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CONSIDERATIONS FOR THE STRUCTURAL STABILIZATION OF DETERIORATED INDUSTRIAL RUBBER

Julie Wolfe and Eleonora Nagy

Introduction

Many contemporary artists have used rubber for its resilient properties as a medium for artistic expression. However, rubber artworks weaken in elastic strength as they age. Conservators are left with a serious concern for their structural integrity, especially when the strength of a sculpture is contingent on the elasticity of rubber. The Solomon R. Guggenheim Museum in New York includes several artworks that are composed of rubber. The subject of this article revolves around one particular piece created by Richard Serra in 1966-67, entitled *Belts* (Fig.1). The sculpture includes nine sections of belt that are composed of different types of black, red and tan colored industrial sheet rubber. The sheets are firm, a quarter-inch thick, and 2 to 3 inches wide. Several six-foot long strips of the sheet rubber are tangled together and attached using sharp iron staples. Each of the nine belts weighs approximately 40 pounds. The belts hang in a row from spikes in the wall, and the top strip of rubber in each grouping supports all the weight. A neon element is also attached to the first piece. Guiseppe Panza, an Italian collector, originally purchased *Belts* from Leo Castelli in 1971. Twenty years later, the Guggenheim Museum acquired *Belts,* along with a large group of other conceptual artworks from the Panza collection. The curators at the Guggenheim consider this sculpture to be an important part of the collection, and it was included in the Panza exhibition that opened at the Guggenheim Bilbao in November 2000.

The artist, Richard Serra, completed a series of sculptures in the late sixties made out of strips of industrial sheet rubber (Serra 1978). In an interview, Serra explained these works, "I started working with rubber after I went down to Canal Street and saw all the rubber there. I found more in the rubber than in anything else – a sort of private language going on – and felt if you could only get that language, you could reinforce your art by using that" (Serra 1994, 209). In a conversation between Ms. Nagy and Serra's assistant, we learned that he came across a large stock of rubber from a rubber manufacturer going out of business near his studio (Serra 2000). The belts have been described by an art historian, Clara Weyergraph, "the flexible material becomes subject to gravity: it falls" (Weyergraph 1978, 210). At present, when we consider the belt's preservation – these keywords, "gravity", "hanging" and "falling" seem to linger in our minds as sources for concern as the rubber deteriorates.

The nine belts were stored in crates since the Guggenheim acquired the Panza collection in 1991. Each belt was tucked into a tight compartment, causing it to lie with its edges curled up. They were stored for several years, and the distortion of the belts became permanent due to the oxidation of the rubber. The results of this can be seen in the curve of belt #7 pictured hanging in Fig. 2. Not only are they awkwardly shaped, but the belts no longer hang completely flush against the wall. Furthermore, the rubber strips that hang from the spikes on the wall have become fatigued and three of them are cracking. The cracks widen as they are laid to rest on the

spike. The cracking on the top section of belt #4 penetrates halfway through the thickness of the sheet (Fig. 3). Belt #5, which has a cotton cloth interlayer, starts cracking at the back and the separating is moving forward (Fig. 4). These serious cracking conditions give rise to our primary concern that the most severely deteriorated rubber pieces may fail during installation. Anticipating a 3-6 month display time for the upcoming exhibition, the belts were vulnerable to failing without structural support or repair. The artwork was not considered to be in exhibitable condition.

Three Phase Conservation Program
Richard Serra, *Belts*, 1966-67

I. Preservation	II. Structural Repair	III. Replacement
mounting	adhesive testing	collecting rubber
crating	solvent testing	that matches *Belts*
storage	apply strip linings	replacing cracked strips

Serra's studio was contacted about these different treatment options. The artist did not want the piece modified, preferring that our actions involve minimal intervention. Based on our discussions, a long-term conservation plan has been worked out starting with the least interventive approach and gradually moving to future replacement if necessary. The first steps taken are non-intrusive preventative measures that include supporting mounts and a new crating system. The second step is to research the methods and materials for a local strip lining to repair the cracking rubber. The authors have carried out several mock-up treatments that involve using a toned fabric lining adhered to the inner curve of the belting for structural support. A support lining would be a short-term structural repair to extend the life of the *Belts* in its original form. The third step may involve the eventual replacement of these supporting rubber strips. The artist has agreed to collaborate with the Guggenheim conservators when and if the time for replacements arrives.

Preservation: Mounting

In the original display of *Belts*, each belt section was hung on a spike nailed to the wall. There have been several variations in the positioning and type of hardware for assembling the belts, as documented in past photographs. It is essential that the belts continue to be hung as the artist originally intended, with casual display on spikes. This has been a defined guideline despite the fact that the rubber has become less pliable. The original hardware for hanging the belts has been lost and replacement spikes were purchased. Early installation photographs were used for this purpose. In order to maintain the artist's original intent to hang the belts on spikes, these had to be modified slightly in order to compensate for the fact that the *Belts* do not hang flush against the wall any more. The belts have stiffened in varying configurations, requiring that each spike

be positioned on the wall at a slightly different angle. In order to find the best angle for each spike, a mock-up wall was constructed with a hole drilled where the spike could be inserted and adjusted up and down. The belts were hung one by one, and the ideal angle of the spike was measured.

A complex mounting system was designed for the Bilbao installation in order to more safely hang each belt on a spike. Fig. 5 shows a diagram of the mount as it attaches to the spike. The spike was secured into a metal back plate made of steel. The plate screwed into the wall and held the spikes at the correct angles. To prevent the spike from rotating, the spike was locked in position with a tightening screw on the steel tubing. This screw allowed easy installation and small adjustments if necessary. Each back plate is stamped with the identification number of the belt since they cannot be interchanged. The back plates were made invisible by insetting them a quarter inch into the wall so they could be covered with plaster and paint (Fig 6).

The cracked and stiff rubber strips were bending too sharply over the top of the spikes. To compensate, each spike had a custom fabricated thin sheet of steel welded onto the shoulder of the spike to soften the angle of bend (Fig. 7). Also, the steel support helped to distribute the weight of the belt over a larger area, and reduced the strain on the cracked areas. The plate was camouflaged by toning with a thick layer of Beva® D-8 and dry pigments. The thick layer of paint also served to cushion the metal plate that was in contact with the rubber surface. Fig. 8 shows one of the belts installed on its mount after inpainting to match the tone of the rubber.

Preservation: Crating, Storage

New crates for transportation and storage were fabricated to mitigate ongoing, irreversible distortion. When the belts hang on the wall, they stretch vertically and expand in length, holding a position quite different from when they are lying down. The belts must lie in a horizontal position when they are stored. However, they should not be allowed to slump in shape as the form relaxes and widens. The belts are stapled together so loosely, that they move around freely when handled. It is important to hold the belts in their elongated "hanging" position even when they are lying down in storage. Ideally, the belts should harden as they age in the "hanging" position, in other words, the position they hold when they are hanging from the spikes. The rubber no longer has the elastic strength to be repeatedly stretched during installation and deinstallation.

Anoxia was considered as an option for long-term preservation. Studies published in the conservation literature have shown anoxia to be a successful means for slowing down the deterioration process of rubbers (Shashoua 1999; Shashoua 1993). There were a number of reasons why anoxia for the Serra *Belts* was not found to be a viable option. First, the large scale of each belt made it difficult to prepare individually sealed and effective enclosures. The extremely sharp iron staples were an added risk for tearing barrier films. Second, a tremendous amount of Ageless (oxygen scavenger) and possibly a constant nitrogen stream would be

required, making the cost and maintenance time high. Finally, a failed system would most likely create a worse environment for the rubber.

The new crating system was designed with three functions in mind: to house the sculpture during storage, to aid in the installation, and to provide a safe environment for transportation. Each belt is stored on its own tray made out of plywood lined with Marvelseal. The inside of the crate has been lined with Corrosion Intercept to absorb the rubber's off-gassing and to prevent contamination of the storage environment. A wooden block screwed into the plywood to support the top strip of each belt. The block has been carved and padded with Ethafoam to mimic its interior curve of the belt strip. With the belt resting on the tray, the entire tray can be raised to a vertical position and the belt would hang from the piece of supporting wood. Additional supporting pieces of wood were cut to conform to the shape of the belt along its length. A cage of padded plywood cauls holds the belt in the ideal position even when it is resting horizontally (Fig. 9). The trays can also be used for installation to carry the belts to the wall. After tilting the tray and leaning it against the wall, the plywood supports can be removed and the belt can be directly transferred to the spike on the wall. The installation trays have been used with great success during the 2000 installation of the *Belts* in Bilbao.

Structural Repair: Strip Lining

Methods have been tested for structural repair to determine whether a strip lining can be adhered to the rubber for support. The limited time frame before the exhibition in November 2000 resulted in adhesive testing that began prior to the completion of analytical identification of the rubbers. As the belts could have consisted of several different types, a small selection of elastomers was collected. Products that would have been available to Serra in the 1960's were EPDM, neoprene, and butyl rubber. These types were also visually comparable to Serra's sculpture. It was thought that by choosing three types of rubber, applicable information for the Serra *Belts* would be obtained. All of the lining tests using solvents and adhesives were done using new sheets of rubber, with known compositions, purchased from McMaster-Carr.

Solvent Cleaning Tests on New Rubber

Solvent effects have to be considered when testing adhesives. The published literature on this topic shows that exposing rubber to solvents has long-term detrimental effects causing swelling and the removal of surface crusts containing oxidized rubber and migrating plasticizers. It is possible that surface crusts may in fact be protective (Sale 1988; Loadman 1993). Studies have not included the vast array of different industrial rubber types, nor do we know how short-term solvent exposure affects the surface. The question must also be asked whether there are cleaning systems that would remove surface contaminants to facilitate adhesion. Technical references stress the importance of surface preparation prior to adhesive bonding (Shields 1984). Solvents are recommended for pre-cleaning to remove grease or lubrication from the original fabrication

process, and studies have shown that weak bonding can be linked to surface contamination of plasticizers that have migrated to the surface (Fust 1966).

A very strong adhesive bond is required for a strip lining, since each belt weighs approximately 40 pounds. The 3" x 1" area of rubber on the top strip bears the entire weight of the sculpture as it curved over the spike; this is the intended area for a possible surface lining. The surface of this area may need solvent cleaning in order to obtain a strong adhesion between the rubber and fabric lining. The effects of swabbing solvents onto the three rubber types, EPDM, neoprene and butyl rubber, were tested. The list of solvents used on each includes: water, isopropanol, ethanol, toluene, acetone, Shell mineral spirits 135, and Duro-Clean®. Duro-Clean® is a proprietary rubber cleaning product, the primary contents of which include water and butyl cellosolve (US Chemical 1995). Visual observations as well as viewing under a reflective microscope at 6X magnification were used to monitor immediate swelling or rubber dissolution. Afterwards, the solvent test strips were attached to a piece of mat board and each area was labeled. The writing was protected with a sheet of Marvelseal, and they have been exposed to sunlight for one and a half years. The test strips were re-examined periodically, and no additional changes from the original observations, such as cracking or deterioration, have been observed on the areas that received short-term exposure to solvents. It is important to note that re-testing using the same list of solvents on untreated rubber sections show that the rubbers have deteriorated to the point that they are now more sensitive to solvents. All of the solvents caused the cotton swabs to turn black, indicating surface dissolution. Therefore, the results of the solvent testing presented in this paper are only relevant to new, unaged rubbers.

EPDM rubber, an ethylene-propylene diene monomer, was first produced on a large scale in 1963 and was used in the belting industry (Morton 1987; Hofmann 1989). The black, ¼" thick EPDM had a smooth surface and a durometer hardness of Shore A60. The EPDM rubbers have been purported to be very resistance to chemicals, and they are only moderately attacked by acetone, alcohol, dilute acids and alkalis. Due to its non-polarity, EPDM swells in aliphatic, aromatic or chlorinated hydrocarbons (Hofmann 1989). Using the solvents listed previously, areas were swabbed with each solvent. Isopropanol and ethanol appeared to change the surface the least. The other solvents caused the surface of the rubber to become abraded in raking light and therefore appear more matte. Acetone and toluene showed dissolution and swelling of the rubber and the swabs turned black.

A black neoprene sample was purchased as a commercial-grade rubber with a durometer hardness of Shore A: 45-55. Neoprene was considered one of the first synthetic rubbers and was developed in the 1930's. It was a typical elastomer used for belting (Brady 1991). Overall, the surface exhibited a typical whitish bloom that may be a layer of microcrystalline wax. Waxes were commonly used as short-term antidegradants, and they were added to the bulk rubber in concentrations high enough to cause migration at the surface. The recommended surface degreasers in Shields' Adhesives Handbook are toluene, methanol, and isopropanol. All of the solvents listed above for testing removed the whitish surface bloom. The isopropanol and Duro-clean® showed the least change in surface and caused no visible swelling in the neoprene.

The third rubber for testing was a black butyl sheeting with a durometer hardness of Shore A: 55-65. Butyl rubbers are an inexpensive synthetic rubber composed of isobutylene-isoprene copolymers. As with the neoprene, it had a whitish bloom on the surface that is slightly metallic in appearance. The surface bloom did not adhere to the surface well, and it could be removed with the soft scratch of a fingernail. Shields' Adhesives Handbook states that toluene is a recommended surface degreaser prior to adhesion. All of the solvents listed above for testing remove the whitish bloom. The butyl rubber showed the least surface change when exposed to water and DuroClean®. The rubber appeared to be resistant to swelling from the short-term exposure all of the tested solvents.

Solvent Cleaning Tests on Aged Rubber

It should be noted that no extensive testing has been performed on the artwork itself. From the series of belt sections, the black belt #9 was predicted to need a support lining in the future. The top rubber section began cracking and the rubber feels stiffer than the others. The surface of the rubber has a whitish bloom and the black color has faded to a chocolate brown. The edges appear greenish in color due to abrasion. Surface cleaning tests on belt #9 were carried out using the same solvents listed before. As anticipated, the rubber was found to be much more sensitive to solvents. Water immediately turned the rubber a matte brown, rust color. Isopropanol did not cause any visual change to the surface. However, by the next day the area tested had turned brown. Mineral Spirits 135 and odorless mineral spirits did not cause any visible change until several days later. Application of ethanol resulted in no visual change in the surface other than moderate surface cleaning. Several months later, the area tested with ethanol still did not show any changes. It is important to note that the solvents did not always show immediate effects, and that changes often took several days to occur.

Adhesive Testing

A large group of adhesives ranging from proprietary products to well-known conservation adhesives were tested for adhesion. Several Scotch Grip™ contact adhesives containing a range of rubber bases were recommended by 3M. The ScotchWeld™ DP8005 has recently come onto the market and was recommended by 3M for adhering rubber. Other adhesives such as Beva® D-8, Beva® Film, hide glue, and acrylic emulsions were recommended for testing by other conservation professionals (Bruno 2000, Landgrebe 2000, Blank 2000). The adhesives were tested on the same three rubbers: EPDM, neoprene and butyl. A complete list of adhesives is shon below with results categorized as poor, fair, or good. The adhesive testing involved gluing strips of fabric onto the sample rubber giving a 1 inch square simple lap join. Also, there is a list below of different lining fabrics that were compared against each other as being poor, fair or good.

Primary list of adhesives tried:	Results:
Beva® D-8 Dispersion	good
Beva® 371 Film	good
Hide Glue	good
3M Scotch™ 300LSE tape	good
3M™ High Temperature Aluminum Foil Tape 433	poor
3M™ Glass Cloth Tape 361	poor
3M Scotch Grip™ 1300	poor
3M Scotch Grip™ 847	fair
3M Scotch Grip™ 4799	poor
3M Pronto™ CA-40H	good
3M Pronto™ CA-5	good
3M ScotchWeld™ DP8005	good
Pliobond 20	poor
Jade 403	fair

Lining fabrics tested:	
Goretex	fair
Woven polyester fabric	good
Tyvek	fair
Thera-Band natural rubber sheeting	poor
Polyester/Linen fabric	good

The shear strength of the adhesives and lining materials was initially tested using a simple, manual pull test. As testing proceeded, five adhesives that appeared the strongest were selected. This group was retested using the polyester/linen fabric to provide direct comparisons. The table in Fig. 10 shows the testing results for the three rubbers using Beva® D-8, Beva® Film, ScotchWeld™ DP8005, Scotch Grip™ 847 and Scotch™ 300LSE tape. For the Beva® D-8, one layer of undiluted adhesive was brushed onto the fabric and allowed to dry prior to the reapplication of Beva® D-8 before adhesion. Two layers of Beva® Film were heat set onto the fabric prior to heat setting the fabric onto the rubber. The other adhesives had only one layer added prior to clamping onto the rubber. Shear strength testing was performed using a homemade device with a spring-loaded pressure gauge, vices and clamps (Fig. 11). The join was slowly strained by manually increasing 1 pound per 20 seconds until the join eventually failed. Also, since ethanol showed minimal swelling of the three rubbers and showed the least change in the surface of Serra belt #9, the adhesive strengths with and without surface cleaning using ethanol was compared (abbreviated in the table as EtOH prep).

The strength of a particular adhesive varied depending on the rubber type. The strongest adhesive for EPDM was the Beva® D-8 dispersion on an uncleaned rubber surface. The Beva®

Film on uncleaned rubber was second, yet almost half as strong when compared with the Beva® D-8. The third strongest join was the 300LSE tape on an ethanol cleaned surface. The Scotch Grip™ 847 was weaker still, and the ScotchWeld™ DP8005 failed almost instantly.

For neoprene, the strongest adhesive was the Beva® D-8 dispersion, followed closely by the Beva® Film. The spring gauge was limited to 28 pounds, consequently the full strength of the neoprene/ Beva® D-8 could not be completely measured - it sustained 28 pounds. The Scotch™ 300LSE tape was the third strongest join with the ethanol pre-cleaning. The fourth strongest adhesive was the ScotchWeld™ DP8005, however it is important to note that the product was difficult to use as it is heavily bulked and difficult to spread over the surface evenly. The weakest join was the Scotch Grip™ 847.

The strongest adhesive for butyl rubber was the Beva® Film after ethanol pre-cleaning. The second strongest was the 300LSE tape pressed onto an ethanol cleaned surface. The Beva® D-8 (uncleaned) and the Scotch Grip™ 847(cleaned) were the same in strength after the tape. The weakest adhesive was the ScotchWeld™ DP8005.

It cannot be stated conclusively whether the ethanol pre-cleaning of the rubber surface aided in the strength of the adhesive join. Some of the tests showed that the join was stronger with the ethanol pre-cleaning. For example, the Beva® Film strength more than doubled for neoprene cleaned with ethanol. However, the data show that this is not always the case and the results are random. The Beva® D-8 strength on EPDM was actually weaker when it was pre-cleaned with ethanol. Retesting is required in order to make any conclusions on the necessity for surface preparation using solvents.

Clamping Rubber During Adhesion

While carrying out the adhesive testing, it was noted that the rubber easily becomes distorted during clamping. It was not uncommon for the mock-ups to have a dimple in the rubber where the clamp jaws were attached. This can be avoided by using Plexiglas plates on flat surfaces. However, adhering a lining to a curved section on the belts would require making a caul to support the patch during clamping. The caul needs to have an identical shape to the inside and outside curve of each individual belt as it hangs on the spike. Evenly distributed pressure is extremely important to avoid distortions during clamping. Tests on a mock-up using a caul made from a moldable polycaprolactone sheeting called Klarity™ showed promising results. The Klarity™ sheeting could be cut on the table saw, and softened in hot water. It turns transparent when it becomes moldable. Mylar was used as a barrier while the softened Klarity™ could be molded to the inside of the belt, and a second piece molded to the outside of the belt. Easily and accurately, two shaped cauls were made for a mock-up strip of curved rubber. A lining was adhered to the inside curve and was clamped using cauls. No distortions were observed in the rubber after the mock-up treatment.

Toning Fabric

Toning the fabric would be required because the location for a strip lining is visible to the viewer's eye. Several layers of Beva® D-8 toned with dry pigments could create an excellent likeness to rubber. At least eight or more thin layers were brushed on and each layer was sanded prior to the next application of Beva in order to reduce brush strokes. While experimenting with pigmented Beva® D-8, it was discovered that by bulking with Scotchlite™ H50 glass bubbles, a thick putty could be made. The putty was easy to manipulate and it held its shape during drying. When dry, it has the appearance of rubber and it remains slightly elastic. Using a scrap of distressed rubber, it was possible to fill thick gaps with the putty, maintaining minimal shrinkage upon drying. It should be noted, however, that when the piece of rubber was stretched, the join at the fill would fail. With more testing, and consideration for reversibility, bulked Beva® D-8 may be a useful fill material for losses in rubber.

Replacement

The final phase of the conservation program for the Serra *Belts* was to begin collecting samples of rubber that match the various colors of each individual belt. Eventually, the top strips of rubber on each belt section will become too weak and brittle to support the weight of the belt, and in order to exhibit the artwork, the only solution would be to replace the top strip with a new piece of rubber. This would involve opening up a few iron staples, removing the approximately six foot long section, inserting a new replacement piece, and re-closing the staples. This operation will only be carried out with the consultation of the artist's studio, and when all other options have been exhausted. A complete set of replacement rubbers have been purchased from several rubber suppliers within New York and are stored for future use.

Summary

A major work by a prominent artist was successfully stabilized for the installation in Guggenheim Bilbao using minimum intervention. The authors hope that the improved crating and installation system will extend the lifetime of this sculpture. The second phase exploring structural repairs has been researched and is ongoing. Due to the lack of published work in the area of repairing rubber, basic groundbreaking experiments and research was carried out. After completing tests to the degree presented in this paper, identification of the rubbers were received from James Martin of Orion Analytical. Using FTIR microscopy, he identified belts #4 and #5 as natural rubber, while the remaining seven are composed of neoprene (Martin 2000). Fortunately, we have already gained some knowledge about the adhesive properties of neoprene, and Beva® D-8 seems to be promising. Solvent cleaning prior to the structural reinforcement appears to be beneficial, however that still needs to be confirmed. We have also resolved a successful technique for clamping the linings using formed Klarity™ sheeting. More testing is required on natural rubber as well as artificially aged rubber samples before any treatment can be

done on the Serra *Belts*. The final phase of the conservation involving partial replacement is on going and the conservators at the Guggenheim Museum continue to collect rubbers that resemble the Serra *Belts*.

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Materials

Crating:
Corrosion Intercept
Engineered Materials, Inc., 113 McHenry Road, Suite 179, Buffalo Grove, IL 60089, (847) 215-1725, (847) 215-1743

Marvelseal
Benchmark, (609) 397-1131

Solvents:
Acetone, ethanol, isopropanol, toluene
Fisher Scientific, Fair Lawn, New Jersey, 07410

Duro-Clean®, concentrated detergent cleaner
Advanced Products Distributors, Inc., 601A Lofstrand Lane, Rockville, MD 20850, (800) 421-1048

Mineral Spirits 135 (15% aromatic content), Shell hydrocarbon solvents
Conservators Emporium, 18124 Wedge Parkway, Ste. 458, Reno, Nevada, 89511, (775) 852-0404, fax (775) 852-3737

Linings:
Goretex, Tyvek, woven polyester fabric
Talas, 568 Broadway, New York, NY 10012, (212) 219-0770.

Thera-Band
Canal Rubber, 329 Canal St., New York, NY 10013, (800) 444-6483

Polyester/Linen fabric, 220 g/m
Art et Conservation, 33 avenue Trudaine, 75009 Paris, France, artetco@aol.com, +33 1 48749582, Fax: 33 1 42803538

Rubbers: all from McMaster-Carr Supply Company, www.mcmaster.com

Butyl rubber, for solvent and adhesive testing, Shore A: 55-65, part number 8609K19

EPDM, for solvent and adhesive testing, part number 8610 K86

Neoprene, for solvent testing, reinforced commercial-grade, Shore A: 45-55, part number 8698K75

Neoprene, for adhesive testing, commercial-grade, part number 9455K15

Adhesives:

3M Scotch™ 300LSE tape, double sided, acrylic adhesive base
Construction Products Corporation, 3M distr., 305 W. Torrance Blvd., Unit D, Culver City, CA, (310)323-1104

the following eight samples from 3M Adhesives Division, St. Paul, MN 55144-1000, (800) 364-3577:

3M Scotch Grip™ 1300, polychloroprene base, yellow colored

3M Scotch Grip™ 847, nitrile rubber base, dark brown color

3M Scotch Grip™4799, SBR rubber base, black color

3M™ High Temperature Aluminum Foil Tape 433, silicone adhesive base

3M™ Glass Cloth Tape 361, silicone adhesive base

3M Pronto™ CA-40H, ethyl cyanoacrylate, poly(methyl methacrylate), hydroquinone

3M Pronto™ CA-5, ethyl cyanoacrylate

3M Scotch-Weld™ DP-8005, methacrylate – ABS resin copolymer

Beva® D-8 Dispersion, vinyl acetate/ethylene copolymer with vinyl alcohol/vinyl acetate and soap
Conservator's Products Company, P.O. Box 411, Chatham, N. J., 07928, (973) 927-4855.

Beva® 371 Film, vinyl acetate/ethylene copolymer with paraffin wax
Conservator's Products Company

Hide Glue, Kremer Pigments Inc., 228 Elizabeth Street, New York, NY 10012, (212) 219-2394

Jade 403, vinyl alcohol/vinyl acetate copolymer with vinyl acetate/ethylene copolymer and soap
Talas, 568 Broadway, New York, NY 10012, (212) 219-0770.

Klarity™, polycaprolactone sheeting, thermoplastic splinting materials
Larson Products, Inc., 2844 Banwick Rd., Columbus, OH, 43232, (614) 235-9100

Pliobond 20, nitrile rubber, thermosetting phenolic
McMaster-Carr Supply Company, www.mcmaster.com

Scotchlite™ H50, soda-lime-borosilicate glass bubbles, 20-60 micron particle sizes
3M Specialty Additives, 3M Center Bldg. 220-8E-04, St. Paul, MN 55144-1000, (800) 367-8905

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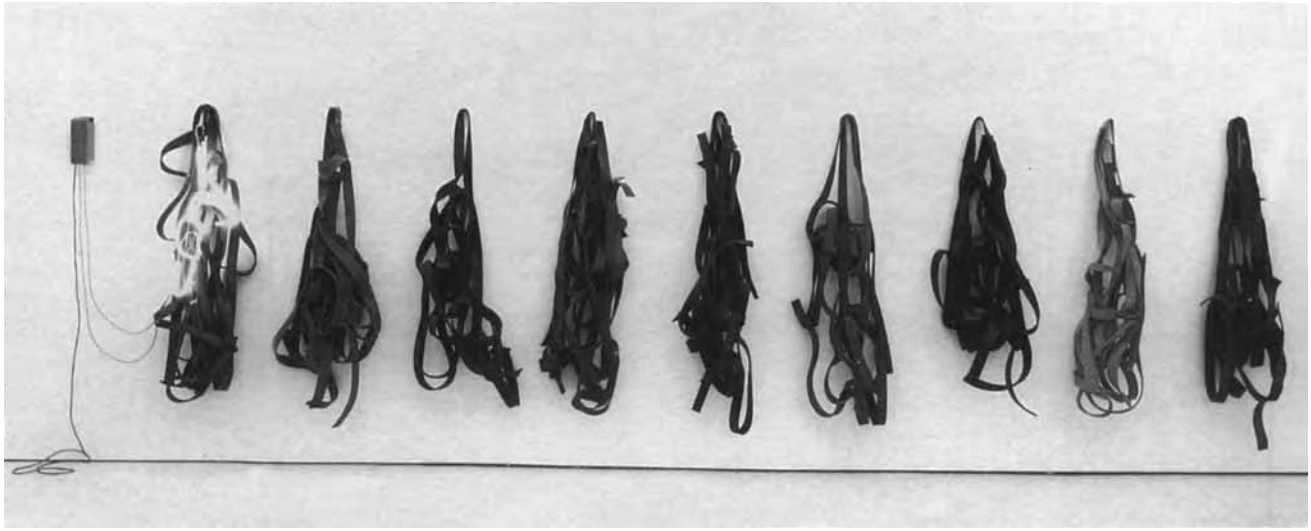

Figure 1. Serra, *Belts*, 1966-67, rubber, neon, iron staples.

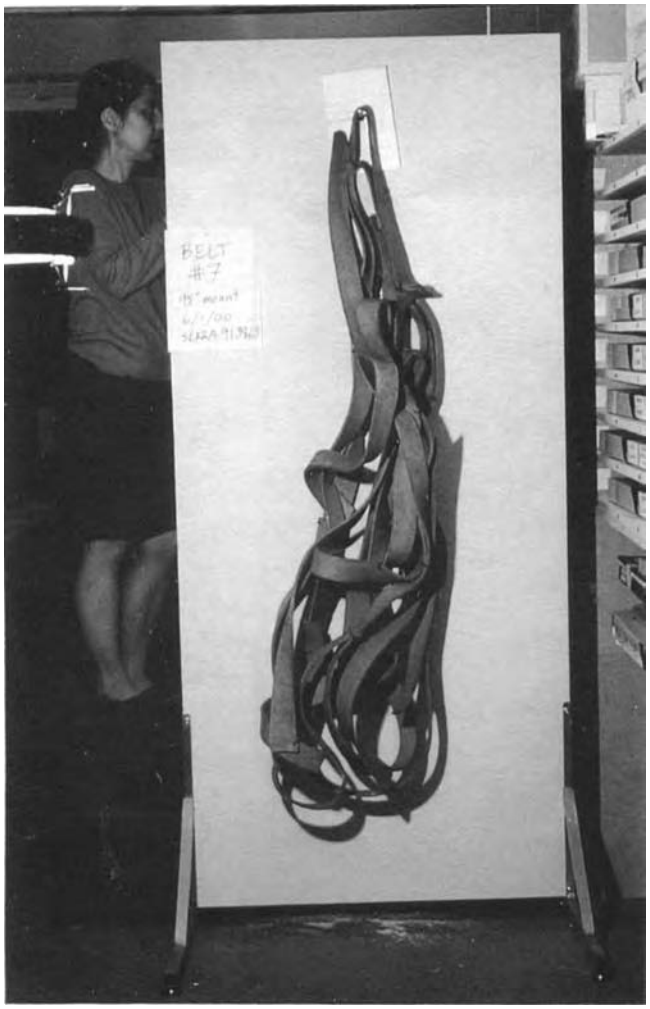

Figure 2. Serra's belt #7 having a mount prepared on a temporary wall.

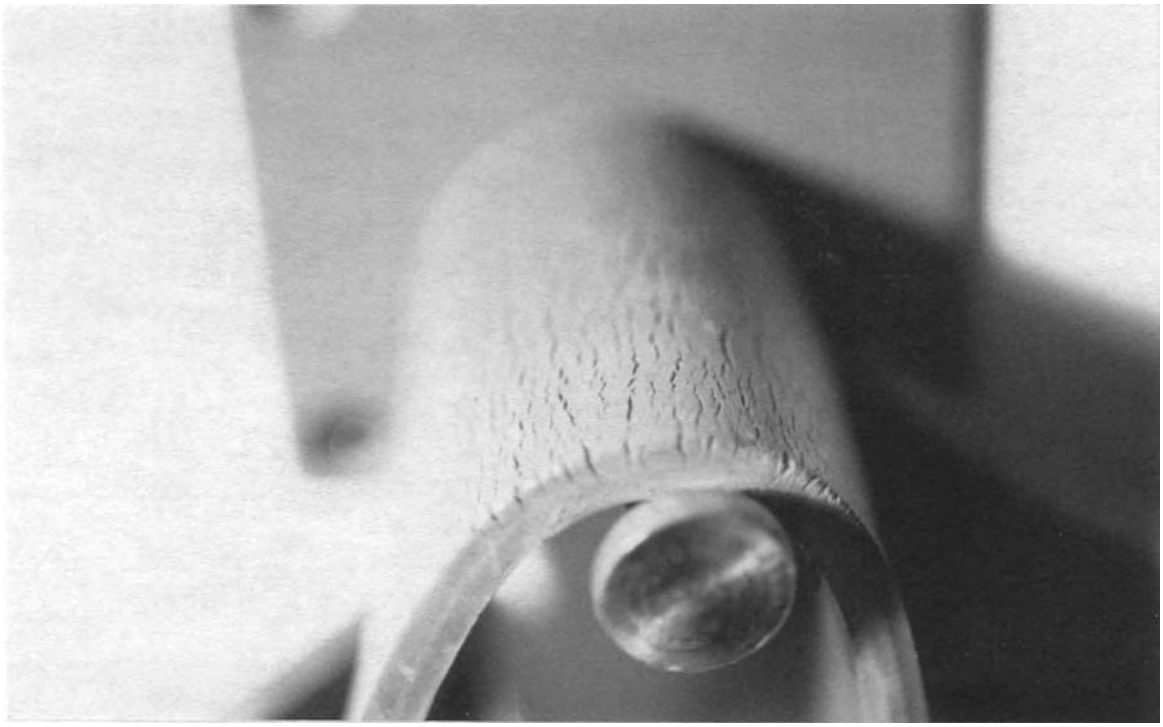

Figure 3. Cracking rubber on belt #4.

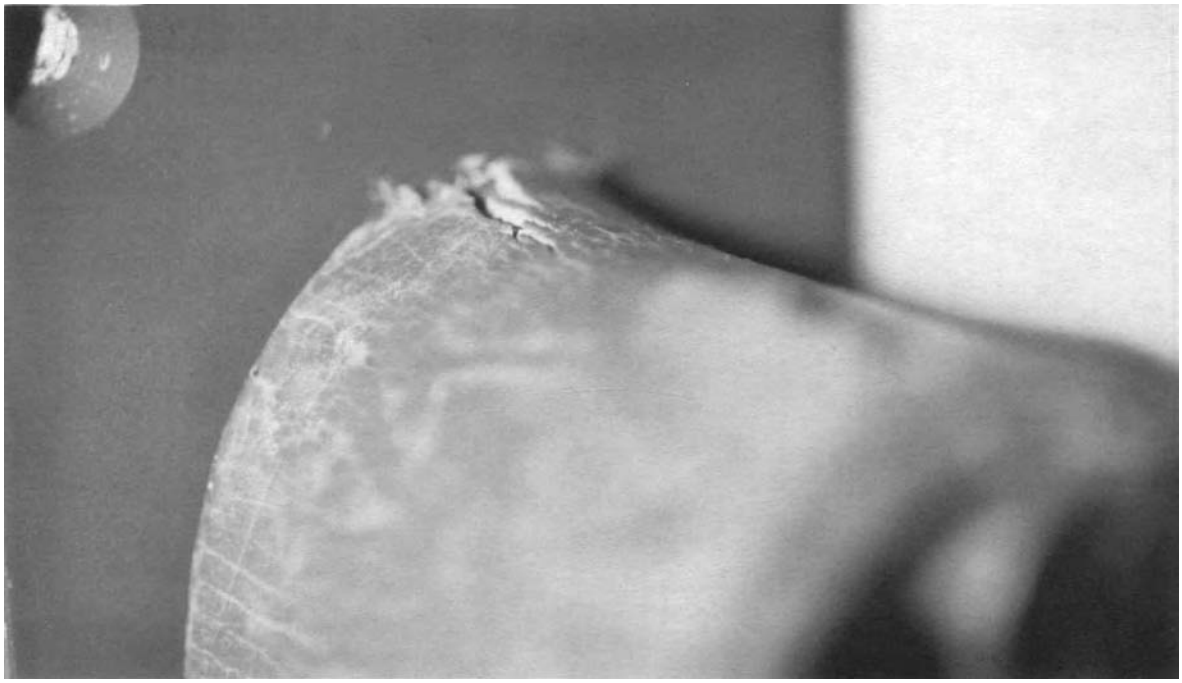

Figure 4. Cracking rubber on belt #5.

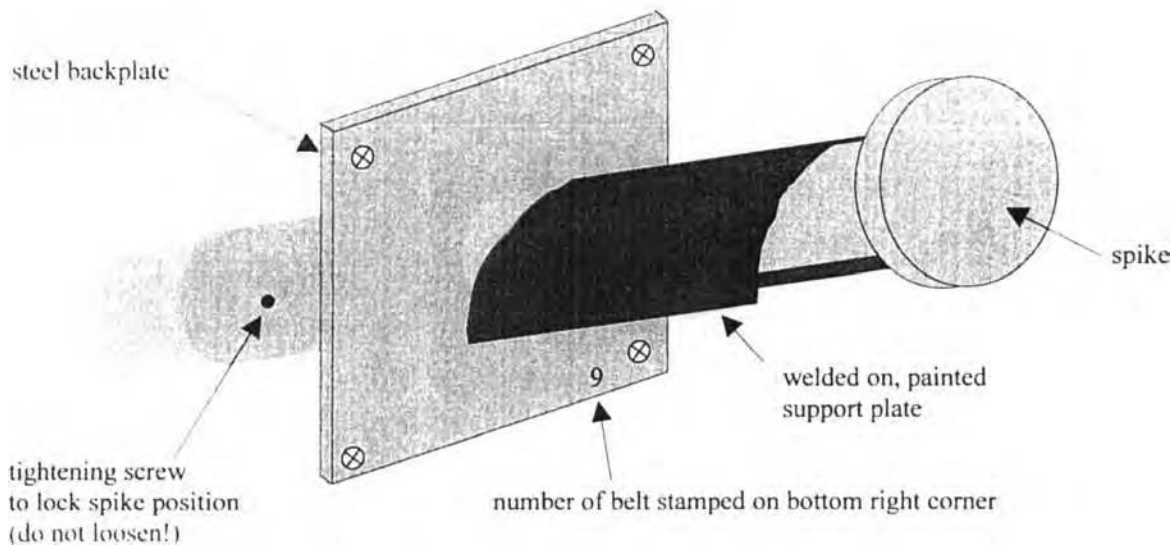

Figure 5. Mount diagram for wall spikes that hang the Serra belts.

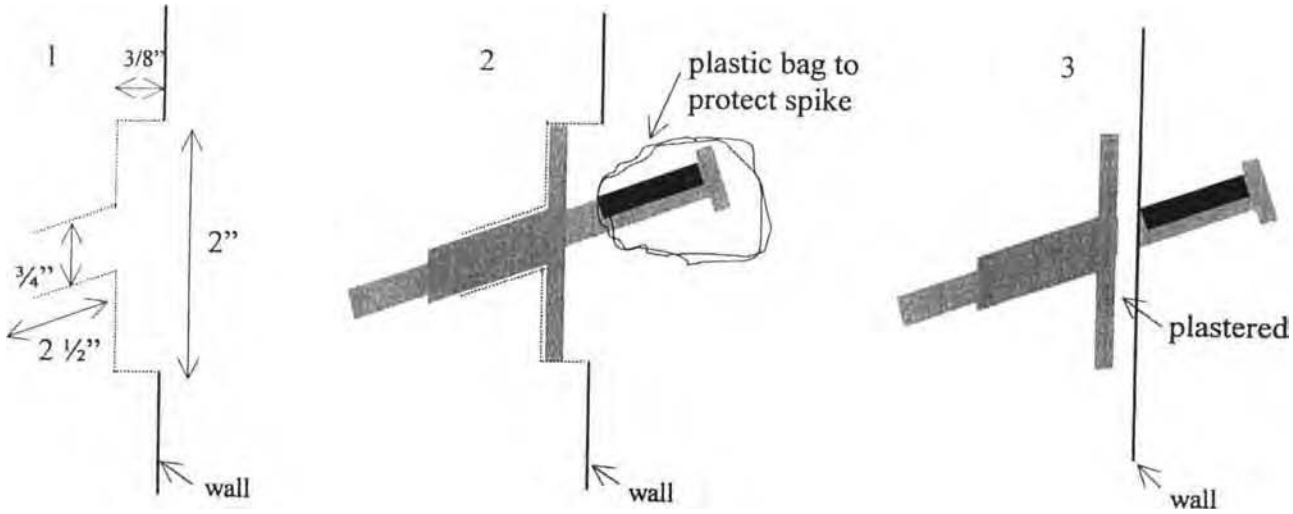

Figure 6. Diagram for installing the mounted spikes.

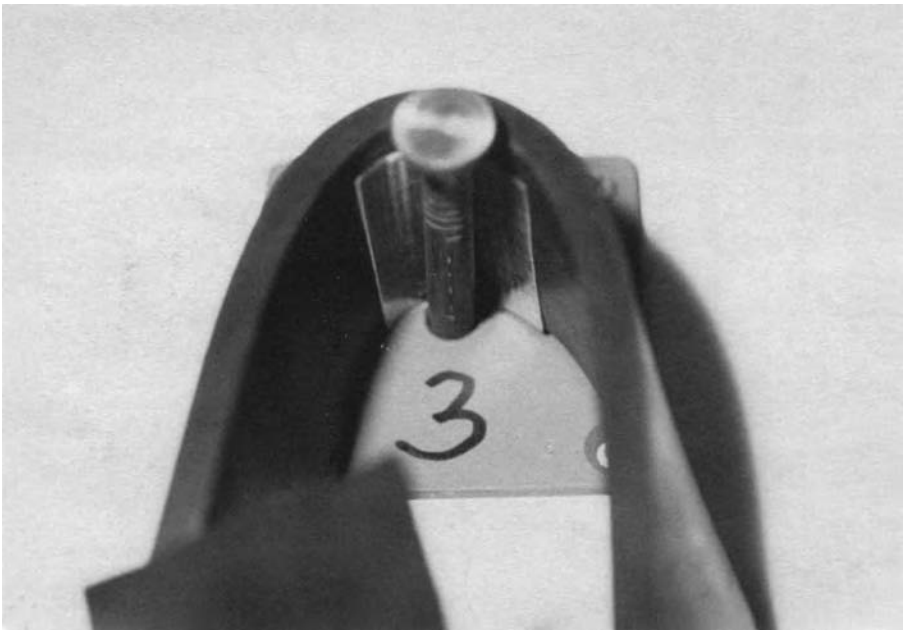

Figure 7. Detail of the steel support plate welded onto the spike for belt #1, before toning.

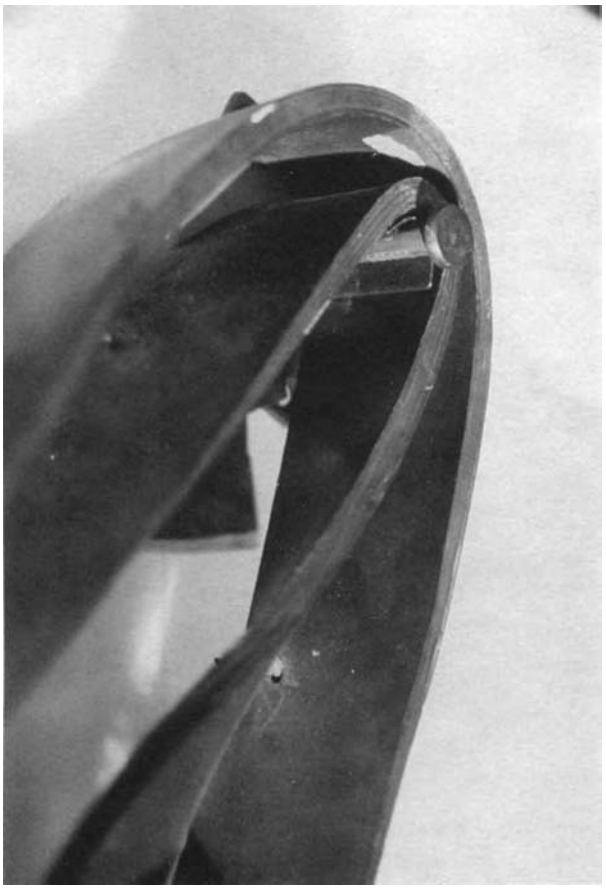

Figure 8. Detail of spike after installation of belt #1, support plate has been toned.

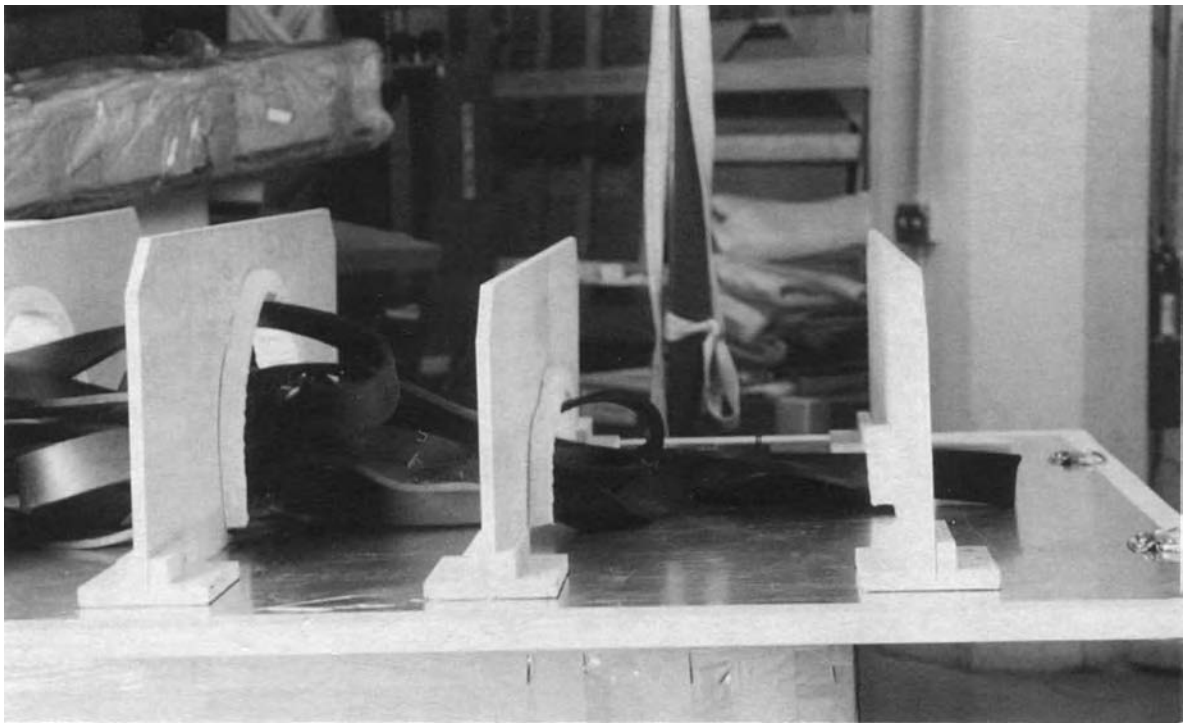

Figure 9. Mounting system for the belts on a cradled tray for crating and storage.

ADHESION SHEAR STRENGTH
RUBBER/POLYESTER-LINEN FABRIC
(psi)

Adhesive	NEOPRENE		EPDM		BUTYL	
	uncleaned	EtOH prep	uncleaned	EtOH prep	uncleaned	EtOH prep
Beva® D-8	10	>28	27	11	11	6
Beva® 371 Film	11	26	16	12	16	20
ScotchWeld™ DP8005	4	16	1	2	8	8
Scotch Grip™ 847	13	11	7	8	3	11
Scotch™ 300LSE tape	6, 13	18	9	12	10	14

Figure 10. Table of results for the adhesion shear strength testing.

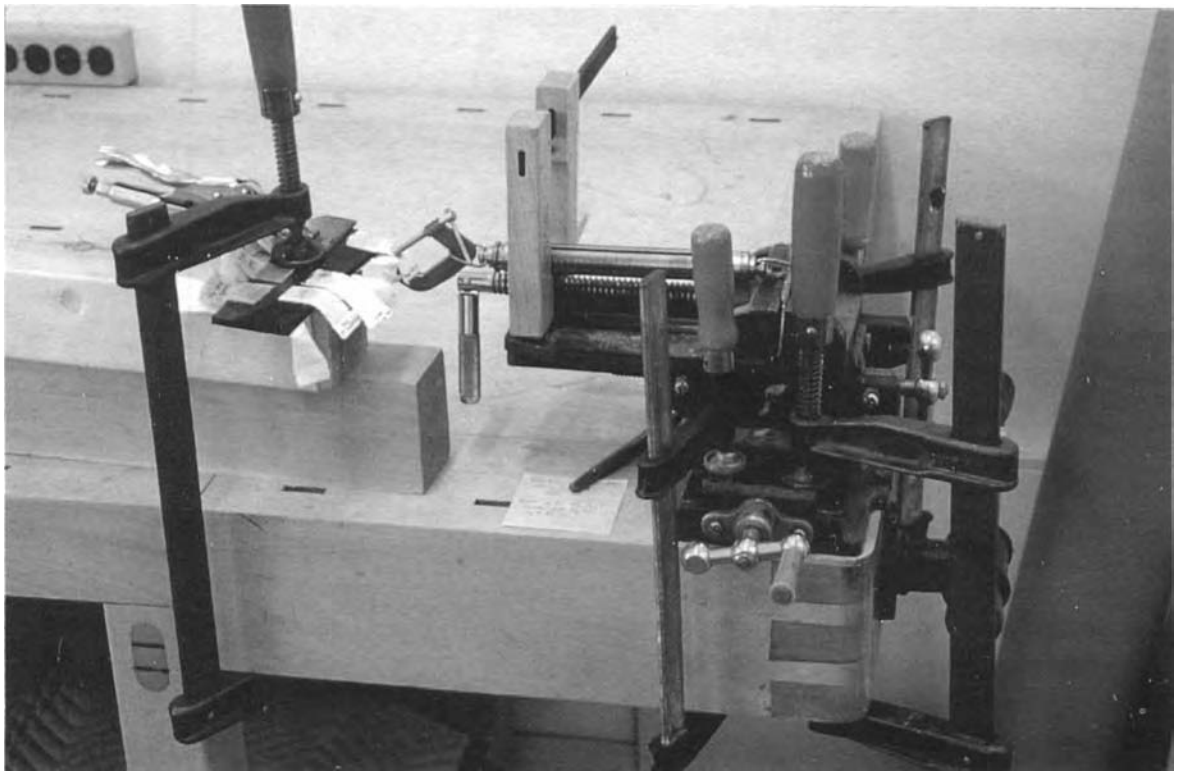

Figure 11. System for testing shear strength of adhesives using a spring gauge, vices and clamps.