MAINTENANCE OF ROLLING GATES – PIANC WG 173

by

Timothy Paulus[1]

1. INTRODUCTION

Maintenance of rolling gates is a major consideration since many of the components are underwater. This can be up to 70% of the components depending on the gate design. As such, rolling gates need to be designed to minimize maintenance requirements. The wear of the lower rail tracks is a major problem for many rolling gates including the Belgian locks. Therefore, like in Germany, special maintenance cofferdams were developed to provide access to these tracks and to enable the change of rails. The gate recess should also be designed as a dry dock with bulkhead provisions. Sediment and debris needs to be controlled as the gate moves across the lock chamber. The Belgian locks in Antwerp utilize mixers and a venturi system to keep sediment from settling as the gate is moved across the lock chamber. The inlet openings of the venturi system are easily clogged with debris. So, in recent installations, the inlet of the venturi system was placed in a vertical position. This mounting position gives better protection against clogging.

Condition monitoring of equipment is recommended for the drive machinery. Items of major and recurring maintenance include gear boxes, wire ropes, bearings (greased or greaseless), wear surfaces, lubrication, paint, anodes, and rails. Wire rope supports include both rollers and wear pads and both need to be designed to prevent damage to the wire rope. The guide roller system will reduce friction compared to a sliding system and will reduce the required power for the driving machinery. The wear on a guide roller is limited and the life time expectancy is high. Disadvantage for such a system is its reliability and required maintenance. For rack and pinion driven rolling gates, the alignment is a critical consideration and needs to be verified on a periodic basis. The lubrication of the drive system on rolling gates is a significant maintenance effort. Drive systems need to be designed with maintenance considerations in mind. The use of environmentally acceptable lubricants is recommended. The Port of Antwerp utilizes a maintenance frequency for their rolling gates. This includes moving the rolling gate with the emergency driving unit every 3 months, testing the emergency power supply (diesel generator) every 2 weeks, visual inspection of the 4 installed mixers every year, visual inspection of wire rope every 2 months plus re-tensioning as required, change the under carriage wagon every 20,000 movements, remove the accumulated debris with crane and divers every 6 months, and inspection of the ballast chambers every 6 months.

2. MAINTENANCE FREQUENCY

The designs of the rolling gates at the Bremerhaven Port noted several other considerations. The carriages there are usually changed every 7 years by lifting and floating up the gate and putting it aside. The regular change out interval for the gate is 15 years. The rails are designed to last for 30 years. Under water inspections of the gate hull, wagons and rails happen 2-3 times per year by an in-house diving team. The Port of Antwerp utilizes a maintenance frequency for their rolling gates. A summary is provided below:

- Move the rolling gate with the emergency driving unit every 3 months;
- Test the emergency power supply (diesel generator) every 2 weeks;
- Visual inspection of the 4 installed mixers every year;
- Inspection of the ballast chambers every 6 months;
- Monitor the weight at the 2 load cells every 3 months plus graph;
- Visual inspection of the inside of gearbox every year;

[1] U.S. Army Corps of Engineers, St. Paul District, timothy.m.paulus@usace.army.mil

- Oil samples of gearboxes once per year;
- Visual inspection of steel rope every 2 months plus re-tensioning as required;
- Change the under carriage wagon every 20,000 movements;
- Remove the accumulated debris with crane and divers every 6 months.

3. COLD WEATHER OPERATION

Ice can hinder the operation of rolling gates. In countries even with a moderate climate, cold weather can play a role in rolling gate operation. For instance the Krammer lock in the Netherlands is equipped with several systems to deal with icing. To avoid the building of ice in the gate chamber, a low flow compressed air bubbler system and an electric heating system on the waterline of the gate chamber walls are used. To avoid the blocking of the gate by floating ice when the gate is being closed, a high flow compressed air bubbler system is installed at the gate recess. Both air bubbler systems bring warmer water near the bottom towards the surface.

Ice and debris control systems utilizing compressed air bubbler systems are used on many USACE locks and navigation structures. These systems also are used on the St. Lawrence Seaway and European navigation structures. There are other means to address ice conditions at navigation structures, including mixers and heaters.

4. PORT OF ANTWERP

Some general considerations can be provided from the Antwerp Port Locks and rolling gates. One significant consideration is to avoid overload of tracks and carriages to reduce power consumption and damages. Other considerations include:

- Use of mixers to remove the sediment from the top of the buoyancy tanks;
- Use a venturi system to move the sediment away from the lower track and carriage;
- Measure weight onto the carriages by means of load cells – real time load measurement;
- Use heavy load rails;
- Follow replacement strategy for undercarriage replacement. Undercarriages are exchanged every 20,000 cycles with a spare one.

Some rails have been in use for over 50 years before being replaced. Rails should be replaced preventively as the highest risk for damages are loose rails as a result of worn anchor bolts. A special dewatering caisson has been employed to facilitate rail maintenance without dewatering the lock.

For the Port of Antwerp, one action is to monitor on a long term period, the most important process parameters, one of which is the motor current. An increase of this parameter indicates a change of the situation of the rolling gate. By monitoring, they expect to detect technical defects at an early stage. The second action is to acquire data of the sealing capacity of the combination wood-freestone/concrete of the rolling gates plus the wheel gates. The plan is to check the loss of water during a planned shutdown of the lock of several rolling gate combinations. All the activities are written down in a database system which produces work orders automatically. The frequency of the work orders is related to the number of movements (historical data, not actual). The more movements, the higher the frequency of work order generation. The work orders are grouped per type of asset (hydraulic wheel gate, rolling gate, bascule bridge, Strauss bridge, etc.) and produce a general description of the maintenance activities.

To execute the maintenance activities, a shutdown of the lock is often required. Therefore, the Port of Antwerp has successfully implemented fixed maintenance windows of typically 8 hours. These shutdowns are scheduled a long time in advance and allow detailed planning together with a planned impact on vessel traffic. Other maintenance activities are done while the lock is in operation. The availability of the lock is the main driver, and its short term target must be above 98.5%.

REFERENCES

PIANC. (2017). Report of Working Group 173: Movable Bridges and Rolling Gates, Design, Maintenance and Operation Lessons Learned, PIANC, Brussels.