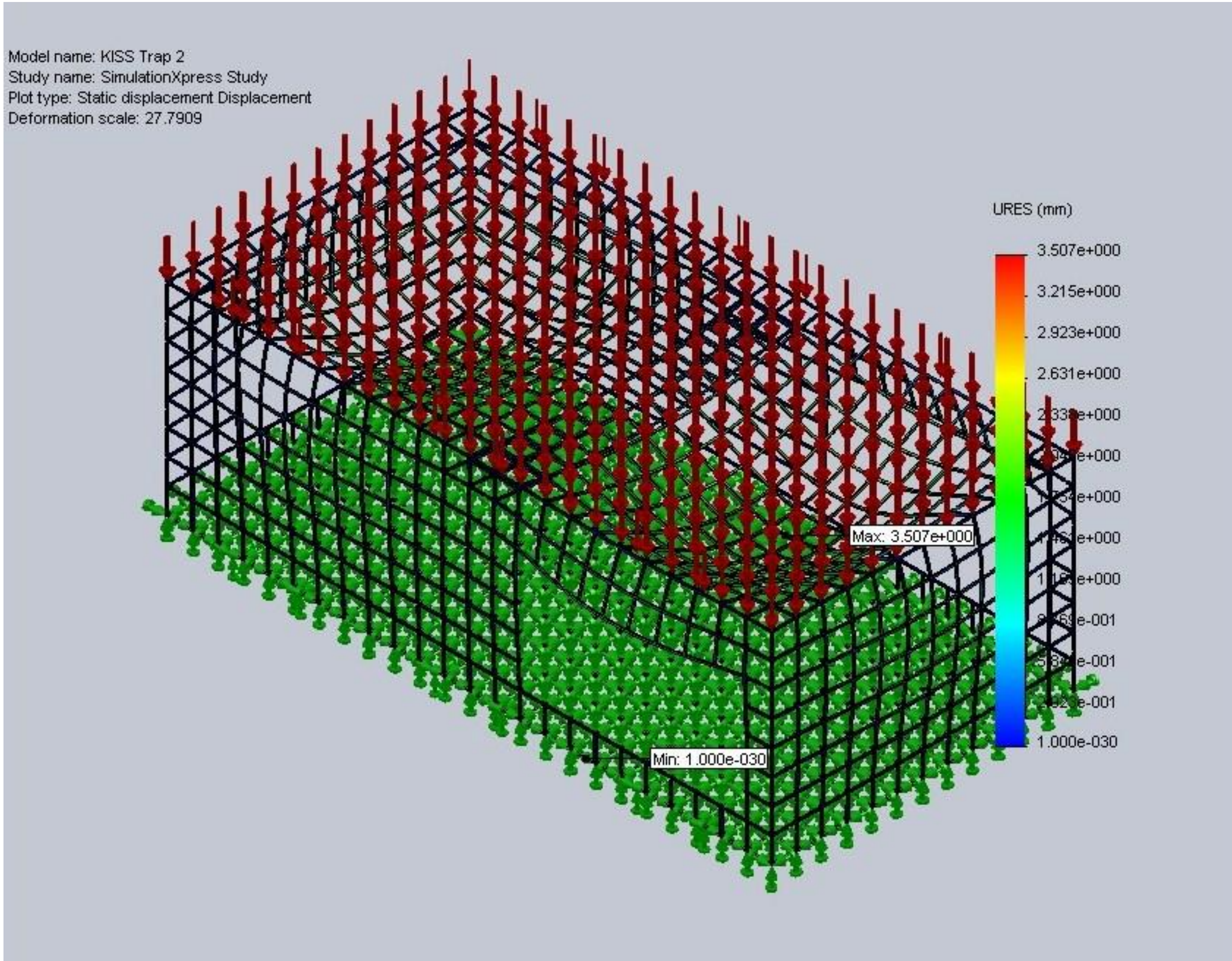


Figure 18 (Deformation Graphic)
(Source: Solidworks SimulationXpress)