

Survey and Evaluation on Corrosion Protection Coatings for Concrete Structures of Wastewater Treatment Plants

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ABSTRACT

The corrosion protection coatings for concrete structures of wastewater treatment plants began to be applied generally from 1990s' in Japan. Based on its research results, Japan Sewage Works Agency published technical guideline concerning the corrosion protection coatings for concrete structures of wastewater treatment plants. The guideline has dealt with resin lining method, painting type and sheet type. Recently, the guideline has included sulphuric acid resistant mortar.

In 2010, Japan Sewage Works Agency and Japan Concrete Erosion Prevent Association conducted a survey, in which questionnaires were sent to 900 local authorities that applied concrete protection coatings on concrete structures of sewerage facilities. This report summarized the results of the survey.

Keywords, Corrosion protection coating, Resin lining, Painting type, Sheet type, Sulphuric acid resistant mortar

1. PURPOSE

Corrosion of the concrete structures of the wastewater treatment plants is mainly caused by sulphuric acid, which was originated from sulphur in wastewater. The purpose of the survey was to investigate actual condition and maintenance situation of the corrosion protection coatings for the concrete structures of wastewater treatment plants.

2. SURVEY METHODS

Japan Sewage Works Agency and Japan Concrete Erosion Prevent Association sent the questionnaire to local authorities concerning the concrete protection coatings in 2010. The number of the local authorities, which answered the questionnaires, was about 600. Analysis was conducted based on the collected replies.

The questionnaire was consisted of the following items;

- (1) Wastewater treatment process
- (2) Facilities where corrosion protection coatings were applied
- (3) Type of corrosion protection coatings
- (4) Surrounding environment of corrosion protection coatings
- (5) Time when corrosion protection coatings were applied
- (6) Measurement of hydrogen sulphide gas
- (7) Inspection of corrosion protection coatings, and condition of corrosion protection coatings
- (8) Repair works of corrosion protection coatings
- (9) Opinion, request, or comment concerning corrosion protection coatings

3. RESULTS

The results of the survey are summarized as shown follows.

3.1 Type of corrosion protection coatings

Total of the replies consisted of 724 wastewater treatment facilities and 671 sludge treatment facilities. Figure 1 and 2 show type of concrete protection coatings for wastewater treatment facilities and sludge treatment facilities, respectively. Painting type resin lining occupied 620 (86%) for sewage treatment facilities, and 535 (80%) for sludge treatment facilities. The sheet type resin lining was 35 (5%) for wastewater treatment facilities, and 42 (6%) for sludge treatment facilities. We think that painting type was selected because the painting type is more economical than sheet type. Also, because sulfuric acid resistant mortar was developed recently, application of sulfuric acid resistant mortar was limited.

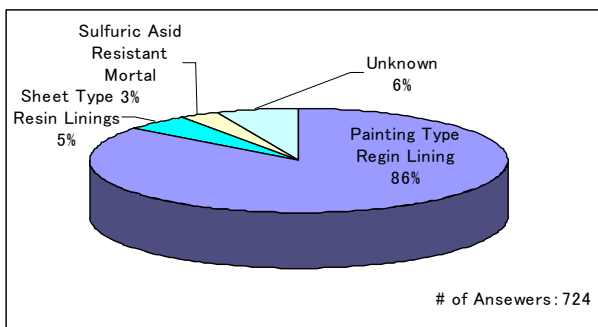


Figure 1. Type of corrosion protection coating (wastewater treatment facilities)

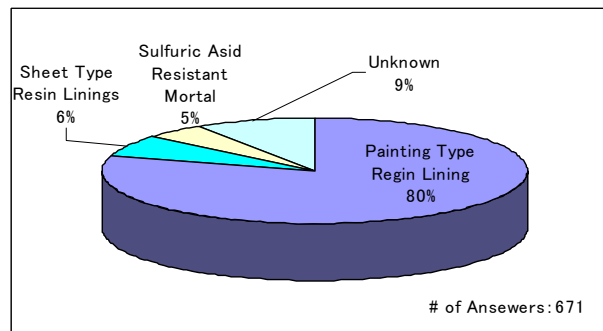


Figure 2. Type of corrosion protection coating (sludge treatment facilities)

3.2 Measurement of hydrogen sulphide gas

We asked whether hydrogen sulphide gas concentration was measured in wastewater treatment facilities (Figure 3) and in sludge treatment facilities (Figure 4). Figure 3 shows the number of the reply ‘yes’ was 129 (18%) in total number of reply, 708. Figure 4 show the number of the reply ‘yes’ was 156 (24%) in the total number of reply, 648.

This result indicates that the risk of hydrogen sulphide gas to the concrete corrosion of the wastewater treatment facilities may not be understood well; or, due to their budgetary limitation, measurement of hydrogen sulphide gas may not be done generally. Measurement of hydrogen sulphide gas is important to prevent concrete deterioration. Thus, importance of measurement of hydrogen sulphide gas must be emphasized.

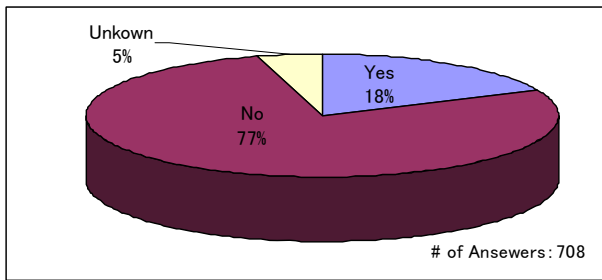


Figure 3. Measurement of hydrogen sulphide gas (wastewater treatment facilities)

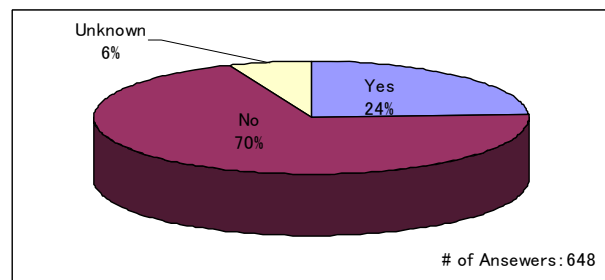


Figure 4. Measurement of hydrogen sulphide gas (sludge treatment facilities)

3.3 Inspection of the corrosion protection coatings

We asked whether inspection of the concrete protection coatings had been done. Figure 5 and 6 show inspection of corrosion protection coatings for wastewater treatment facilities and sludge treatment facilities, respectively. Figure 5 shows the number of the reply ‘yes’ was 182 (26%) in total number of reply, 700. Figure 6 shows the number of the reply ‘yes’ was 186 (29%) in the total number of reply, 645.

Although operational staff understands the importance of inspection, such inspection may not get enough budgetary support. In wastewater treatment plants, operation/maintenance of machinery and electrical equipment have the first priority for financial aspect. These results show that inspection of the corrosion protection coatings was not conducted generally. Thus, importance of the inspection must be emphasized.

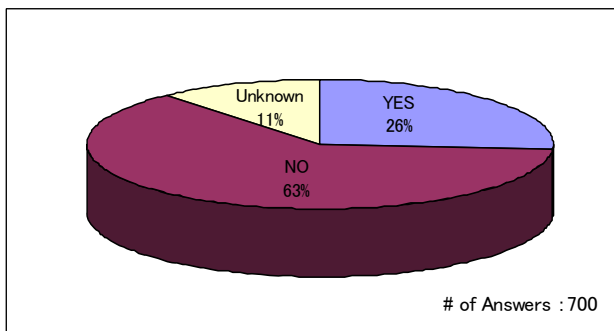


Figure 5. Inspection of corrosion protection coating (wastewater treatment facilities)

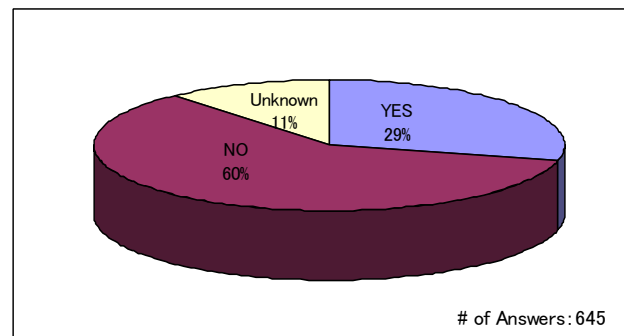


Figure 6. Inspection of corrosion protection coating (sludge treatment facilities)

3.4 Condition of the corrosion protection coatings

We asked condition of the corrosion protection coatings; whether pinholes were found, and whether any unhealthy situation was found at edge and convex corner of the corrosion protection coatings. The number of yes, which means any pinholes or unhealthy situation was found, was 42 (6%) in total number of reply, 720, concerning wastewater treatment facilities (Figure 7). Also, the number of yes was 52 (8%) in total number of reply, 648, concerning sludge treatment facilities (Figure 8).

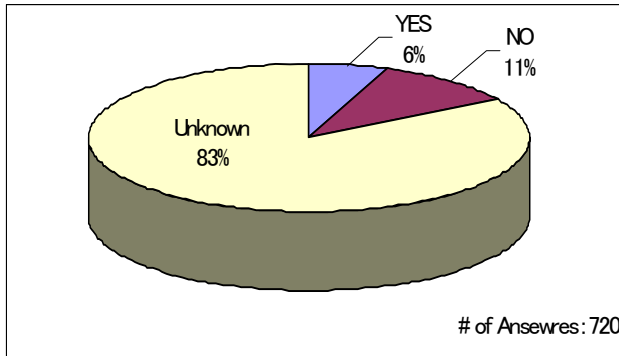


Figure 7. Unhealthy condition of coatings (wastewater treatment facilities.)

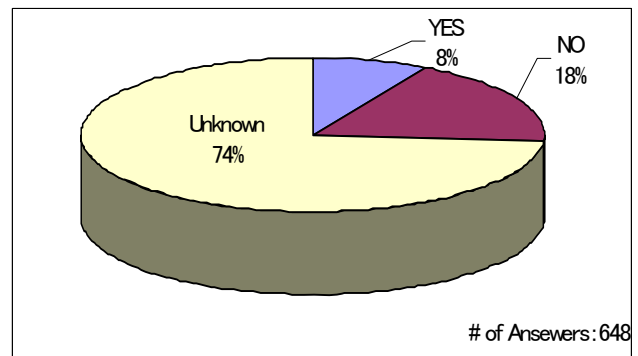


Figure 8. Unhealthy condition of coatings (sludge treatment facilities.)

Most of the reply was 'unknown'. Even though inspection was done, it is thought to be difficult to find any unhealthy situation for staff working at wastewater treatment plants. Expert is necessary to inspect corrosion protection coatings from this finding. Photo 1 shows pinholes of concrete protection coatings in the last stage. If such pinholes are found in early stage, it is possible to prolong the life of the coatings with small expenditure.



Photo 1. Pinholes of concrete protection coatings

3.5 Repair works of corrosion protection coatings

We asked whether corrosion protection coatings had been repaired. Figure 9 and 10 show repair works of corrosion protection coatings for wastewater treatment facilities and sludge treatment facilities,

respectively. The repair work had been done at 53 (7%) wastewater treatment facilities (Figure 9). Also, the repair work had been done at 58 (9%) sludge treatment facilities (Figure 10).

Less than 10% the facilities had been repaired; however, these numbers are more than our expectation. From this result, it can be said that inspection should be done as early as possible to maintain corrosion protection coatings healthy.

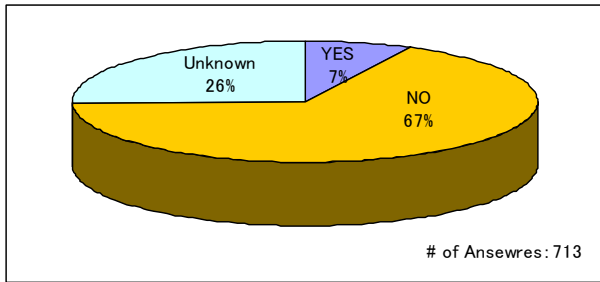


Figure 10. Repair works of corrosion protection coatings (wastewater treatment facilities)

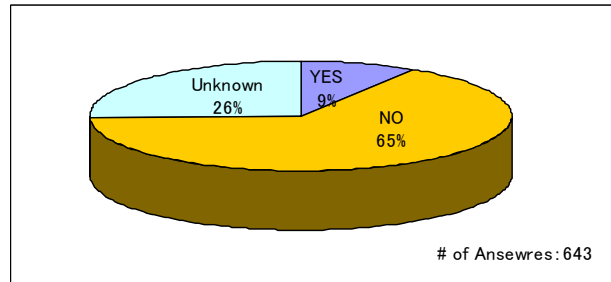


Figure 11. Repair works of corrosion protection coatings (sludge treatment facilities)

3.6 Location of the repair works of corrosion protection coatings

Figure 12 and 13 show the location of the repair works of corrosion protection coatings for wastewater treatment facilities and sludge treatment facilities, respectively. The number of reply concerning location of the repair works consists of wall area 36 (49%), edge part 19 (24%), convex part 14 (19%), and entire surfaces 6 (8%) in wastewater treatment facilities (Figure 12). Wall area occupies about a half of the reply.

Concerning sludge treatment facilities, the number of reply on location of the repair works consists of wall area 55 (44%), edge part 26 (21%), convex corner 26 (21%), and entire surfaces 17 (14%). Wall area occupies about a half of the reply. Compared to the wastewater treatment facilities, percentage of 'entire' is about twice. It may be the reason of this result that, in sludge treatment facilities, the density of hydrogen sulphide gas is usually higher than that of wastewater treatment facilities.

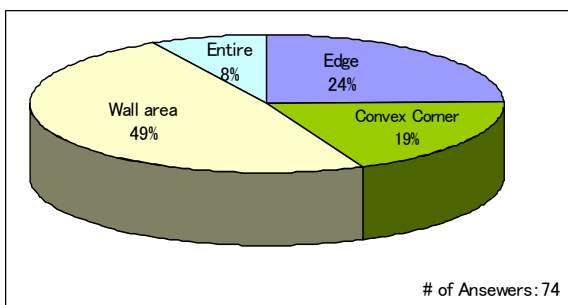


Figure 12. Location of repair works of corrosion protection coatings (wastewater treatment facilities)

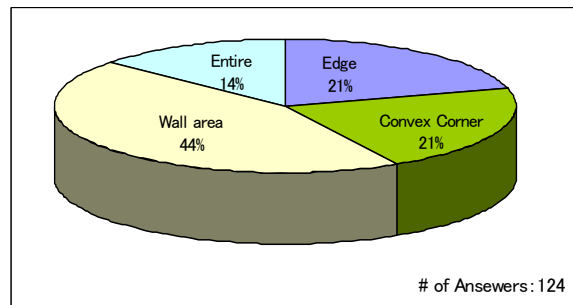


Figure 13. Location of repair works of corrosion protection coatings (sludge treatment facilities)

3.7 Situation of the unhealthy part of corrosion protection coatings

Generally, the unhealthy situation of concrete protection coatings proceeds from swell (see Photo 2), crack, peeling off (see Photo 3) and finally loss. Figure 16 and 17 show the situation of the unhealthy part of corrosion protection coatings for wastewater treatment facilities and sludge treatment facilities, respectively.

In wastewater treatment facilities, ‘peeling off’ occupies 43%. Also, in sludge treatment facilities, ‘peeling off’ was 45%. Swell often proceeds peeling off. At the stage of swell, corrosion protection ability is still functioning, but corrosion protection ability is lost at the stage of peeling off because the concrete surface is exposed directly to the atmosphere. It is important to inspect the condition of corrosion protection coating at the early stage of deterioration.



Photo 2. ‘Swell’ of concrete protection coatings



Photo 3. ‘Peeling off’ of concrete protection coatings

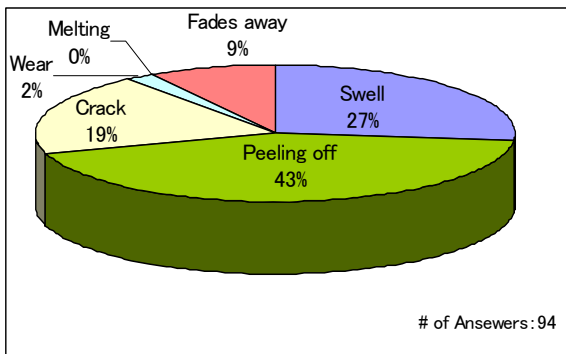


Figure 14. Details of unhealthy situation of corrosion protection coating (wastewater treatment facilities)

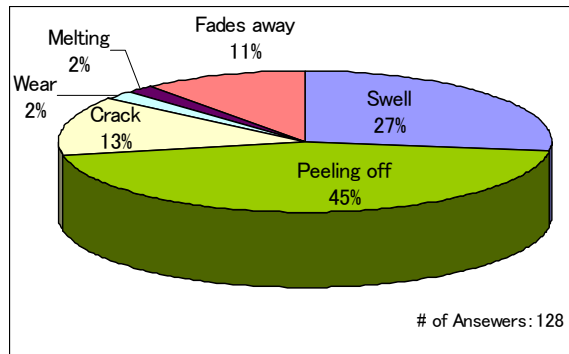


Figure 15. Details of unhealthy situation of corrosion protection coating (sludge treatment facilities)

4. CONCLUSION

- Concerning the type of corrosion protection coatings, painting type resin lining method was about 80 %.
- There were many places where the measurement of the hydrogen sulphide gas density had not carried out in all of the wastewater treatment facilities and sludge treatment facilities.
- There were many places where the inspection and survey of corrosion protection coatings had not been carried out yet. It is recommended that inspection of corrosion protection coatings should be done more frequently to find any unhealthy situation and thus to repair in earlier stage.
- There were many replies of 'unknown' to the question on unhealthy situation of corrosion protection coatings.
- The locations, where unhealthy situation was found at various places, like wall area, edge, and convex corners.
- Main cause of unhealthy situation was not identified in this study. More study should be done to analyse this subject further.