PART 3 : GUIDANCE FOR DESIGN

SECTION HC

CONTENTS

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Gr 10

SABS 1200 HC : CORROSION PROTECTION OF STRUCTURAL STEELWORK

1. SCOPE

1.1 This part of the code gives guidance on how to select and specify the most suitable corrosion-protection system for a particular set of circumstances. The systems presented in the Selection Chart are those most commonly recommended for use on structural steelwork. This code may not adequately cover the selection of protective systems for those parts of structures that are located in severely aggressive environments, such as portions of chemical plants, offshore oil rigs, harbours, dam installations and mine shafts. Should the engineer using this code find that he cannot confidently select the appropriate protective system(s) for his project, specialist advice should be sought.

NOTE: For some situations, stainless or alloy steels may be used as an alternative to ordinary coated structural steel. No detailed recommendations on the use of these steels are given in this code and when their use is contemplated, advice should be sought from the steel industry.

For roofing and cladding, the recommendations of SABS 0120 HB[1] should be followed. However, under highly corrosive conditions, suitable systems from this code may be preferred.

2. PROCEDURE FOR SELECTION OF PROTECTIVE SYSTEMS

2.1 For corrosion prevention, no protective system can adequately compensate for poor structural design details. Therefore, review detailed design aspects with reference to Appendix A. Then

a) With the desired life of the structure(s) in mind, identify the environment(s) (the humidity isograms in SABS 064[2] may be an aid) and, with reference to Clause 3, identify suitable candidate systems in the Selection Chart. It should be noted that the "time to first major maintenance" quoted in the Selection Chart is for guidance only.

b) Select the preferred system from the candidate systems with reference to the additional criteria set out in the left-hand column of the Selection Chart and with reference to Clause 4.

A system should not be used if the Selection Chart shows a bar against an essential or a desired criterion.

For convenience, weighted numerical ratings can be assigned for the descriptive terms used in the chart for relevant criteria and the aggregate of these weighted ratings can be used to aid in the selection process.

Any additional criteria that may be important on a specific project can be inserted and weighted on the blank lines.

c) Define the system(s) as completely as possible with reference to Clause 5.

d) Draw up the detailed specification and compile the schedule of quantities, using the guidelines set out in Parts 2 to 4 of this code.

3. CHOICE OF CANDIDATE SYSTEMS

NOTE: When choosing candidate systems from the Selection Chart, consider the factors set out in 3.1 and 3.2.

3.1 DESIGN LIFE OF STRUCTURE AND COATING SYSTEM(S)

a) *For how long are the structure and coating systems required to fulfil their functions?*

Most structures are designed for a specific functional life which can be achieved by choice of materials and design factors. In rare cases where access for repair or maintenance of the protective coating is impossible, the coating will be required to have the same life as the structure. It will not normally be economical to choose materials and coating systems which gives freedom from major maintenance for the design life of the structure; reasons of hygiene or aesthetics may dictate shorter maintenance periods. It therefore becomes practical to use a protective system which will require periodic maintenance during the design life of the structure.

All systems should be inspected for possible maintenance needs at regular planned intervals, e.g. at commissioning, after 1 year, and thereafter at suitable intervals.

Periodic maintenance embraces running and major maintenance.

1) Running maintenance is the ad hoc repair of isolated areas necessitated by design, application and maintenance deficiencies, together with mechanical damage, spillages and latent defects. There is at this stage no indication of general system failure and the work can be managed by the usual maintenance staff.

2) Major maintenance, usually beyond the scope of running maintenance, becomes necessary when early signs of rusting (red or white) appear at weak spots and at critical areas such as welds, sharp edges or condensation zones. These affected areas will need to be cleaned back to the substrate (steel or metallic base coat) and the complete paint system reapplied. In addition, the whole surface of the steelwork should then be completely overcoated with a top coat. These operations should be carried out before the primer or metallic base coat shows general failure.

For duplex systems which incorporate zinc-rich, galvanized and sprayed metal base coats, the total life of the coating system is the sum of the time to breakdown of the top coats plus the life of the underlying metallic coating. However, the expected "time to first major maintenance" as given in the Selection Chart is the time to breakdown of the top coat.

In severe corrosive environments where long life to first major maintenance is required, attention to design is of the utmost importance. Crevices, stitch-welding and fasteners are weak links in the protective system. Twenty plus (20+) years to first major maintenance can be achieved on the main structural steel but in some instances (e.g. moving parts and fasteners), regular maintenance and greasing is necessary.

b) *What access is there going to be for effective maintenance after erection?*

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1) Cladding and sheeting.
2) Preparation of steel surfaces for coating.

In addition to obvious examples such as the inside surfaces of box sections, it is necessary to assess the life of each part of a structure separately. For example, in a simple column-and-truss building, the upper flanges of the roof trusses and outward-facing surfaces of columns, purlins and sheeting rails can easily receive appropriate protection against this microclimate whilst they are accessible, before cladding and whilst erection damage is being repaired or final coats are being applied (or both). After cladding, these surfaces would become accessible only at great expense and with potential damage to the cladding.

3.2 ENVIRONMENT(S)

a) What is the general climate (macroclimate) at the site of the structural component? (See the humidity isograms in SABS 064[2]). Note that the charted humidity values are those measured in a standard meteorological box (Stevenson screen) 1,23 m above the ground.)

The most common types of environment are:

1) Indoor - dry. Normally dry. Very little corrosion. Relative humidity generally below 60 % .
2) Exterior inland - low pollution. Relative humidity below 70 % for at least 16 h/d .
3) Indoor or under cover - wet. Relative humidity frequently over 80 % . Substantial condensation on cold surfaces.
4) Exterior coastal - mild to medium. Relative humidity greater than 70 % for 16 h/d . Low to medium airborne sea salt. 5-30 km from coast.
5) Exterior coastal - severe. High relative humidity. Airborne sea salt common. High water mark to 5 km inland.
6) Exterior industrial - coastal or inland. High incidence of industrial pollution.

b) What localized effects (microclimates) exist or are to be expected (e.g. fumes from chimneys or benign or aggressive environments inside plants or buildings)?

c) Will the environment change markedly after completion of the structure or in the foreseeable future?

d) Should the worst environment be catered for when determining protective systems or should the project be divided into different parts from an environmental point of view?

NOTE: A multiplicity of systems could be impractical, confusing and difficult to maintain.

To simplify the final specification and possibly reduce the number of systems thought necessary, the environments given in 3.2(a) have been grouped in the Selection Chart as follows:

Mild : 1 and 2
Medium : 3 and 4
Severe : 5 and 6

4. CHOICE BETWEEN CANDIDATE SYSTEMS

NOTE: In narrowing down the candidate systems identified in the Selection Chart, consider the factors set out in 4.1-4.3 inclusive.

4.1 EXPERIENCE. *Are there successful case histories in similar environments?*

4.2 FUNCTIONAL REQUIREMENTS AND MAINTENANCE

4.2.1 Functional Requirements. *What criteria are to be considered?*

a) Corrosion protection only;
b) Colour:
1) decorative
2) statutory (colour coding)
c) Resistance to damage (rolling, impact, scratching and abrasion);
d) Temperature;
e) Immersion;
f) Chemical attack, etc.;
g) Hygiene.

4.2.2 Compatibility with Engineering and Metallurgical Features

a) Is the preferred coating system compatible with the design and detail of the structure? e.g. galvanizing of thin elements or sealed joints, site welding and friction-grip joints.

b) Is the chosen surface preparation method compatible with the mechanical properties of the component? e.g. possible hydrogen embrittlement during pickling. Distortion of thin plate during abrasive blasting of thin plate.

c) Is the system compatible with cathodic protection? (See the Selection Chart.)

4.2.3 Maintenance. *Can the chosen system be easily maintained?* (See the Selection Chart - RECOATING, and 3.1(b), keeping in mind that single-pack materials are easier and more convenient to use.)

4.3 COST EFFECTIVENESS. *Is the life cycle cost of the chosen system the most economical?* Take into account

a) the initial applied cost;
b) the maintenance costs during the life cycle chosen, including production losses and dismantling costs;

A budget estimate using the desired specification(s) should be compared with the capital vote for the project. If the vote is insufficient, ideally it must be increased, or the specification(s) (performance or expected life to first maintenance) must be changed to meet the money available. Alternatively, cost priority may initially be given to critical areas, and less critical areas built up under maintenance budgets.

4.4 FABRICATION AND CONSTRUCTION CONSTRAINTS RELATING TO COATING SYSTEMS. When choosing between candidate systems and when deciding the location and sequence of operations to suit the candidate systems, consider the following advantages and constraints:

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2)See page 1.

4.4.1 Location of Fabrication and Coating Operations. There are many options when deciding in which location the coating system is to be applied.

a) At the fabricator's shop (or a coating contractor's yard);
b) On site before erection;
c) On site after erection;
d) Combinations of (a)-(c) above.

4.1.1.1 Application at fabricator's shop (or coating contractor's yard). Shop application has the following advantages:

a) The atmosphere is relatively clean and unpolluted.
b) Early protection of new steelwork is possible.
c) The surface of the steelwork is more easily accessible.
d) Better equipment is available, e.g. mechanical handling and conveyors.
e) Surface preparation using centrifugal abrasive cleaning is cheaper.
f) More efficient use can be made of supervisors, giving better quality.
g) A more highly trained fixed labour force is available, giving better productivity.
h) The supply line for materials and technical service is shorter.
i) Full shop coating reduces intercoat contamination.
j) Shop application is less dependent on the weather.

4.4.1.2 Application on site

a) Site application has the following advantages:
1) Damage during handling, loading, hauling, unloading and storing on site is eliminated.
2) Wider use can be made of softer coatings such as alkyds and chlorinated rubber.
3) Centralized quality control of multisource supplies is possible.
4) It is convenient for site fabrication, e.g. galleries, pipework and flooring.
5) The responsibility for coating and erection damage is undivided.
b) Despite the above-listed advantages, certain overriding considerations may apply, e.g.:
1) The limitations on open site blast cleaning;
2) the availability of acceptable blast-cleaning medium;
3) the availability of electric power at suitable voltage, phase and frequency;
4) the availability of potable water;
5) the availability of accommodation;
6) the availability of skilled or other labour;
7) climatic problems;
8) the cost of site establishment;
9) site administration costs;
10) the accessibility of the site;
11) international border problems;
12) currency controls;
13) the construction program;
14) the cost of inspection.

4.4.1.3 Combined shop/site application. A combined shop/site application permits the optimization of the advantages given in 4.4.1.1 and 4.4.1.2(a). Inorganic zinc and metal coatings in general have excellent resistance to handling damage, combined with excellent self-weathering for periods of a year or more, without a top coat.

It is possible therefore to have the whole of the priming application completed centrally and the remaining coats applied on site where the ideal is probably to apply the intermediate coat (or undercoat) whilst the steelwork is on the ground before erection and to apply the final coat after erection but before cladding.

This sequence of coatings has the great advantage of keeping the blast-cleaning operation off site and greatly reducing the risk of contaminating the coats applied on site. There is also less danger of exceeding the critical overcoating periods of hard coatings such as epoxies and polyurethanes.

4.4.2 Health and Safety. ***Are any problems to be taken into account during coating operations?*** Consider aspects such as safety requirements, operation in closed spaces, local authority limitations on sand blasting, fire hazards, or explosion risks and toxicity of materials.

4.4.3 Constraints Relating to Coating System

4.4.3.1 Time intervals

a) What intervals can be allowed between coating operations, taking account of climatic considerations?
b) Do any of the candidate systems have critical overcoating intervals?

The short pot-life of mixed two-component materials such as solventless epoxy and inorganic zinc may cause difficulties or even preclude their use in very hot conditions on sites exposed to direct sunlight. (See SINGLE(S) or MULTIPLE(M) PACK entries in the Selection Chart.)

The use of slow-curing materials such as alkyds, some epoxy tars during the winter and some inorganic zincs under very low humidity conditions, may result in

1) shipment, erection and recoating schedules being impossible to meet;
2) hold-ups due to weather;
3) extra covered working area being required;
4) extra scaffolding and staging being required;
5) lower productivity with increased unit costs.

Metallic coatings and fast-curing materials such as most inorganic zincs, single-pack etch primers, and most epoxies and polyurethanes enable steel to be handled and recoated with a minimum of delay. The resultant increased productivity with reduced unit costs will tend to offset the higher cost of materials. A short maximum recoating interval, e.g. with some epoxies and polyurethanes, makes it impracticable to apply the initial coats at a central yard and the final coat on site without an expensive abrading operation on the hard cured surface. For the same reason it may be impracticable, when coating on site, to apply the final coat after erection. (See RECOATING (AGED or FULLY CURED) in the Selection Chart.)