Research Plan

2006 Science Fair Project

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Title

"An Evaluation Of Spray Foam Insulation When Used To Stabilize Paleontological Specimens For Recovery"

A. Question being addressed

Are there new materials available which are more suitable for use in the stabilization and recovery of paleontological specimens as compared to the traditional use of Plaster of Paris (calcium sulfate hemi-hydrate; $CaSO_4$ $1/2H_2O$) imbedded fabric?

B. Problem

Traditional materials (Plaster of Paris and burlap) used for stabilization and recovery of fossil and bone specimens have several negative characteristics which commercially available modern materials might be able to overcome. These problems include heavy raw materials (Plaster of Paris and water) which must be carried into remote sites, even heavier plaster jackets encasing the specimen and surrounding matrix which must be carried out from the site, a method of application which is labor intensive and requires up to two days to dry before handling, and the opening of a plaster jacket which requires specialized cutting equipment and produces a dust which poses a respiratory hazard.

Despite the listed shortcomings, there are a number of positive characteristics which have kept scientists using the traditional materials for many years. These attributes include adaptability to any shape or size and extreme rigidity when dry, making it highly resistant to crushing, bending, and twisting forces. It is also easy to learn to apply these materials which are readily available, are resistant to weathering conditions and can be stored for years without degrading. The traditional materials will not chemically affect fossil or bone if applied properly.

Goals

The goal of this experiment is to determine if one or more of the commercially available spray foam insulation products will provide all of the positive characteristics of the plaster & burlap jacket while also solving the problems encountered with the plaster.

Hypothesis

I believe that spray foam insulation products are better suited for use in the stabilization and recovery of paleontological specimens than is the traditional method using Plaster of Paris (calcium sulfate hemihydrate; $CaSO_4$ $1/2$ H_2O) imbedded fabric.

C. Description in detail of method or procedures

To compare plaster jackets to those jackets made of spray foam insulation products, uniform pedestals of Ohio clay with imbedded samples of Pleistocene bone and Jurassic Period fossils will be formed to represent typical paleontological specimens in matrix. For each specimen, the exposed bone and adjacent soil on top of the pedestal will be covered with a layer of moistened toilet tissue and a layer of aluminum foil to protect the exposed bone.

Standard Plaster Jacket

A number of sources consulted all describe the same method of preparing specimens for recovery. The best detailed written description found comes from the South Dakota State Historical Society Archaeological Research Center. (WC) The steps described by that source will be followed for the purposes of this experiment.
In summary, strips of burlap will be cut, soaked in water and then dipped in mixed plaster. Any left over plaster will be used to fill in holes and smooth out the jacket. Burlap can be cut to the widths or lengths needed for each specimen. Starting at one end of the block, a plaster soaked strip will be wrapped under the undercut, bringing the ends up and over the top of the block. Additional strips will be added until the top and bottom of the block are fairly well covered. The second layer will be oriented in the opposite direction to add strength to the jacket. Strips will be added until the jacket is approximately five centimeters thick on all sides. The jacket will be allowed to dry and harden. The pedestal will be undercut and the jacketed block rolled over in one quick movement. Any excess soil/rock on the exposed underside will be removed to lighten the jacket. The opening will then be covered with layers of plaster soaked burlap and allowed to dry. Each jacket will then be labeled for identification.

Method for Creating Jackets with Spray Foam Insulation

For the purposes of this experiment, plastic storage containers will be used to limit and shape the foam material to a consistent size and thickness for comparison tests. The bottom of each container will be cut out to exactly fit over a pedestal. Containers will rest on spacers to allow access to undercut the pedestal when it is time to turn it over. A plastic bag will be used as a liner to allow easy removal of the container from the jacket material. Containers will be reusable. Test material will be sprayed into container using manufacturers' instructions for each product. Sides and top of pedestal will be covered so that the resulting jacket will be approximately five centimeters thick. These materials are designed to expand to fill all voids and to adhere to all surfaces. After the material has dried or set-up, over-expanded material above the top of the container will be trimmed away to leave approximately five centimeters of jacket material. The pedestal will then be undercut and the jacketed block rolled over. The container will be removed from over the jacket. Any excess soil or rock on the exposed underside will be removed. Additional foam material will be sprayed over the exposed surface, will be allowed to dry and will then be trimmed to leave approximately five centimeters of jacket covering the matrix. Each jacket will then be labeled for identification.

Materials to be tested (A-F):

(A) Calcium Sulfate Hemihydrate ($CaSO_4$*½H_2O) 75.0 – 85.0%,
Calcium Carbonate (filler) 15.0 – 25.0%, Crystalline Silica 0.1 – 0.5%
DAP® Plaster of Paris (Dry Mix), DAP Inc.

(B) Isopropyl alcohol 1-5%, Ethylene glycol 1-5%, Dimethyl ether 1-5%, Propane1-5%, n-Butane1-5%, Vinyl acetate 0.1-1.0%, Aliphatic amines N.E.
DAPtex Multipurpose Foam Sealant, DAP Inc.

(C) Chlorodifluoromethane 10.0-30.0%, 4,4'-Diphenylmethane Diisocyanate (MDI) 10.0-30.0%, Higher Oligomers of MDI 10.0-30.0%
DAP KWIK FOAM Polyurethane Insulating Sealant, DAP Inc.

(D) Polymethylene Polyphenylisocyanate 100%
ULTRALITE Component "A" – Instapak Family, Sealed Air Corporation

(E) Polymethylene polyphenyl isocyanate containing 4,4'Methylene bisphenyl isocyanate 5-10,10-30%, Liquefied Petroleum (mixture containing; Isobutane, Propane, Dimethyl Ether) 10-30%, Prepolymers of MDI and Polyether polyol 40-70,60-100%
GREAT STUFF Big Gap Filler, Dow Chemical Co.

(F) Polymethylene polyphenyl isocyanate containing 4,4'Methylene bisphenyl isocyanate 60-100%, Chlorodifluoromethane 5-10%
FROTH-PAK Polyurethane Spray Foam System, Dow Chemical Co.

Other Materials Used

*Burlap ® DuPont Co.
Aluminum Foil (heavy duty)
Toilet Tissue
Water (well)
Plastic Storage Containers - 36 cm x 23 cm x 23 cm
Plastic garbage bags

*Some brands of Plaster of Paris have fillers which may affect drying rate. Product with 100% Calcium Sulfate Hemihydrate ($CaSO_4$*½H_2O) was not readily available in this area. All local brands had Calcium Carbonate 15.0 – 25.0%. A possible future study could evaluate types of Plaster of Paris.

Criteria to be tested:

Measurable Data

Jacket Stability:

Weights will be applied on top of fully cured jackets adding 4.5 kg (10 lbs.) at a time. Jackets will be observed after each weight is added for amount of compression if any, cracking, collapse or any other distortions. The jackets will receive additional testing for bending or twisting by applying weights over the long ends of the jacket and noting any distortions.

Weight: All samples (paleontology specimens & matrix) will be of uniform volume (measured in cubic centimeters). Test materials will be applied at uniform thickness of five (5) cm. on all sides. Finished jackets will be weighed (measured in kilograms)

Time to apply: Time from when begin preparation of materials until finish application of top jacket plus time required to apply under side jacket equals total application time. (To nearest minute / does not include drying time)

Time to dry / harden: Time from finish application of top jacket until jacket may be safely turned to apply under side jacket plus time from finish of under side jacket until completed jacket may be safely moved from site equals total drying time. (To nearest half-hour)

Non-measurable Data (Pass / Fail)

Adapts to shape & size of specimen: A variety of samples of the sizes and shapes common to paleontology specimens will be jacketed with the test materials.

Stores indoors or outdoors without significant deterioration: Samples of each material will be stored outdoors in direct sun and all weather conditions from November through January (three months).

Ease of access to specimen in lab: Various methods of cutting open each sample jacket to access the specimen will be tested.

D. Bibliography

Bement, Leland C. "Spray Foam: A New Bone Encasement Technique." *Journal of Field Archaeology* Vol.12, No.3 (1985) 371—372.

Everhart, Mike. "Use of Plaster Jackets." 22 March 2003. <http://www.preparator.org/comments.htm#comment133>

"The History of Casting." W.L. Gore & Associates. <http://castliner.com/hist.html>.

"The History of Plaster." Lafarge Prestia Company. <http://www.lafargeprestia.com/body_caso4__h2o.html>.

Kidston, Martin J. "A Tail of Tails." *Sunday Independent Record.* Helena, Montana. 7 August 2005.

"Standard Plaster Jacket." South Dakota State Historical Society Archaeological Research Center. <http://www.sdsmt.edu/wwwsarc/repos-guide/repos05.html>.

Walker, Cyril and Ward, David. "Fossils." *Smithsonian Handbooks.* Dorling Kindersley Limited. London. ©2002. Pg. 18.

Product Information

DAP® Plaster of Paris (Dry Mix), DAP Inc.
http://www.dap.com/product_details.aspx?product_id=326

Material Safety Data Sheet, DAP® Plaster of Paris (Dry Mix), DAP Inc., 2400 Boston Street Suite 200, Baltimore, MD 21224-4723

DAPtex Multipurpose Foam Sealant, DAP Inc.
http://www.dap.com/product_details.aspx?product_id=384

Material Safety Data Sheet, DAPtex Plus Window & Door Foam Sealant, DAP Inc., 2400 Boston Street Suite 200, Baltimore, MD 21224-4723

DAP KWIK FOAM Polyurethane Insulating Sealant, DAP Inc.
http://www.dap.com/retail/retail_detail.cfm?catid=1&subcatid=71&prodhdrid=10

Material Safety Data Sheet, DAP KWIK FOAM Polyurethane Insulating Sealant, DAP Inc., 2400 Boston Street Suite 200, Baltimore, MD 21224-4723

ULTRALITE Component "A" – Instapak Family of Foams, Sealed Air Corporation
http://www.sealedair.com/products/protective/instapak/foam_formulations.html

Material Safety Data Sheet, ULTRALITE Component "A" Sealed Air Corporation, 10 Old Sharman Turnpike, Danbury, CT 06810

GREAT STUFF Big Gap Filler, Dow Chemical Co.
http://greatstuff.dow.com/greatstuff/cons/biggap.htm

Material Safety Data Sheet, GREAT STUFF Big Gap Filler, Dow Chemical Co., Midland, MI 48674

FROTH-PAK Polyurethane Spray Foam System, Dow Chemical Co.
http://www.dow.com/buildingproducts/frothpak/feature.htm

Material Safety Data Sheet, FROTH-PAK Polyurethane Spray Foam System, Dow Chemical Co., Midland, MI 48674

Plaster of Paris

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It adapts to any shape and size	Raw materials (Plaster of Paris and water) are heavy – must be carried into site
Extremely rigid when dry	Plastered fossils and surrounding matrix are very heavy and must be carried out
Highly resistant to crushing, bending, or twisting forces	Plaster jacket applied in two steps, top and bottom. Each step requires 24 hours to dry before handling.
Easy to learn to apply this material	Opening of plaster jacket requires an expensive oscillating saw and creates a hazardous dust
Materials readily available at any hardware store	Method of application is labor intensive
Resistant to weathering conditions	Does not dry well in humid conditions
Can be stored for years without degrading	
Will not chemically affect fossil material if applied properly	

Additional studies could evaluate drying times at different humidity conditions, performance at extreme temperatures or high mountain altitudes and evaluations of chemical effects, if any, of jacket materials on bone specimens.

Plastic Storage Containers

36 cm x 23 cm x 23 cm 19 liter

Pedestal cut to 26 cm length x 13 cm width x 18 cm plus spacer deep