a conventional steel. On the other hand, under conditions in which the film thickness was 10 μm or larger, while a result that anti-rusting properties were still poor was obtained in a conventional steel, a result that anti-rusting properties were excellent was obtained in a steel of the present invention.

[0143]

Table 6 shows results obtained when an alkali-silicate inorganic zinc coating film in the present invention or an inorganic zinc coating film to compare is provided on a steel of the present invention or a conventional steel, and the corrosion tests 2 and 3 were performed. When a steel of the present invention was used, and the atomic molar ratio (Si/M) in the coating film was in a range of 2.0 to 125, a result that anti-rusting properties were excellent was obtained. On the other hand, in cases where the molar ratio was outside the range, a result that anti-rusting properties were poor was obtained even when a steel of the present invention was used. Even in cases where the molar ratio was inside the range, a result that anti-rusting properties were poor was obtained when a conventional steel was used. Accordingly, it is thought that excellent corrosion resistance over a long period of time was obtained due to a synergistic effect among a corrosion product, an alkaline component, and Cr.

[0144]

Table 7 shows results obtained when ~~an inorganic zinc~~

~~coating film of~~ an alkali-silicate inorganic zinc coating film of the present invention is provided on a steel of the present invention, and the corrosion tests 1 and 3 were performed. In Examples D1 to D9, since the atomic molar ratio (Si/M) in the coating film was in a range of 2.0 to 125, a result that anti-rusting properties were excellent was obtained in the corrosion test 1 for 180 days. In Examples E1 to E9, a result of particularly excellent anti-rusting properties, in which an evaluation according to the rating-number method was B (more than 9.8-1 and up to 5-2), was obtained even in the corrosion test 3 for 365 days.

[0145]

Regarding Examples D1 to D9 and Examples E1 to E9, Fig. 1 illustrates a graph obtained by plotting the Cr content in the steel material with respect to the atomic molar ratio (Si/M) (logarithmic scale) in the coating film.

[0146]

From numerical analysis results for points in Fig. 1, a straight line: $\{0.25 \times \ln(\text{molar ratio (Si/M)}) + 0.5\}$ can be drawn which divides Examples D1 to D9 in which an evaluation according to rating-number method was C in the corrosion test 3 and Examples E1 to E9 in which an evaluation according to rating-number method was B in the corrosion test 3. From this result, in Examples E1 to E9 satisfying an expression: $[Cr] \geq \{0.25 \times \ln(\text{molar ratio}$

(Si/M)) + 0.5}, it is found that a coating film having a film thickness of 20 μm had excellent anti-rusting properties even in the corrosion test 3 for a longer period of 365 days. In other words, in the case of a combination of a steel material and a coating film satisfying the above-described expression, it is found that an anti-corrosion coating film having excellent anti-rusting properties over a year in the corrosion test 3 was obtained.

[0147]

Table 8 shows results obtained when ~~an inorganic zinc coating film of~~ an alkali-silicate inorganic zinc coating film of the present invention was provided on a steel of the present invention, and the corrosion tests 1 and 3 were performed. Since, in Examples D10 to D16, the atomic molar ratio (Si/M) of the coating film is in a range of 2.0 to 125, a result that anti-rusting properties were excellent was obtained in the corrosion test 1 for 180 days. Further, in Examples E10 to E16 satisfying an expression: [Cr] ≥ {0.25 × ln(molar ratio (Si/M)) + 0.5} × 20 (μm)/(the film thickness (μm) of the coating film formed on the surface of the steel material), a result that anti-rusting properties were excellent was obtained even in the corrosion test 3 for a longer period of 365 days. The results are illustrated in Fig. 2 (in logarithm).

[0148]