# Short-time Corrosion Behavior on Steel Surface after Abrasive Blast Treatment

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**1. Introduction** Offshore structures are exposed to an aggressive marine environment, where substrates in repainting process after Abrasive Blasting Treatment (ABT) surface perpetration will be contaminated by aerosols containing salts within hours. Localized corrosion studies of carbon steel surfaces undergoing residues are characterized. Significantly, the corrosion products are found to grow rapidly and inhomogeneously. They evolve to higher oxidation state oxides quickly within short corrosion time. Therefore, microscopic corrosion products will form on substrates just treated by ABT surface perpetration in the repainting process, even before the protective paint is applied. This work investigates the corrosion of steel surfaces over particularly short timescales after aged coatings and corroded parts are treated by ABT and before paint is applied. It focuses on the short-term effects of the repainting process between surface preparation and coating application (turning time, typically several hours).

**2. Specimen and test method** Corroded steel panels have been treated by ultrasound salt deposition method[1)] ray 1g/m$^2$ NaCl aq and accelerated in Okinawa cycle for a year. Surfaces perpetration and condition of testing surfaces, as in Fig.1 shows. Stage a) that corroded panels are surface perpetrated by ABT to the level of Sa 3 (ISO 8501-1). ABT parameters are written in Fig.1, and abrasive materials are steel grit and alumina grit, respectively. Surface condition after ABT (Stage b) indicates abrasive metals (blue points), remaining rust on steel surface (orange points) and residues chlorides (black points) remains on substrates, due to the limitation of ABT surface preparation process. To stimulate the atmosphere condition of a short period of timescale between finishing ABT treatment and applying coating, ABT treated surfaces are exposed to constant temperature and relevant humidity (T and RH respectively) chamber with 28°C, 87%RH (gauging T and RH data of average summer's daytime in Okinawa) in different timescales: 0h, 2h, 4h, 24h. In the study, this timescale is named turning time.

Corrosion identification of surfaces (70×30mm) undergoing turning time use spatial statistics numerical simulation to quantify corrosion. The distance of closest approach of two objects is the distance between their centers. The expected value is E[W], and the average of the distance of closest approach $l$ is W, respectively. The value of $P$=E[W]/W was used to evaluate the corroded adhesion property. When $P \gg 1$, $P = 1$, and $P \ll 1$, the points of corroded area are spot distribution, pinpoint distribution, and general distribution, respectively. Electrochemical measurements, the electrochemical approach was performed in 0.5M $Na_2SO_3$ aq electrolyte which shows reduction[2,3)] as electrolyte at room temperature (±23°C) using the Princeton Applied Research potentiostat. The testing surfaces ($\phi$25mm) being through different times of exposure as the working electrode and an Ag/AgCl electrode in saturated potassium chloride (Sat.KCl) solution as the reference electrode.

**3. Test results** Fig. 2 shows corroded steel panels are treated by ABT with steel grit and alumina grit, respectively. For surfaces that using steel grit as abrasive material, 2 hours of exposure visible corrosion production have been observed. Meanwhile, corrosion production is invisible until 4 hours' exposure on surfaces treated by alumina grit. So the visual appearance of rust on the blast-cleaned surface treated by steel grit is severer which indicates alumina grit has inhibiting effect on corrosion than steel grit in the same environmental condition. The visual appearance of rust along turning time is calculated, as Fig.3 shows, the result of the percentage of corroded area indicates that the short-term of corrosion within 4 hours is increases and shows linearity. And increasing tendency has scaled decreases after 4 hours. As Fig.4,5,6, shows, using spatial statistics numerical simulation to quantify corrosion on surfaces undergoing turning time. Firstly, the number of corroded point (Fig.4) is growing along turning time, surfaces treated by steel grit or alumina grit have the same rising tendency which increases over time. And Fig.5 is showing the development of the distance of closest approach. Both the expected value E[W]and the average value W of the distance of closest approach of rust has decreased on surfaces treated by steel grit and alumina grit, respectively. So that surface over a longer time of exposure, which indicates that corroded points on surfaces grow up along time so that the closest distance of each point are narrowed down. Fig.6 describes that the rust distribution is spot distribution in the first 4 hours of exposure. Gradually $P = 1$, the distribution changes into pinpoint distribution can be regarded as uniform corrosion after 24 hours of exposure. Therefore, it indicates corrosion production has been accelerated because residues exist at the first 4 hours and gradually become uniform corrosion after longer time of exposure. Using electrochemical approach which $Na_2SO_3$ uses as redactor agent to detect

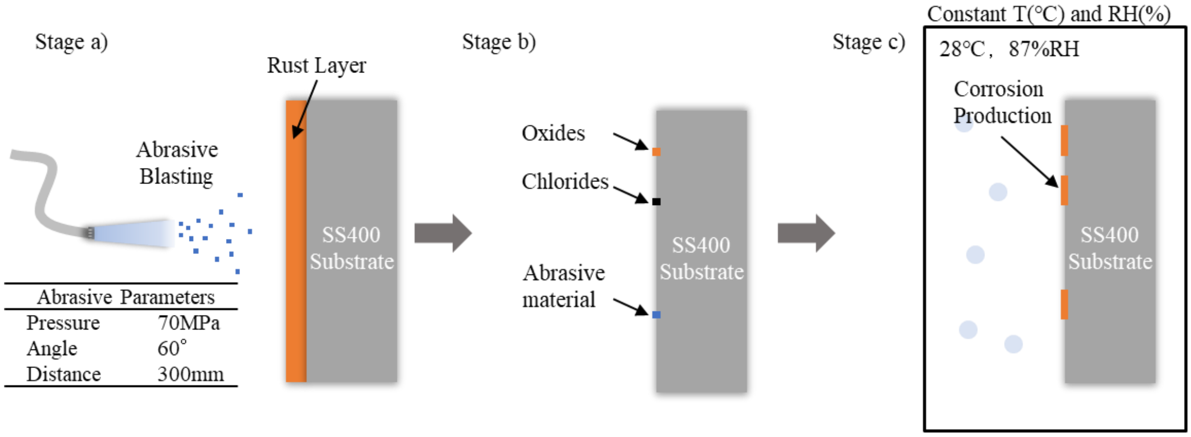


Fig.1 Schematic Illustration of Short-term Impact of Residues on ABT Treated Surfaces

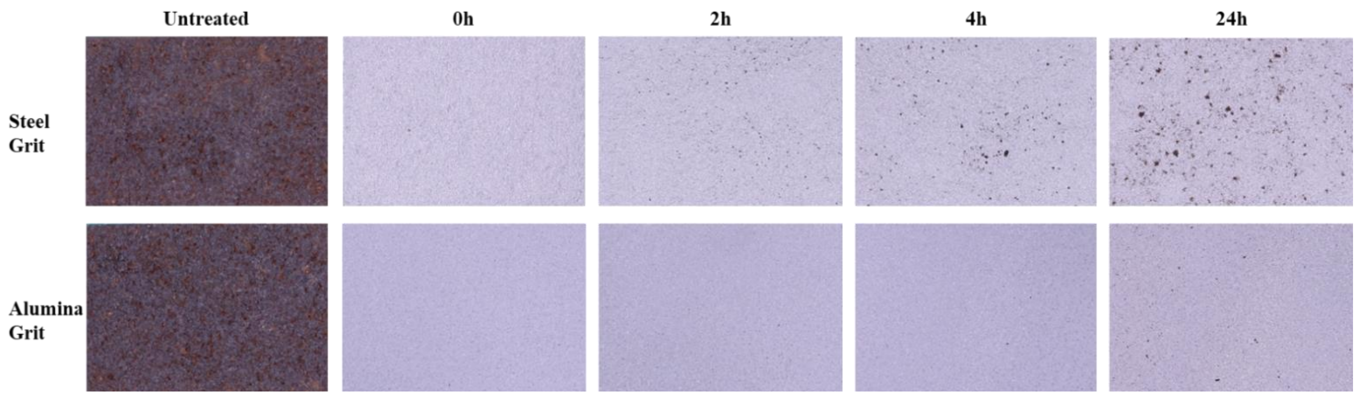


Fig.2 Digital Photos Undergoing Turning Time at Constant Temperature and Relevant Humidity Chamber

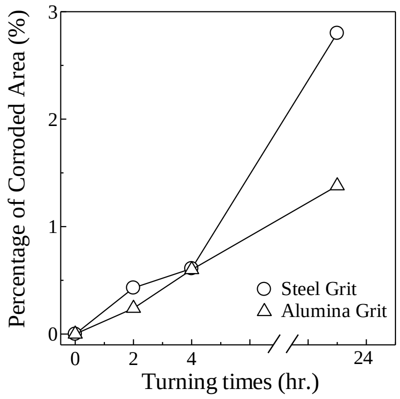


Fig.3 Percentage of Corroded Area along Turing Time

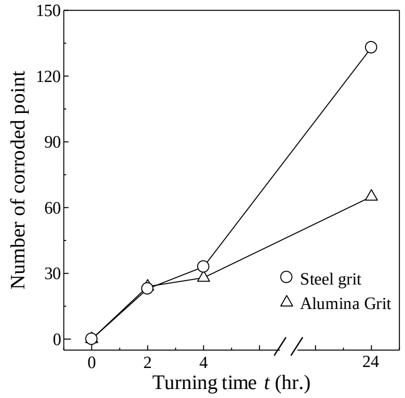


Fig.4 Number of Corroded Point Grows along Turing Time

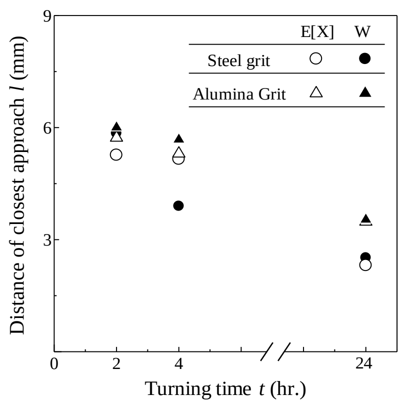


Fig.5 Distance of Closest Approach along Turing Time

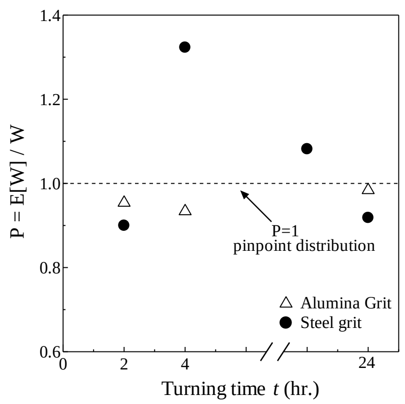


Fig.6 Length of Shoulder Time along Turing Time

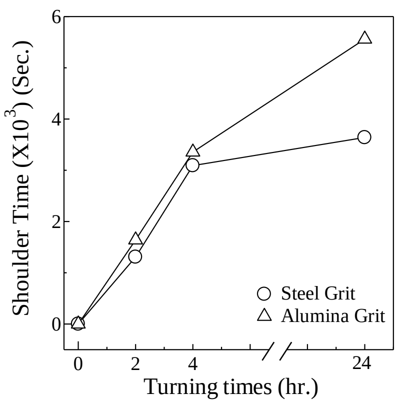


Fig.7 Distribution of Corrosion Production along Turing Time

invisible iron(III) oxides and alumina. The electrochemical potential will keep at shoulder potential that proposes the exist of iron(III) oxides and alumina as long as corrosion products exist on the testing surface. The electrochemical result shows in Fig.7, both surfaces treated by steel grit and alumina grit, the time kept at shoulder potential is longer along 0h, 2h, 4h, 24h. After 4 hours of exposure, the length of shoulder time is a time than after 2 hours, and after 4 hours the rising tendency has scaled decrease. Besides, the length of shoulder potential of surfaces treated by alumina grit is similar to one treated by steel grit over 0,2,4 hours of exposure, however, because alumina also response and longer the shoulder time. So that alumina grit has inhibiting effect on corrosion than steel grit in the same environmental condition.

**4. Summary** 1) Corrosion production on substrate has been accelerated because residues (Oxides, abrasive material, Chlorides) exist at the first 4 hours of exposure and gradually convert from spot distribution to pinpoint distribution after 24 hours of exposure. 2) The short-term corrosion on substrate ABT treated by either steel grit or alumina grit within 4 hours is linearity, after 4 hours the increasing tendency has scaled decreases. And alumina grit has a positive effect on inhibiting the development of corrosion production than steel grit.

**Reference** 1) S. Kainuma and A. R. Kim: Fundamental Investigation of Adhering Method for NaCl Particle by Ultrasonic Spray and Its characteristics, Rust Presentation & Control, Vol. 64, No.6, 2020. 2) Bard, A.J, Parsons, R, Jordan, J: Standard Potentials in Aqueous Solution, Marcel Dekker, New York, 1985. 3) J. Luo, G. Li, M. Rao, Zh. Peng, Y. Zhang, T. Jiang: Atmospheric leaching characteristics of nickel and iron in limonitic laterite with sulfuric acid in the presence of sodium sulfite, Minerals Engineering, Vol.78, pp.38_44 ,2015.