TECHNICAL INFORMATION ON BUILDING MATERIALS

TIBM - 1

FOR USE IN THE DESIGN OF LOW-COST HOUSING

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THE NATIONAL BUREAU OF STANDARDS.
UNITED STATES DEPARTMENT OF COMMERCE
WASHINGTON, D. C.

March 3, 1936.

CORROSION OF METALS USED IN HOUSE CONSTRUCTION

An important factor affecting the durability of metals used in the construction of a house is the extent to which these metals corrode. Such corrosion may often be minimized by proper choice of materials or the use of preventive measures. To proceed intelligently in selecting materials or preventive measures, it is necessary to recognize and differentiate between the more important kinds of corrosion which may occur at different points in the building structure. This memorandum deals with the corrosion of iron or steel and will be followed by subsequent memoranda dealing more specifically with the subject of ferrous metal corrosion from the standpoint of the home builder or owner. Non-ferrous metals will also be discussed in a later memorandum.

A number of types of metal corrosion are now recognized. As far as corrosion of metals in houses is concerned, however, consideration of four types is sufficient: (1) atmospheric, (2) underground, (3) submerged or semi-submerged, (4) special kinds.

1. Atmospheric Corrosion

In the atmosphere, metals corrode mainly by the combined action of oxygen from the air and of water which must be present in liquid form. If the air is dry or if it contains water only as vapor, corrosion is entirely negligible except possibly at very elevated temperatures. The air in a building, of course, is never perfectly dry but always contains water vapor, the amount depending on the climate, season, and other causes. It is only when this water vapor condenses on a cold metal surface that corrosion is possible. The atmosphere outside the building may also cause corrosion in this way, but in this case most of the water would come from rain or snow.

Exposure tests of long duration made by the American Society for Testing Materials have established the fact that the atmosphere varies in severity of corrosion in different locations. The most severely corrosive type is an "industrial" atmosphere such as is found in Pittsburgh. The main factors increasing the severity of corrosion are smoke particles, dust, and sulphur oxides in the air resulting from the combustion of fuel. A marine or seacoast atmosphere also corrodes metals on account of its salt content. The least corrosive atmospheres are found in rural or suburban locations where sulphur gases from smoke, and salt are negligible.

The test locations of the American Society for Testing Materials included these different kinds of atmosphere. A memorandum giving the essential details of their "Atmospheric Tests", will be issued. Three practical conclusions demonstrated by these tests are:

(a) Since the rural atmospheres are only slightly corrosive, metals of somewhat thinner section may be tolerated than in industrial locations.

(b) Protective metallic coatings (e.g., zinc) of a specified thickness can be relied upon to have a much longer useful life in rural atmospheres than in industrial.

(c) Certain types of steel are better than others for resistance to atmospheric corrosion.

2. Underground Corrosion

Underground corrosion of metals differs in the following respects from atmospheric corrosion:

(a) Although water and oxygen (from the soil atmosphere or dissolved in the soil water) are the principal active agents, oxygen does not have as ready access to all parts of the metal as it has in the air.

(b) Salts in solution in the soil water may influence the nature and extent of the corrosion.

Drainage of the soil is important in retarding underground corrosion.

The National Bureau of Standards during the past 14 years has investigated metal corrosion in more than 47 different types of soil in various parts of the United States. Several Bureau publications are available on different phases of this work and a later memorandum will be issued covering the important details of these investigations.

Soils differ greatly in corrosive character according to soil type, annual rainfall, and other factors. Where large underground installations of metal are contemplated the selection of such metals should be governed by the type of soil in which they are to be imbedded. The corrosiveness of the soil may be determined by laboratory tests.

The corrosive characteristics in steels and irons themselves are, in general, secondary to the corrosive effects upon them resulting from their contact with soils.

3. Submerged or Semi-Submerged Corrosion

When the metal is wholly or partly covered with water, the active corroding agents, as in the preceding cases, are water and oxygen. The latter may come from air dissolved in the water, or from the atmosphere at the air-water boundary. In general, the oxygen content of such confined or dissolved air is different from that of unconfined atmosphere.

Special features of submerged or semi-submerged corrosion are:

(a) Greater severity at the air-water boundary.

(b) Effect of "soft" or "hard" water on the rates of corrosion.

This type of corrosion is typified in buildings by storage tanks, hot water or steam boilers, range boilers, etc. A memorandum dealing with measures for lessening such corrosion will be issued as one of this series.

4. Special Kinds of Corrosion

Special kinds of corrosion will be discussed in a subsequent memorandum on the subject. This will deal with parts of a building where corrosion is especially severe, and measures for its prevention or mitigation will be recommended.

Some examples of this type of corrosion are gutters and spouts, range boilers, and metal smoke-stacks.

General Conclusions

From the foregoing comments on the three types of corrosion it will be realized that because a metal is superior in one type of service it does not follow that it will prove to be superior in other types of service.

It is a mistake to assume that a laboratory or accelerated test can, in a few days or weeks, show whether a metal is superior for service under any or all of the corrosion conditions which have been described. Attempts by skilled investigators to do this have often failed. However, such accelerated tests are deemed most useful in corrosion research.

IN GENERAL, THESE RELEASES PRESENT, VERY BRIEFLY, ESSENTIAL FACTS DEVELOPED THROUGH RESEARCH WORK AT THE NATIONAL BUREAU OF STANDARDS AND REFER TO LONGER PUBLICATIONS WHERE METHODS OF INVESTIGATION AND RESULTS OBTAINED ARE GIVEN IN GREATER DETAIL.

THESE WERE PREPARED PRINCIPALLY FOR THE GUIDANCE OF FEDERAL AGENCIES ENGAGED IN HOUSING, IN MATTERS PERTAINING TO THE PROPERTIES AND USES OF BUILDING MATERIALS, BUT A LIMITED NUMBER ARE ALSO AVAILABLE TO THE TECHNICAL STAFFS OF MANUFACTURING CONCERNS, TRADE ASSOCIATIONS, AND BUILDING ORGANIZATIONS, ALSO TO LIBRARIES, EDUCATIONAL INSTITUTIONS, ARCHITECTS, AND ENGINEERS.

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