NATIONAL BUREAU OF STANDARDS REPORT

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REPORT ON FIELD PERFORMANCE OF BITUMINOUS PROTECTED METALS

by

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U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

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U. S. DEPARTMENT OF COMMERCE

NATIONAL BUREAU OF STANDARDS

REPORT ON FIELD PERFORMANCE OF BITUMINOUS PROTECTED METALS

1. INTRODUCTION

Accelerated performance tests have been conducted on samples of bituminous protected metals produced by three manufacturers on at least four occasions at the National Bureau of Standards. Specimens of each material were subjected to a number of laboratory tests which were designed to simulate on an accelerated basis the various conditions to which these materials may be exposed. The following tests were included in the laboratory program:

a) Accelerated Weathering Tests.
b) Low Temperature Impact at 0°F. and -30°F.
c) Salt-Spray Tests.
d) Abrasion Tests.
e) Outdoor Exposure Tests.

The results of each series of tests have been reported in detail to the sponsoring agencies in the following National Bureau of Standards Reports:

a) NBS Report No. 1808 dated 12 August 1952.
b) NBS Report No. 4963 dated 14 December 1956.
c) NBS Report No. 5148 dated 5 February 1957.
d) NBS Report No. 6389 dated 30 April 1959.

As a result of these laboratory tests, many data are available for the performance of each material in a given test. It was recognized, however, that an accurate interpretation of these data, in terms of actual performance, was lacking. Therefore, in order to obtain data on the actual field behavior, a survey was conducted to investigate the performance of each material exposed under various climatic conditions.

2. FIELD INSPECTIONS

The field inspections were made in November and December 1959 by an inspection team made up of three members representing:

a) Office of the Chief of Engineers, U.S. Army.
b) New England Division, Corps of Engineers, U.S. Army.
c) National Bureau of Standards.*

*Inspections in the New England Division only.

The inspections were made of various types of structures which employed protected metals as roofing or siding or both, located at the following Air Force Installations:

a) New England Division, Corps of Engineers, U. S. Army.

1) Otis A.F.B., Massachusetts.
2) Pease A.F.B., New Hampshire.
3) Westover A.F.B., Massachusetts.
4) Barnes A.F.B., Massachusetts.
5) Bradley A.F.B., Connecticut.
6) Hanscom A.F.B., Massachusetts.

b) Missouri River Division, Corps of Engineers, U. S. Army.

1) Ellsworth A.F.B., South Dakota.
2) Lincoln A.F.B., Nebraska.
3) Lowry A.F.B., Colorado.
4) Sioux A.F.B., Iowa.
5) Forbes A.F.B., Kansas.
6) McConnell A.F.B., Kansas.
7) Richards-Gebaur A.F.B., Missouri.

c) South Atlantic Division, Corps of Engineers, U. S. Army.

1) Eglin A.F.B., Florida.
2) Tyndall A.F.B., Florida.
3) McCoy A.F.B., Florida.
4) Patrick A.F.B., Florida.

The inspections consisted of a critical examination of each structure by each member of the team. A previously prepared check list was used to insure uniformity during the inspections and an inspection form was completed for each structure that was observed. A copy of the inspection form is attached to this report. When sidings were involved, observations were made of each exposure, including the upper courses, when facilities for such inspections were available. In regard to the protected metals used as roofings, "on the roof" inspections were made by the team members. The team was usually accompanied by representatives of the Division and of the Base. Information regarding the history, age, maintenance, etc., of each installation was supplied by the Base personnel.

3. RESULTS OF INSPECTIONS

Tables 1, 2 and 3 summarize the results of the performance of each material as they were observed during the inspections. The tables do not, of course, indicate the severity of the particular deficiencies which were evident and ranged in degree from mild to severe. For example, a large proportion of the sheets on a structure may show exposed felt, or exposed metal, whereas on another structure, only a very small proportion of the sheets exhibited these defects. However, they establish the trends as to the types of defects noted and the frequency with which these defects occurred on a specified material.

The ratings are a summation of the general appearance and performance of the material on a particular installation. They bear out the general conclusion that protected metals, properly applied, perform adequately even though individual installations may show a number of minor defects.

In addition to the structures presented in the tables, a number of additional structures were observed that were not rated, since they were either erected under the same contract as one that was rated or had been painted a number of times for reasons not established.

4. DISCUSSION

4.1 Effectiveness of Protection

If it is considered that the primary function of a protective system is to prevent the deterioration of the base metal, the field observations indicated that, in general, Galbestos, Plasteel and Steelbestos performed adequately.

In many cases the materials which were located in areas subject to impact (lower courses, doors, corners, etc.) were damaged to such an extent that the base metal was exposed. The Plasteel material apparently is the most frequent offender in this area. It was evident that with this material, a loss of adhesion between the metal and protecting system resulted from an impact at a low temperature, and the metal was subsequently exposed by a secondary force. It is doubtful whether this same condition would exist if the impact had occurred at a higher temperature (70°F. and above). Of course, once the base metal is exposed, prompt maintenance is required to prevent early deterioration. It was also noted that when ice which accumulated on horizontal surfaces (flashings) of Plasteel was shattered, the weather coating under the ice was removed completely.

In regard to the loss of the weather coating from material utilizing a felt in the protective system (Galbestos and Steelbestos), either from abrasion, sticking of sheets prior to erection, etc., this defect did not appear to have an immediate effect on the deterioration of the base metal since some protection from the felt and adhesive was still available.

The use of a tape to protect the raw cut edges as called for in the specifications appeared to be ineffective since the tape rarely remained in place. In addition, the inspections indicated that, except in areas under severe salt exposure, additional protection for the raw cut edges was not required.

Failures of the protective systems of Galbestos and Steelbestos were observed at both factory and field bends, but, in the case of Plasteel, this type of failure was evident only at field bends. The condition of head and sill flashings of Plasteel (field bends) was such that continuous lengths of exposed, corroded metal were observed. Factory bends which had cracked and were recoated appeared to give adequate protection.

A number of instances were noted where patching material, used on Plasteel, was incompatible with the weather coating. Wherever this material was used the coating had curled, exposing the bare metal.

4.2 Appearance

A primary reason for the poor appearance of Galbestos and Steelbestos was the failure of the installer to recoat areas where the felt was exposed during the separation of sheets which had stuck together because of failure of the anti-stick compound. It was recognized, of course, that the exposed areas were not readily apparent since the asphalt-saturated felts were black. However, when exposed, the asbestos felt approached its characteristic white color shortly (within one year) after erection, because of the rapid weathering of the asphalt saturant.

The poor appearance of the Plasteel material was attributed to the uneven loss of mica which occurred on the various sheets during the weathering process. This condition did not affect the protecting qualities of the coating, but resulted in a mottled appearance. It was also noted that with Plasteel, the color of the patching material was not similar to that of the weather coating after exposure which contributed to a poor appearance.

The number of painted protected metal sheet installations which were observed during the survey indicated to the team a general dissatisfaction with the black materials. Frequently, materials of all types which were installed as little as 4 years had been painted at a considerable cost. For example, two DC hangars, erected in 1954, were painted in 1958 at a cost of $20,000.

As a matter of interest, structures constructed of both painted and unpainted galvanized sheets, in many cases exposed longer than those using protected metal siding, were observed and were apparently giving satisfactory service.

4.3 Fasteners

The protected metal sheets on the observed structures were fastened to the framing members with either the screw- or stud-type fasteners, with few exceptions. It was the opinion of the inspecting team that the screw-type fastener gave the better performance. The following deficiencies were common to the stud-type fasteners:

a) Sheets were not drawn as tightly as with the screw type.

b) Loose sheets were noted at the corner laps, apparently because of failure to install studs of sufficient length.

c) A greater loss of adhesion of the protecting system to the metal in the vicinity of the fasteners was more pronounced with the stud-type fasteners.

d) A number of missing caps were observed and, in some cases, broken studs were evident after the structure was subjected to high winds.

e) The daubing of the stud-type fasteners frequently resulted in a poor appearance for the siding as a whole.

f) Several installations were noted where overtightening of screw-type fasteners on Plasteel also resulted in loss of adhesion of the coating in the vicinity of the fasteners. This appeared to be more more severe when the material was installed during cold weather.

4.4 General Comments

It was observed that the most severe damage occurred on areas located in the vicinity of doorways, entrances, loading docks, etc., and in the lower courses (4 ft. and below) of the structure, regardless of the type of protected sheet used. This condition was noted particularly on the lower courses of the large, sliding doors of the nose dock type structure where it was common practice to use power vehicles to open and close the sliding doors.

On DC hangars where the Plasteel material was selected for use, the specifications called for the use of a zinc base sheet on the lower courses. However, zinc base sheets were intermixed with regular sheets throughout the structure. It was assumed that this deficiency resulted from the failure of the manufacturer to properly identify the individual sheets as to their base.

5. CONCLUSIONS AND RECOMMENDATIONS

The following conclusions and recommendations are based on the field examinations of protected metal installations described in this report:

1. In general, the performance of the protected metals which were observed during the field survey tends to substantiate the validity of the performance data which were obtained in the laboratory tests made at the National Bureau of Standards.

2. The bituminous (black) protected metals, properly used and installed, should provide adequate protection with little maintenance for a number of years when appearance is not a major consideration.

3. The common deficiencies noted with each material were:

Plasteel - Exposed metal which resulted from poor resistance to impact.

Galbestos and Steelbestos - The loss of protecting weather coat from abrasions, sticking of sheets to each other in storage, etc., resulted in a general poor appearance when the asphalt saturant weathered from the asbestos felt.

4. Specifications should insure the complete coverage of all abraded or damaged areas, prior to acceptance or during the guarantee period, with a material which is similar in color and compatible with the weather coating.

5. The manufacturer should be required to provide the means to prevent the sheets from sticking to each other prior to erection.

6. Protected metal sheets should not be used at door jambs or on walls within 4-5 feet of ground or platform levels.

7. The protection of raw cut edges should be mandatory in areas subject to salt-air exposure.

8. Consideration should be given to the use of conventional metal flashing materials for all horizontal flashings at head and sill of openings.

9. When two types of sheets from one manufacturer are specified, such as the zinc base or regular base sheet, the individual sheets should be marked plainly for identification.

10. Self-tapping screw type fasteners provide a superior installation of protected metal sheets and their exclusive use is recommended. If it is necessary to permit stud-type fasteners, their use should be restricted to materials which employ a felt in the protective system. Specifications should also require the use of extra length studs where corner laps occur.

11. Specifications should be more emphatic in regard to the following points:

a) Discouragement of the use of field bends.

b) The precautions necessary to minimize cracking when making field bends, and the need for immediate protection of both factory and field bends if cracks or damage are evident.

c) Care during cold weather installation of Plasteel. This might include a prohibition against the use of air wrenches on screw type fasteners.

12. Anticipating the probability of future painting of the black sheets because of the general dissatisfaction with the appearance of this material, consideration should be given to the use of painted galvanized sheets on an optional basis.

13. The proposed specification change calling for a guarantee against defects for a one year period is very desirable. However, careful inspection and correction of defects just prior to acceptance should also be stressed.

TABLE 1. RESULTS OF FIELD SURVEY OF GALBESTOS.

NUMBER	AIR FORCE BASE	AGE	SALT EXPOSURE	USED AS ROOFING	USED AS SIDING	FASTENERS SCREW	FASTENERS STUD	WEATHER COATING BRITTLE	WEATHER COATING CHECKING	WEATHER COATING PIN HOLES	WEATHER COATING CRACKING	LOSS OF ADHESION AT DAMAGED AREAS	LOSS OF ADHESION AT FASTENERS	CORROSION AT DAMAGED AREAS	CORROSION AT EDGES	CORROSION CREEP	FLASHING CRACKS AT BENDS	FLASHING CORROSION	APPEARANCE MOTTLED	APPEARANCE EXPOSED FELT	APPEARANCE PATCHED	APPEARANCE PAINTED	RATING GOOD	RATING FAIR	RATING POOR
1	Eglin	2	X		X	X			X	X					X	X						X	X		
2	Lincoln	7			X		X				X									X		X	X		
3	Richards	5			X	X			X	X	X			X						X				X	
4	Richards	6			X	X		X	X	X	X		X	X	X		X			X				X	
5	Forbes				X																	X			
6	Barnes	8			X		X	X			X			X								X	X		
7	Eglin	6									X						X						X		
8	Eglin	7	X		X					X	X						X					X	X		
9	Canaveral	8	X		X	X									X	X						X	X		
10	Eglin	2	X	X	X	X								X	X								X		
TOTALS		*5.6	4	1	9	5	2	2	3	4	6	0	1	4	4	2	3	0	0	3	0	6	7	2	0

*Denotes average age.

TABLE 2. RESULTS OF FIELD SURVEY OF PLASTEEL

NUMBER	AIR FORCE BASE	AGE	USED AS			FASTENERS		WEATHER		COATING		LOSS OF ADHESION		CORROSION		FLASHING		APPEARANCE				RATING		
			SALT EXPOSURE	ROOFING	SIDING	SCREW	STUD	BRITTLE	CHECKING	PIN HOLES	CRACKING	AT DAMAGED AREAS	AT FASTENERS	AT DAMAGED AREAS	AT EDGES	CREEP	CRACKS AT BENDS	CORROSION	EXPOSED METAL	MOTTLED	LOSS OF MICA	PATCHED	PAINTED	GOOD	FAIR	POOR
1	Otis	1	X		X	X						X		X	X					X	X			X		
2	Otis	4	X	X			X					X												X		
3	Otis	4	X		X		X					X	X	X	X				X					X		
4	Pease	3			X		X					X		X					X			X				X
5	Pease	4			X		X			X		X	X	X	X				X	X	X	X			X	
6	Pease	3			X		X					X	X	X					X		X			X		
7	Hanscom	5			X		X			X		X		X	X		X		X		X			X		
8	Westover	5			X		X					X	X	X						X	X			X		
9	Hanscom	5			X		X			X		X		X	X				X		X			X		
10	Eglin	6	X		X		X					X	X						X				X	X		
11	Canaveral	1	X	X		X									X									X		
12	McCoy	5			X		X								X									X		
13	McCoy	6			X		X					X	X	X					X						X	
14	McConnell	7			X	X	X					X		X					X	X		X				X
15	Lowry	7			X	X						X		X			X		X		X	X		X		
16	Ellsworth	3			X	X						X							X				X	X		
17	Richards	5			X	X			X	X		X					X		X		X			X		
18	Forbes	5			X		X					X	X	X					X		X			X		
19	Forbes	5			X		X					X	X	X							X			X		
20	Eglin	1	X		X	X																	X	X		
TOTALS		*4.2	6	2	18	13	8	0	1	4	0	17	8	13	7	0	3	0	13	4	10	4	3	16	2	2

*Denotes average age.

TABLE 3. RESULTS OF FIELD SURVEY OF STEELBESTOS

NUMBER	AIR FORCE BASE	AGE	SALT EXPOSURE	USED AS FASTENERS				WEATHER COATING				LOSS OF ADHESION		CORROSION			FLASHING		APPEARANCE			RATING		
				ROOFING	SIDING	SCREW	STUD	BRITTLE	CHECKING	PIN HOLES	CRACKING	AT DAMAGED AREAS	AT FASTENERS	AT DAMAGED AREAS	AT EDGES	CREEP	CRACKS AT BENDS	CORROSION	MOTTLED	EXPOSED FELT	PATCHED	PAINTED	GOOD	FAIR	POOR
1	Otis	3	X		X	X	X	X	X	X	X	X		X	X		X		X	X				X	
2	Pease	2			X		X					X		X			X			X			X		
3	Pease	2		X			X															X	X		
4	Pease	2		X			X			X				X			X			X				X	
5	Pease	2			X		X		X	X		X		X			X			X				X	
6	Pease	3			X		X		X	X		X	X	X	X		X			X				X	
7	Pease	5			X		X		X	X	X	X	X	X			X			X			X		
8	Pease	4			X	X		X	X	X		X		X			X			X			X		
9	Westover	5			X	X				X	X			X			X					X	X		
10	Bradley	2			X		X		X	X	X	X					X			X			X		
11	Otis	2	X		X	X		X	X			X	X	X	X									X	
12	Ellsworth	12			X			X	X		X	X										X		X	
13	Eglin	1	X		X		X	X	X	X				X		X				X		X	X		
14	Eglin	1	X		X	X			X	X		X					X						X		
15	Eglin	1	X		X	X						X		X	X	X	X					X	X		
16	Eglin	1	X		X	X								X	X	X						X			
17	Tyndall	1	X		X	X			X	X				X			X			X			X		
18	Tyndall	1	X		X	X			X	X				X						X			X		
19	Tyndall	1	X	X		X			X			X		X						X	X				X
TOTALS		*2.7	9	3	16	10	9	5	13	12	5	12	3	15	5	3	12	0	1	12	1	6	11	6	1

*Denotes average age.

Date_____ Temp._____°F.

Date erected_____ Location _____ Building _____

Material: Galbestos ____ Steelbestos ____ Plasteel ____ Color _____
Corrugated ____ V-Beam ____ Other _____

Fasteners: Stud ____ Screw ____

Atmosphere: Chemical ____ Salt ____ Other _____

Exposure: Siding ____ Roofing ____

Weather Coating: Hard & Brittle____ Soft & Pliable ____ Blistering ____
Checking ____ Pinholes ____ Spalling ____
Describe:_____

Cracking: Valleys ____ Crests ____ Bends ____ Surface ____
Thru Surface ____ Av. Width _____
Extent _____

Loss of Adhesion to Metal: General ____ At Fasteners ____ At damaged areas ____ Comment _____

Corrosion _____ Pinholes _____ Edges _____ Damaged Areas _____ Other _____
Creep _____ Describe _____

Patching: Pliable ____ Hard ____ Tight ____ Loose ____

Fasteners: Tight ____ Loose ____ N. Washer ____ Covered ____ Rusty _____
Remarks_____

General Appearance: Good ____ Fair ____ Poor ____ Mottled ____ Loss of Mica ____ Exposed Felt ____ Exposed Metal ____ Spot patching _____
Around doors _____ Near Ground _____
Comments_____

Interior Insulation: Type _____ Wainscot _____ General Appearance:
_____
_____

Photos: No. Showing
_____ _____
_____ _____
_____ _____

Remarks: _____
_____
_____

U.S. DEPARTMENT OF COMMERCE
Frederick H. Mueller, *Secretary*

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THE NATIONAL BUREAU OF STANDARDS

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Optics and Metrology. Photometry and Colorimetry. Photographic Technology. Length. Engineering Metrology.

Heat. Temperature Physics. Thermodynamics. Cryogenic Physics. Rheology. Molecular Kinetics. Free Radicals Research.

Atomic and Radiation Physics. Spectroscopy. Radiometry. Mass Spectrometry. Solid State Physics. Electron Physics. Atomic Physics. Neutron Physics. Radiation Theory. Radioactivity. X-rays. High Energy Radiation. Nucleonic Instrumentation. Radiological Equipment.

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