CALTEX 610 Ø JETTY PILE WRAP TRIAL

CALTEX REFINERY SINGAPORE 9TH JUNE 1998

TECHNICAL REPORT

AND

RECOMMENDATION

RETROWRAP (STD) WRAPAROUND PILE

ENCAPSULATION SYSTEM

PREPARED BY

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INTRODUCTION

Two x two meter interlocking Retrowraps (Std) Splash Zone Corrosion Protection Wraps were installed on a 610mm pile by divers at the Caltex Refinery in Singapore where the total protected length provided equated to 4 meters and the maximum tidal range is 3 meters.

Prior discussions between Cathodic Protection Technology (CPT) and Caltex suggested that an easily installable one piece system was required which could accept minimum substrate preparation without impairing the long term performance of the system. Also there is the facility of easy removal and replacement to facilitate routine inspection of the riser substrate at regular intervals throughout the design life.

Since Retrowrap is a cold applied system not requiring shot blasted substrate preparation, installation was not restricted by the requirement of a hot work permit which simplified the issue of the work permit.

The installation was carried out under the technical supervision of the writer on the 9th of June 1998 using divers employed by Commercial Diving Services.

Substrate cleaning was limited to hand removal of marine growth and delaminated coal tar epoxy coating. The divers selected had no previous experience of the system.

After completion of the installation it was agreed that an engineering report and recommendation should be prepared based upon the actual experiences gained during the installation and to writer's findings relating to establish finishing operations in Singapore using materials supplied by Caltex and facilities provided by CPT.

8th of JUNE 1998 **2**

The crate containing installation tools and the upper and lower 24" x 2m wraps cleared customs and was delivered to the Cathodic Protection Technology factory by mid morning awaiting arrival of the Commercial Diving Services representative (CDS).

A training session was arranged for CPT staff followed by the viewing of the wraps and closure tools. Later in the afternoon, the diving company representative was instructed in the wrap installation procedure, with particular emphasis placed on the overlap interlocking of the upper to the lower units. The wraps were repacked and loaded on the CDS truck for delivery to the diving vessel.

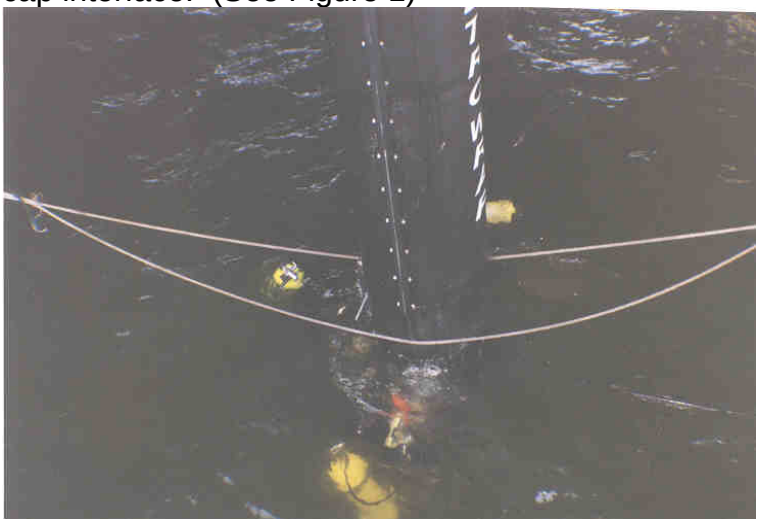
The meeting concluded with CPT undertaking to arrange security passes for the divers and the vessel to enter into the waters adjacent to the Caltex jetty.

9th of JUNE 1998

The writer, together with CPT, visited the jetty to learn that CDS had in fact arrived in a "40' workboat" with no pontoons or small craft suitable for working under the jetty.

In consideration of above and since the tide was still rising and the wrap needed to be installed in a manner where maximum visibility was available to those observing the installation, the writer decided to reverse the installation by partially installing the upper wrap first. It was followed by the underwater installation of the lower wrap then continuing the upper wrap installation over the integrated circumferential seal extending from the lower wrap.

With no small boat available, it was necessary to rig a double rope sling "cats cradle" to provide the divers with working access to the underside of the pile/pile cap interface. (See Figure 1)



Double rope access slung from adjacent piles with lateral stabilizing ties

Figure 1

PILE CLEANING 3

Since Retrowrap provides active corrosion protection by the reaction of corrosion inhibitors contained within the thixotropic gel impregnated into the inner layer of the wrap surface, substrate preparation is reduced to its simplest form. The divers were able to manually prepare the pile by using long handled scrapers in approximately 15 to 20 minutes for the total 4 meter length required to a standard acceptable to CCI. (See Figure 2)

Underwater photograph of substrate preparation after removal of marine growth and delaminated pile coating

Figure 2

TOP SEAL

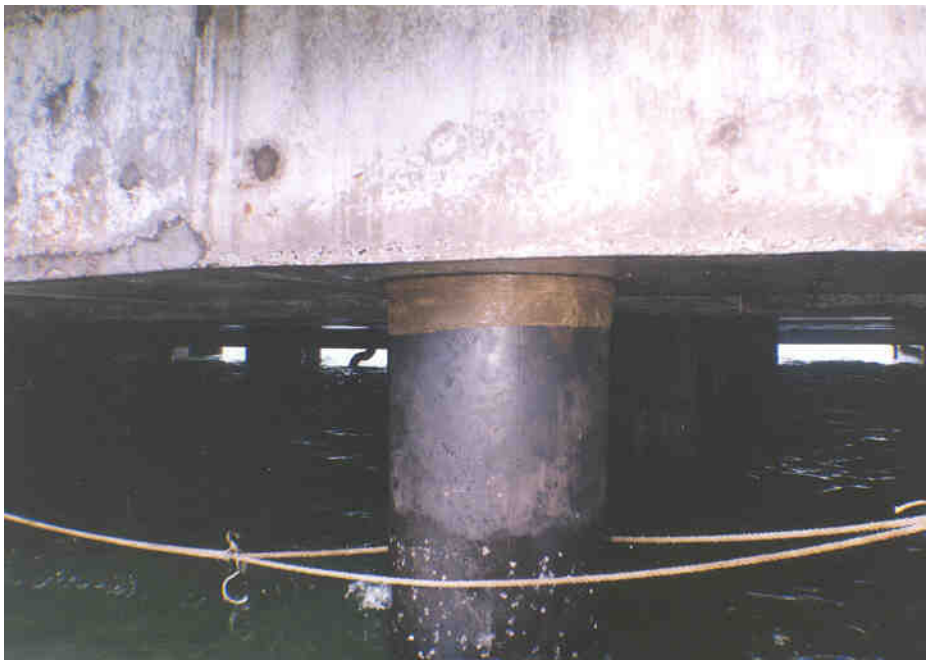
To insure a good seal at the pile/pile cap interface, CCI recommended the use of a supplementary top seal for both vertical and racker piles.

Experience gained over 13 years of similar installation has demonstrated on multiple occasions that if provision can be made for human error within the design installation efficiency e.g. quality and the installation time significantly improved with the divers acknowledgment that every effort has been made to reduce the complexity of their task.

Top seal comprises of a 150mm x 2mm x 10m roll of polyester felt impregnated with the same thixotropic gel as used within the wrap panel. The tape is wrapped around the pile interface such that 100mm overlaps the vertical pile while 50mm is positioned against the pile cap to form a roughly triangular section collar. (See Figure 3 & 4) Note: The top seal also makes allowance for the slight reduction, approximately 1 percent, with the wrap length during tensioning and provides the diver with a 50mm positioning tolerance when lifting the wrap into final position prior to closure.

Divers installing top seal tape while safely standing within cats cradle

Figure 3



Top seal in position. Note fillet extending over pile cap surface.

Figure 4

UPPER RETROWRAP INSTALLATION 5

Due to tide levels and lack of small boat access, the upper wrap (see figure 5) was installed by divers standing within cat cradle. The draw bolts shown were preinstalled in both closure flanges in opposing directions to provide the divers with lifting facilities prior to being driven using a compressed air operated impact wrench through the adjacent flanges (See figure 6).

Draw bolts extending from flanges to provide lifting facilities

Figure 5

Divers using compressed air impact wrench to tighten flanges.

Figure 6

Installation continued by exerting stainless steel 316L permanent fasteners between each draw bolt and tightening using a 9/16 socket fitted into an air operated impact wrench. At that point, the draw bolts were sequentially removed from the flanges working from the top down since for this application the draw bolts also provided “ladder access” for the divers to the upper section of the wrap. Installation was halted after 1.25m had been completely installed leaving 750mm, the lower section of the upper wrap, open to accept the circumferential sealing flap of the lower wrap.

LOWER WRAP INSTALLATION

Due to the divers not having any floating work platform, the upper wrap installation was tidal dependent. To conserve a maximum time frame in which observers could witness above water installation, the writer instructed that the lower wrap be installed by divers prior to the completion of the upper wrap.

Before tensioning the wrap, the divers were easily able to lift the unit underwater to engage the underlap of the circumferential interlocking joint and repeat all tensioning operations as carried out for the upper wrap. Permanent bolts were fitted as shown in Figure 7 and the gel was observed to have exuded evenly around the lower edge of the wrap insuring a long-term satisfactory seal.

Underwater photograph showing gel exuding from lower edge flange ensuring that all surfaces under the wrap is fully encapsulated with gel.

Figure 7

Underwater photograph of gel exuding from Retrowrap flanges permanent fastener & locknut fully tightened.

Figure 8

UPPER RETROWRAP COMPLETION

With the arrival of the observers on board the diving vessel, installation of the upper wrap recommenced with the divers inserting draw bolts in the lower section of the upper wrap flanges. (See Figure 9)

Note: Thixotropic gel being exuded from closure as flanges are being tightened.

Figure 9

Upon closing the lower section of the flanges, the outline of the underlap seal was clearly visible in the outer skin. Permanent bolts were fitted. The remaining draw bolts were removed after final tensioning and the permanent fasteners fitted in the vacated holes completing the installation. (See Figure 10) Note: For the record, the writer would comment the divers should have been using a self powered industrial compressor in lieu of the small paint spray compressor which had proved totally inadequate to operate the impact wrench on a continuous basis. This resulted in the wrench continuously stalling under load the results being a considerable increase in installation time. See installation operation recommendations.

Note: Overlap 100mm joint section of lower wrap. Flange positioned approximately 90^0 from upper wrap flange.

Figure 10

INSTALLATION OPERATION RECOMMENDATIONS

Having completed the initial installation, the writer has now experienced the tidal conditions prevailing at the jetty. The following recommendations will significantly improve installation time and efficiency.

1. Work station. At least two floating work stations providing 360^0 working access be constructed to suit the 16"/24" (406mm – 610mm) pile and sized overall to permanent easy access between the piles under the deck. Each unit would be fitted with a 4-point mooring to insure stable positioning of the platform during installation operations. A dedicated simple design utilizing 200-liter plastic drums as buoyancy tanks can be provided by CCI.

2. Crew levels. A crew of 3 divers per work station each operating independently from the other installing upper and lower wraps as required depending upon the state of the tide.

3. Elevated access. Each station would be fitted with a removable 1m "step up" to facilitate access with the pile cap at low water.

4. The diving vessel should have an adequate diesel powered compressor with compressed air storage facilities capable of operating up to 4 impact wrenches. Each work station would have two wrenches--one fitted with 7/8" (22mm) A.F. extended socket for tensioning of draw bolts; the other a 9/16" (14mm) A.F. extended socket for tightening of the permanent fasteners. By this method, constant changing of the sockets can be avoided with significant time saving.

CONCLUSION

From the demonstration detailed in this report we trust that all concerned will agree as to the ease of installation and the superior appearance and performance of our one piece active corrosion protection system. For the record, we take this opportunity to confirm that when installed by well trained divers using the installation equipment and methods as recommended, a 24"Ø (610mm) x 2m wrap should be installed in an average time of **45 minutes** on a precleaned pile where two teams of divers work in a coordinated manner from properly constructed work platforms and an adequate compressed air supply.

Therefore, using two teams of three divers, 8-10 number 24"Ø (610mm) x 4m piles per day which when added to the supply cost of the Retrowrap system will significantly reduce the installed price to that compatible with the supply and installation price of the system previously used on this project.

These trials have been conducted in a similar manner to those performed for Shell, Aramco, Exxon, BP, Mobil, Total, the Port Authority of New York and New Jersey, General Dynamics, and Maraven, Venezuela. CCI hopes we have demonstrated the suitable and long term cost effectiveness of the Retrowrap system for the protection of jetty piles where the additional feature of easy removal and replacement to facilitate routine and substrate wrap inspection or repair, in the unlikely event of accidental damage.

Completed installation of upper wrap. Note top seal forced against pile cap by induced tension within wrap and outline of interlocking seal of lower wrap

Figure 11