SOUTHWESTERN MONUMENTS

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PRELIMINARY REPORT

ON

RUIN STABILIZATION

BY

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By A. E. Buchenberg.

FOREWORD

The predominant interest and enjoyment of the average visitor to many Southwestern National Monuments is centered in and stimulated by the visual and mental impact of the remains of prehistoric architecture and workmanship: In other words the ruins.

Specialists in anthropology, archeology, ethno-botany, and associated sciences also find varied specific personal interests here, but in the summation of all visitors they constitute but a small minority. As the monuments have been set aside for the use and enjoyment of the public it would appear logical that the great preponderence of attention to presentation should be focused on the average visitor made up of workmen, and business and professional men and their families, whose major interest in general lies in the beauty, age, and story of the ruins.

Custodians residences, administration and service buildings are being built; landscaping, road building, and various improvements for public use and convenience are being carried out; archeological data is being collected and recorded for interpretation of the ruins. To my mind none of the above is open to direct criticism, but I submit that the probable absence of public interest or enjoyment in formless mounds of debris does open the question of logical sequence of activity until such time as the ruins are protected against further disintegration, or adequate preservation work is carried on concurrently with the above.

It may be suggested that since these prehistoric structures have in some measure survibed for six or seven centuries, the rate of depreciation must be low and that there is little cause for immediate concern. A careful study and analysis shows that disintegration is going on at a rapidly progressive and alarming rate due to time, and elements, irresponsible archeological excavators, vandalism, and other causes antedating present day protection. Certainly any further controllable depreciation is indefensible when the enjoyment of the public, now and in years to come, is considered. I am aware that there is a growing interest in ruin stabilization on the part of the Park Service, but the extent and rate of destruction make the present activity inadequate to meet the situation.

A deep interest in the preservation of prehistoric Southwestern ruins "as is" for the appreciation and enjoyment of the present generation and those to follow, and the realization of the need for immediate action in effective stabilization work to attain this end are the motivating reasons for the personal research and investigations outlined in the preliminary report which follows.

REPORT

In the general discussion below several basic principles as below are assumed:

1st. That a prehistoric structure shall when possible be preserved "as is", and that no changes in original structural details shall be made unless they are without question of doubt absolutely necessary for the preservation of what remains. Stabilization measures shall in every case involve only the minimum in changes or replacement of prehistoric material or workmanship as dictated by necessary structural requirements.

2nd. Where for unquestionable reasons of stability or preservation any changes are made in or of ancient materials or workmanship, they shall be easily be recognized as modern, but shall not clash in color, texture or contour with the original. Where this is not possible necessary structural supports shall be frankly and obviously modern.

3rd. No reconstruction work shall be done except under conditions of absolute necessity to meet structural requirements assuring stability or preservation of ancient workmanship.

4th. All work must be of such a nature as to allow future stabilization measures to become an extension of same. In other words it must be of a permanent nature with the exception of temporary emergency expedients.

Prehistoric ruins of the Southwest may be roughly classified on a basis of architectural details and stabilization needs as follows:

1st. Structures originally laid up of loose boulders or rock slabs without mortar or other form of reinforcing or support except "chinking". Stabilization "as is" must necessarily be limited to concealed concrete or cement bases or cores, or the use of structural steel members such as stay rods, beams, or channels.

2nd. Solid mud and caliche structures present real problems in preservation, and it would now appear that the solution will be some form of impregnation as protection against the inroads of the elements, without materially changing color, contour, or texture.

3rd. Structures embodying a combination of loose rock, mud mortar or plaster, and original wood reinforcement present specific individual problems, some of which have as yet not been worked out.

4th. Rock structures laid up in mud mortar offer a comparatively simple stabilization problem. Mechanical supports such as reinforced concrete, stay rods, or other structural steel members are sometimes indicated. However in general the stabilization problem resolves into the replacement of the ancient mud mortar which has disintegrated or washed away.

As the predominating types of prehistoric structures at Wupatki National Monument are of stone laid in more or less regular courses in mud mortar, it was deemed advisable to concentrate attention for the present to stabilization problems of this locality. Mechanical measures such as drainage, stay rods, beams, struts, and cores are occasionally dictated by well understood engineering principles. But unfortunately the major requirements call for the replacement of ancient mud mortar with a material whose specifications are in general as follows:

1st. A long time resistance to serious disintegration by the elements.
2nd. Satisfactory mechanical strength and stability under pressure stresses.
3rd. Close matching in color with the original mud mortar.
4th. Close matching in texture with the original mud mortar.
5th. Low cost of materials and transportation.
6th. Application technique allowing the use of unskilled labor under competent supervision.

Since the natural forces of rain, frost, wind, and variation of temperature are the major items now controlling deterioration, it was considered good procedure to subject all contemplated materials and techniques to the conditions which would obtain if they were actually used in ruin stabilization. It was therefore decided to set up an "outdoor laboratory" and record the effect of the elements on both materials and technique. Accurate and detailed data is to be accumulated for a sufficient length of time to afford conclusive comparative results. The limited rainfall in this locality has made the use of "accelleration tests" by means of carefully controlled water sprays advantageous to reduce the time required for definate comparative determination.

Standard samples, 6" x 10" x 3/4", have been prepared from various local soils and combinations of sand, from plain soils mixed with water, through various percentages of cement, raw linseed oil, anti-hydro, bituruls, and other admixtures. These samples have been exposed to the weather on a flat bench, one half of each protected by a cover to afford a comparative indication of possible changes inside walls away from the weather. The following tabulation up to date was made using loss of weight by erosion from water spray and light rains, under the same test conditions, as a determinant of stability.

TABULATION OF TEST DATA

Soil #	Sample #	Exposed Date		Color	Texture	Cracking	Erosion
9	15	10-26-41	Water only	Natural	O.K.	None	36%
9	16	" " "	9 water, 1 AH	"	"	Slight	45%
9	17	10-22-41	19 soil, 1 ETC	O.K.	"	None	None
9	18	" " "	9 soil, 1 ETC, 1 AH	"	"	Slight	"
9	20	10-26-41	1 RLO, 1 water	Dark	"	"	"
9	26	3-13-41	3 BIT, 1 water	O.K.	"	None	"
10	21	10-26-41	Water only	Natural	"	"	38%
10	22	" " "	9 water, 1 AH	"	"	Slight	19%
10	23	" " "	19 soil, 1 ETC	O.K.	"	"	None
12	1	10-14-41	Water only	Natural	"	Bad	54%
12	3	" " "	9 soil, 1 MC	Light	"	None	None
12	6	10-31-41	19 soil, 1 MC	"	"	Slight	"
12	8	10-21-41	8 soil, 2 RLO	Dark	"	None	"
12	12	10-22-41	9 water, 1 AH	Natural	"	Slight	33%
12	13	10-23-41	19 soil, 1 ETC	Light	"	None	None
12	14	10-22-41	19 soil, 1 ETC, 1 AH	"	"	"	"
12	19	10-26-41	1 water, 1 RLO	Dark	"	Slight	"
12	24	10-28-41	7 soil, 3 BIT	Black	Bad	None	"
12	25	10-23-41	3 eater, L BIT	O.K.	O.K.	"	"
13	2	10-21-41	Water only	Natural	"	Badly	60%
13	4	" " "	9 soil, 1 MC	Light	"	None	None
13	7	" " "	19 soil, 1 MC	"	"	"	"
13	9	" " "	8 soil, 2 BLO	Dark	"	Slight	"
14	5	" " "	Water only	Natural	"	None	37%
15	27	10-29-41	Water only	"	"	Bad	56%
18	41	11-3-41	4 soil, 1 ETC	Light	"	None	None
18	42	" " "	9 soil, 1 ETC	"	"	"	"
18	45	" " "	3 gasoline, 1 RLO	Dark	"	"	"
18	43	" " "	19 soil, 1 ETC	Light	"	"	"
18	46	" " "	3 BIT, 1 water	Dark	"	Slight	"
21	29	10-29-41	2 water, 1 RLO	O.K.	"	"	"
21	28	" " "	Water only	Natural	"	Bad	30%
31	30	" " "	3 BIT, 1 water	O.K.	"	Slight	None
22	31	10-31-41	Water only	Natural	"	Bad	45%
22	32	" " "	1 BIT, 1 water	Dark	"	None	None
22	33	" " "	1 RLO, 1 water	"	"	"	"
22	34	" " "	19 soil, 1 ETC	Light	"	"	"
22	35	" " "	9 water, 1 AH	Natural	"	"	50%
23	36	" " "	Water only	"	"	"	10%
23	37	" " "	1 water, 3 AH	"	"	"	23%
24	38	11- 3-41	Water only	"	"	Slight	30%
24	39	" " "	2 water, 1 AH	"	"	"	10%
25	40	" " "	3 water, 1 water glass	"	"	None	28%

NOTE: All mixtures are by volume
Mixtures of oil and water are in emulsion.

SEE KEY ON NEXT PAGE

KEY TO TABULATION

SOIL #9
Taken from partially disintegrated shale beds in Deadmans Wash, on the North side of the canyon.

SOIL #10
Taken from the East bank of Deadmans Wash.

SOIL #11
From same locality as soil #10, but about 50 feet S.W.

SOIL #12
Taken from about 200 yards N. of Clydes stone hogan.

SOIL #13
From a location about ½ miles S.W. of Wukoki.

SOIL #14
Prehistoric mortar taken from Wupatki ruin.

SOIL #15
Prehistoric mortar taken from Wukoki ruin.

SOIL #16
Taken from pit adjacent to Clydes stone hogan.

SOIL #17
From wash on lower slope of east side of Wukoki.

SOIL #18
Disintegrated sandstone from the foot of various ledges.

SOIL #20
Screened sand used in building operations at Wupatki during 1941.

SOIL #21
A mixture of 2 parts of soil #17 and 3 parts of soil #16.

SOIL #22
A mixture of 1 part of soil #16 and 1 part of soil #17.

SOIL #23
A mixture of 5 parts of soil #16 and 1 part of soil #20.

SOIL #24
A mixture of 5 parts of soil #16 and 2 parts of juniper ashes.

SOIL #25
A mixture of 5 parts of soil #16 and 2 parts of soil #20.

AH is symbol for Anti - Hydro.
ETC " " " El - Toro Cement.
RLO " " " Raw Linseed Oil.
BIT " " " Bitumuls.
MC " " " Monolith Cement

NOTE: As nearly as possible all mixtures were made to the consistency of stiff putty.

TEST #106

A replica of a ruin wall of the "core" type, 5' long, 22" wide, and 3' high, was built for the investigation of technique and materials in the "capping" of walls. In accordance to a suggestion made by Mr. E. Preece core material and debris was removed from the top of the wall to a depth of approximately 12", and what remained of the original mortar raked out from the inside from between the top two or three courses of stone. Cement mortar was then forced between these courses from the inside by hand and trowel. What remained of the cavity was filled with soil cement made from 9 parts of soil #16 and 1 part Monolith cement. The top stones were then "bottom bedded" in the same material to duplicate the original position and appearance.

TEST #107

It was found that grouting in the cement mortar from the inside, and then plastering was a somewhat difficult and slow job, and a second wall as above was built to try out a variation in materials and technique. The core material and debris was removed and the courses raked from the inside as above. The cavity was then poured full of soil cement as above but mixed to the consistency of thick molasses, so that all interstices were filled by the thin grout, and the surface of same formed a watershed. The top rocks were then bedded as in test #106.

TEST #108

A third test wall was built in which the capping technique was the same as test #107 except that a soil mortar made up of soil #16 mixed with an emulsion of 3 parts of water and 1 part of raw linseed oil was used.

Various other researches and tests are being conducted and will be covered by full reports as conclusive data becomes available.

It is my conviction, based on tests being made, that soil mortars with the proper selection of local soils for color and texture, and with approximately a 10% addition of cement, will meet ever structural, archeological and asthetic requirement until the possible future development of a much superior material. The cost of materials, handling, transportation, and application is probably as low as can ever be reached with any substitute for the original mortar.

I am offering the above as a contribution from a citizen deeply interested in ruin preservation, for the comment, approval, or dissaproval through the regular channels of the National Park Service, and in hopes that my efforts will in some measure facilitate transition from "reports" to "repairs".