Appendix

Method Statement

Use of Cofferdams for the purpose of constructing

Bridge Foundations and Substructures

The use of cofferdams in the construction of bridge foundations in watercourses is standard practice in the construction sector. Due to the technical challenges involved, the span configurations of bridge structures are designed as far as practical to avoid the need for cofferdams. Nevertheless, there are situations where the construction of foundations within a watercourse is unavoidable.

This method statement describes the processes in the design, construction and removal of cofferdams, and the mitigation measures aimed at minimising the impact on the watercourse.

1. Introduction

- Cofferdams are temporary enclosures to keep out water and soil so as to permit dewatering and construction of the permanent structural elements dry conditions.
- A cofferdam involves the interaction of the structure, soil, and water. The loads imposed include the hydrostatic forces of the water, as well as the dynamic forces resulting from currents and waves.
- In the construction of cofferdams it is difficult to maintain close tolerances since cofferdams are usually constructed in flowing water and sometimes under severe weather conditions. Under these circumstances, significant deformations of cofferdam elements may happen during the course of construction, and therefore it may be necessary to deviate from the design dimensions in order to complete the project according to plan and in time.
- The loads imposed on the cofferdam structure by construction equipment and operations are considered, both during installation of the cofferdam and during construction of the permanent structure itself.
- Removal of the cofferdam is planned and executed with the same degree of care as its installation, on a stage by stage basis. The effect of the removal on the permanent structure must also be considered. For this reason, it may be necessary that sheet piles extending below the permanent structure are cut off and left in place, since their removal could disturb the foundation soils and gravels in the river bed adjacent to the structure.
- In cofferdam construction, safety is of paramount importance, since workers will be exposed to the hazards of flooding and collapse.
- Safety requires that every cofferdam, and every component thereof, shall be of robust design and construction, of suitable and sound materials and of sufficient strength and capacity for the site conditions in which it is used.

- Proper construction of the cofferdam, verification that the structure is being constructed as planned, monitoring the behaviour of the cofferdam and surrounding

area, provision of adequate access, light and ventilation, and attention to safe practices on the part of all workers and supervisors is required.
- Finally, the cofferdam construction shall be properly maintained.

2. Advantages of Cofferdams

Some of the advantages of cofferdams are:

- Facilitates the excavation and the construction of structures in an otherwise poor environment.
- Provides a safer working environment.
- Contractors typically have design responsibility as the experienced contractors have developed their own techniques and systems.
- The sheet piles typically used are easily installed and removed.
- Materials can often be re-used on other parts of the same project or other projects.

3. Installation of Cofferdams

The sheet piling operations typically used, require completion of the following stages for successful construction :

- Competent site investigation, sampling and relevant testing to build up an informed picture of the task.
- Adequate design of all the stages of the construction.
- Proper setting out and installation of the piles.
- Strict adherence to all health and safety requirements.

Items needed for installation are:

- Survey and setting out to fix the correct location.
- Pile driving hammer. (vibratory or impact).
- Crane of sufficient size.
- Steel sheet piles.
- Wide-flange beams for wales and stringers.
- In specific cases, barges may be required for efficient installation.

It is generally specified that work in watercourses is carried out during periods of low average rainfall. This reduces the risks inherent in their construction. Further, the lower stream flows reduce the risks of scour and disturbance of sediment in the river beds during construction. A Hazard Identification and Risk Assessment, together with mitigation measures, is required from the designer.

The installation of cofferdams is described in detail in the reference manuals noted at the end of this method statement. Particular reference shall be made to SANRAL's Construction Monitoring Manual for Bridges and Structures – 1st Edition 2011 – Chapter 4.8, and to the COLTO Specifications.

4. Imposed loads on Cofferdams

A typical cofferdam will experience several loading conditions during installation and during the various construction stages. The significant forces are:

- Hydrostatic pressure
- Pressures due to soil / gravel loads
- River currents
- Wave forces from floods
- Impacts from debris carried by floods
- Ice forces – unlikely on the project under consideration
- Seismic forces
- Accidental loads

5. Construction Method at each Foundation

5.1 Pre-dredge to remove soil or soft sediments and level the area of the cofferdam.
5.2 Drive temporary support piles.
5.3 Temporarily erect bracing frame on the support piles.
5.4 Set steel sheet piles, starting at all four corners and meeting at the centre of each side.
5.5 Drive sheet piles to grade.
5.6 Block between bracing frame and sheets, and provide ties for sheet piles at the top as necessary.
5.7 Excavate inside the grade or slightly below grade, while leaving the cofferdam full of water.
5.8 Drive or otherwise construct bearing piles.
5.9 Place rock-fill as a levelling and support course.
5.10 Place underwater tremie concrete seal.
5.11 Check blocking between bracing and sheet piles.
5.12 Dewater.
5.13 *End of cofferdam construction.*
5.14 Construct new permanent foundation and substructure of the bridge.
5.15 *Start of cofferdam removal.*
5.16 Flood cofferdam.
5.17 Remove sheet piles.
5.18 Remove bracing.
5.19 Backfill as required.

6. Conclusion

Every cofferdam is unique and requires thorough analysis. The designer must take into account a large number of parameters. The design must be compatible with the flow patterns of the watercourse, the expected weather conditions, waves, currents, construction equipment, construction methods, permanent structures and ground conditions.

As soon as reliable geotechnical information is available, comparable cost studies should be analysed to determine if the cofferdam method should be favoured over other techniques, such as pre-cast or caisson construction.

References:

1. SANRAL : Drainage Manual – 6th Edition 2013
2. SANRAL : Geometric Design Guidelines
3. COLTO : Standard Specifications for Road and Bridge Works, specifically Section 6100.
4. SANRAL : Code of Procedures for the Planning and Design of Highway and Road Structures in South Africa – 1st Edition 2002, updated 2008.
5. SANRAL : Construction Monitoring Manual for Bridges and Structures – 1st Edition 2011 – Chapter 4.8.