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Concrete Rock Bear Dens

Man-Made Stone Used to Reproduce Native Environment in Municipal Zoo, Forest Park, St. Louis—Step-by-Step Story of Models, Molds and Construction

By CARL H. JOHNSON
As told to Robert H. Moore

Animal dens made of concrete and built to resemble natural rock formations are believed to have had their origin in the Denver, Colorado, Zoo in 1913, when Carl H. Johnson, author of this article, interested V. H. Borchard, director of the Denver Museum, in this method of housing zoo animals.

Realizing that zoo animals could be better displayed if they were housed in dens similar to their native haunts, Mr. Johnson experimented with concrete for this purpose for several years. He and Mr. Borchard then reproduced a number of typical rock formations in concrete and built a small model den. Their work so impressed the commissioners of the Denver Municipal Zoo that this group commissioned them to start construction of full sized dens. The Denver project was completed in 1913. So realistic were the finished dens that their fame soon spread and in 1920, when it was decided to provide new bear dens at Forest Park, St. Louis, the services of Messrs. Borchard and Johnson were obtained. The former did not live to see the completion of the work, but the job was successfully finished by Mr. Johnson, who is now superintendent of construction for the new dens being built at St. Louis. John E. Wallace, architect for the Municipal Zoo, is also supervising the work.

That the park commission of St. Louis was successful in providing native environment for the big family of bears instead of the conventional animal cages is evidenced by the accompanying photograph which is a present-day picture of the dens built in 1920. These dens proved so satisfactory and economical that the park commission has authorized construction of five more concrete rock animal pits, as they are sometimes called. These are described in Mr. Johnson's article.

Bear pits in the Municipal Zoo in Forest Park, St. Louis, Missouri, where natural environment is reproduced in concrete

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THE concrete rock animal dens now being built in Forest Park, St. Louis, Missouri, are of the same type of construction as the bear pits built there in 1920, with the concrete simulating the limestone strata around St. Louis. The dens will be barless and fenceless, the animals being kept in by dry moats. One of the new dens will be a home for a family of prairie dogs, a second will house a group of Himalayan sun bears, some young American black bears will live in the third, wolverines will be housed in the fourth and the fifth will be a home for raccoons.

True to Nature

The most important consideration in building concrete rock animal dens is to make them resemble the rock formations that are characteristic of the country in which they are built—in this case, the limestone strata in Missouri. I traveled around the state a great deal before finally selecting a bluff along the Mississippi River near Herculaneum, in the foothills of the Ozark Mountains, 25 miles south of St. Louis, for my rock models. Selecting the model does not mean that the intention is to reproduce any certain section in exact detail. The model merely furnishes characteristic rock strata from which a number of small impressions can be made.

Approximately 37 impressions were taken from the bluff at Herculaneum, the sections being selected at random. Waste molds, which will be described presently, are made from the models. These are pieced together to suit the dimensions and layout of the proposed animal dens. When concrete is deposited against the molds, the finished job becomes a rock formation duplicating the original rock in strata but not necessarily in size or shape.

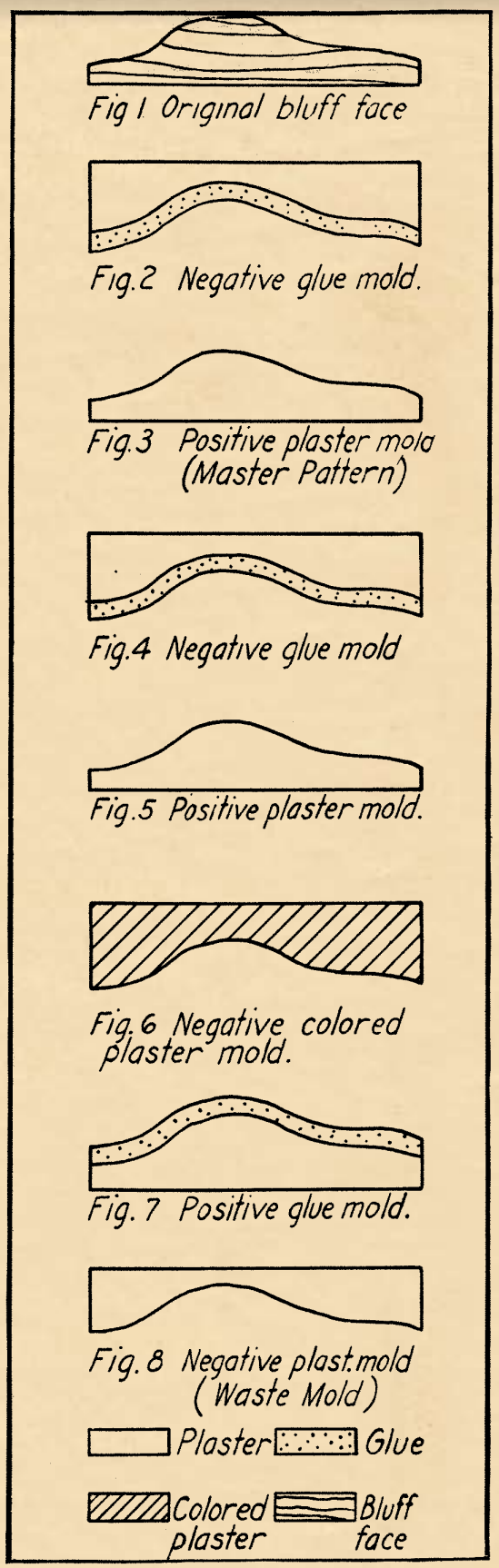
Patterns being used to build the new dens are the same as those which were used in forming the bear pits that were built in 1920, but the new structures will look entirely different. These same patterns could be used for building practically any number of dens and they all would have a different appearance.

Making the Molds

In making the original impression from the natural rock the desired section was first framed with a 1- by 1-inch ridge of plaster. The rock face within the frame was then covered with molder's clay to a depth of ½ inch, the clay being pressed into depressions and worked around projections. A plaster cap about 1½ inches thick was then placed over the clay. When the case hardened and could be handled without breaking, it was removed, the clay raked out and the case replaced. The space between the case and the rock face was then filled with glue. When this stiffened a negative glue mold was formed, as shown in Fig. 2 of the panel showing the sequence of operations.

Glue molds thus obtained are not suitable for forms, however, and several other steps are required to obtain waste molds that are used on the job as forms for the concrete. The next step was to make a plaster model from the negative glue mold. This master pattern is shown in Fig. 3. This is identical with the original bluff face, as the drawings show, and is kept permanently as the master pattern. (The negative glue mold taken directly from the bluff face cannot be preserved as a master pattern because the glue deteriorates.)

As shown in Fig. 4, a number of negative glue molds are made from the master pattern, following practically the same practice as used in obtaining the impressions of the original bluff face. Duplicates of the master pattern (Fig. 5) are obtained from the negative glue molds. These duplicates are used in making the waste molds for use on the job. First, a negative plaster mold as shown in Fig. 6



Drawings showing the sequence of operations. Figure numbers referred to in the text apply to the figure numbers as shown in this cut

Front and rear views of plaster waste molds. Note the 2-by-2's that provide rigidity

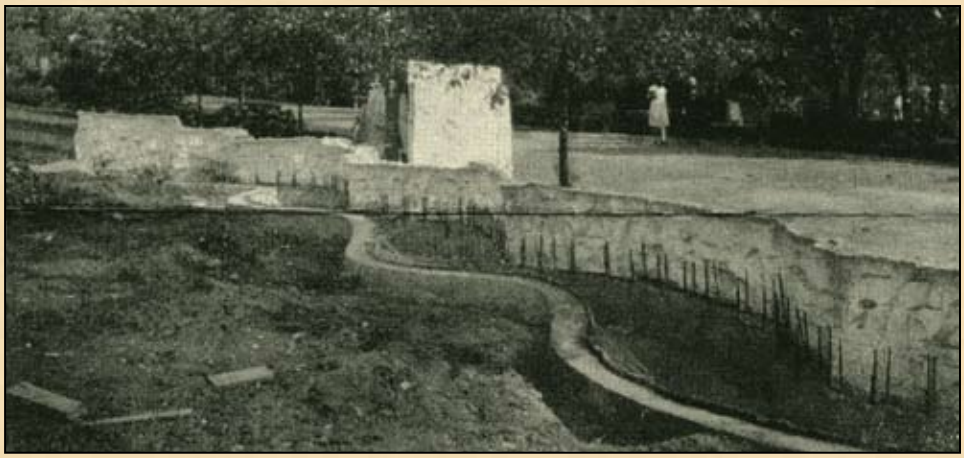
has to be made. This plaster is colored so that when any pieces of the positive mold cling to the new negative mold this will show up immediately and the pieces can then be chipped away.

The next to the last step is to make a positive glue mold, as shown in Fig. 7, from the negative plaster mold. The waste mold which is really a negative plaster mold, as shown in Fig. 8, is made directly from the positive glue mold. The plaster waste molds are braced with 2 by 2's, as shown in an accompanying photograph, to give them rigidity and to permit handling on the job.

About 20 waste molds can be made from one positive glue mold and as many positive glue molds as are needed can be made from one negative plaster mold. The procedure just described is followed for each rock impression taken from the original bluff.

The steps shown by Figs. 2 and 3 and 4 and 5 are identical. This is necessary to prevent the possibility of anything happening to the master pattern. The negative plaster molds could be made from the master pattern, but it is safer to make duplicate master patterns for this purpose.

When concrete is deposited against the waste molds an exact reproduction of the original rock is produced. Now here is an interesting thing—for every original rock impression we can produce two absolutely different rock faces. One is an exact duplicate of the original rock and



Applying first concrete against waste molds. Proportions of white and gray cement are varied to produce variation in color

Applying first concrete against waste molds. Proportions of white and gray cement are varied to produce variation in color

is produced by using the waste mold shown in Fig. 8. The other is just the reverse, being produced from a waste mold of the type shown in Fig. 5. Duplicates of the master pattern can be used as waste molds for this purpose or waste molds can be made from the plaster mold shown in Fig. 8. From our 37 original rock impressions we get 74 rock patterns.

When the bear dens were built in 1920, all 74 patterns were used for the work, but for the dens now being built these patterns are used for only the walls. I have taken several impressions of the rock strata at the Wilson Quarry (near St. Louis) which I am using as patterns for the floor, ledges and overhang of the new dens.

Erecting the Forms

While the waste molds are being made, the sites for the dens are prepared. Hollows are made for pools, the ground is built up where necessary, drainage is put in and other work of this kind is finished. A concrete foundation wall about 12 inches thick is then built. This follows the shape of the finished dens and serves as a foundation upon which the concrete rocks are built. In the rear and along the sides of the dens where the rock formations are to extend quite high, a second wall is built. The space between this and the front wall is usually about 4 or 5 feet. This wall follows the outline of the dens and extends as high as the rocks will be placed. It serves both as a retaining wall for the earth that will later be packed against it and as a support for the rocks. The space between the two walls provides a passageway from den to den as well as a shelter for the animals. It is covered over and concealed, as will be described later.

Inasmuch as the shape of the dens would make wooden form construction rather expensive, an unusual method of form building was used on this job. Reinforcing rods were used to build two frameworks following the outline of the dens. These were spaced 8 inches apart, the thickness of the concrete wall, and then covered with metal lath. The forms were completed by a scratch coat of cement-sand mortar. Concrete was then placed in these forms. So far as I know, this is the first time forms of this kind have been used, and they have been very satisfactory.

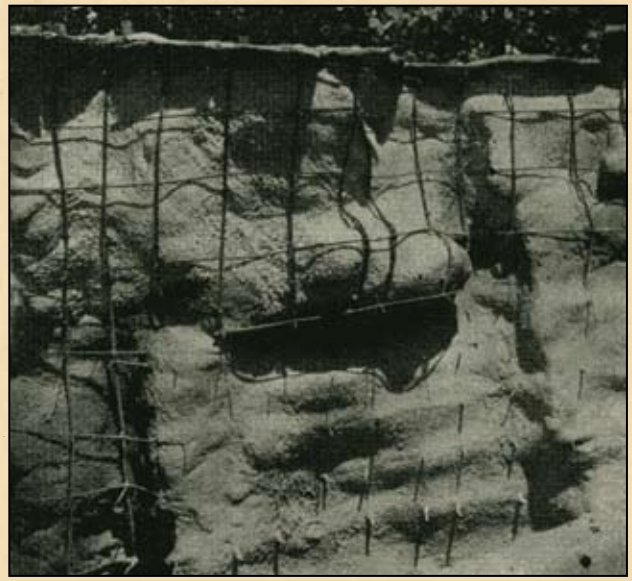
When the walls have hardened sufficiently the waste molds are set in position, as shown in an accompanying photograph, being placed more or less at random but conforming to the general contour. They are braced in position with wooden scaffolding, as is also illustrated. The various waste molds do not fit together perfectly and there is no intention that they should. When they are all in position, plaster is used to fill in depressions along the edge of one section to meet projections in another and vice versa. This process finally joins all of the sections together. The faces of the molds against which concrete is deposited are then painted with a special paint to prevent the concrete from bonding to them.

Placing the Concrete

The concrete for the rock walls is placed with a cement gun. The walls are built up gradually until the proper thickness, which varies from 3 inches at the top to 5 inches at the bottom, is obtained. The first application consists of a 1:2 mix made up of 3 parts of white cement, ½ part of gray cement, 3 parts Ottawa sand and 4 parts Merrimac sand. To prevent uniform color in the face of the concrete rock formation, the proportions of white and gray cement are varied. As the concrete is first sprayed against the plaster molds, the pressure of the gun is reduced to a minimum. This is to prevent the concrete from penetrating into the plaster waste molds. As the face of the molds is covered the pressure is gradually increased.

Method of Reinforcing

The first application builds the walls up to about ½ inch thick. When this concrete has hardened, reinforcement consisting of ¼ and ⅜-inch round bars is placed as shown in one of the illustrations. These rods are bent to follow the contour of the rocks. Horizontal tie-rods, at 2-foot intervals, anchor the rocks to the retaining wall. When the reinforcing and tie-rods are in place, the second application of concrete is placed with the cement gun. The mix is one part portland cement and 3 parts Merrimac sand.



Concrete below has been placed to the desired thickness; above portion has received only the first application. Reinforcing rods are bent to the contour of the rocks

As previously stated, a space is left between the front wall and the rear retaining wall. To cover this passageway, a form is built of reinforcing rods and metal lath, as shown in an accompanying illustration. A scratch coat of mortar is then applied and concrete is deposited to a depth of about 4 inches. Later, this is sodded over and shrubbery planted.

Removing the Forms

The waste molds are left in place until all concrete work is finished. They cannot be removed intact, but have to be broken away from the concrete. This, by the way, is the reason why they are called "waste molds," for they cannot be used again. When the waste molds are off and the concrete cleaned, the landscaping is done and all is ready for the animals to move in. The dens now under construction will probably be completed this fall.

Possibilities in Other Fields

The reproduction of rock formations in concrete is by no means limited to animal den construction. The fact that color, strata and formations of rock can be reproduced makes possible many artistic features in landscaping and beautifying parks, lawns and gardens where natural rock is hard to get or the project is of such a nature that it presents an expensive construction problem.