ZENITH

Flare Tip Replacement, Norway – Concept, Design & Execution

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This paper is intended to provide an overview of a flare tip replacement, completed in Norway, where the client wished to form a different project approach than the traditional crane lifting technique formally deployed.

1. Background

The project in Bergen, Norway was to change out a defective combustion flare tip of a one hundred metre high stayed wire supported elevated flare structure. The flare tip was to be changed out as part of a regular maintenance program with minimum impact on productivity.

The change out process is a repetitive task with the normal course of action being the deployment of a heavy duty lifting mobile crane. The deployment of a crane was rejected by the owner due to on-site issues.

The existing flare tip had a total weight of 3200 Kg, the new flare tip weighed 6700 Kg. Therefore the existing lifting derrick in-situ, incorporated in the original design, was not designed to lift this increased weight.

Figure 1 shows a general drawing of the flare tip.

In consultation with the client's team, combustion engineers and a specialist height contractor a new proposal was developed.

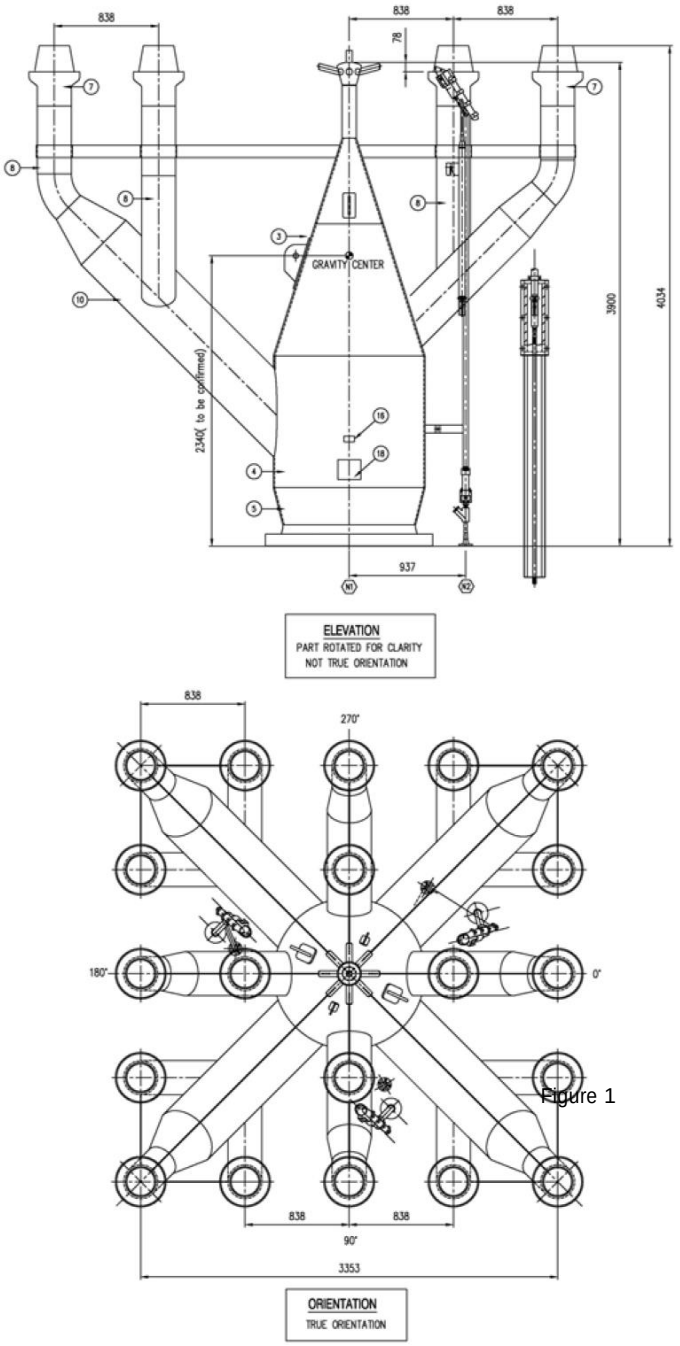

Figure 1

2. Constraints

The major constraints at the planning stage included the following:- (This list is not exhaustive).

2.1 Replication of Site Conditions

Prior to carrying out work on-site, the client approached Zenith requesting the replication of the proposed lifting technique by designing, fabricating and erecting a temporary tower and replica flare tip to ascertain the feasibility of the solution proposed.

2.2 Time line

The flare stack would be available to carry out tip replacement for a period of just 5 days.

2.3 Inclement Weather

Although the project was to be carried out during the month of August, the location of the site, on the west coast of Norway, meant that there could be no assurance of calm weather conditions.

2.4 Existing Flare Stack

Would the existing flare stack structure be suitable for the increased weight of the new flare tip?

2.5 Economics

The parties to the contract worked to provide a solution that was both a success on this project and could offer substantial savings in the medium to long term.

2.6 Environmental Concerns

The existing flare tip resulted in the dispersal of excessive smoke into the atmosphere and the new option had to meet the demands of modern environmental concerns.

3. Other Factors

The client has a number of locations throughout Northern Europe. Could the system be adapted to carry out similar projects of this nature on other structures?

4. Appraisal

In order to deliver this project within the constraints a practical solution was sought. Using the experience gained on similar and dissimilar projects the provision of a purpose designed lifting davit was a preferred option at an early stage, which tackled all the constraints and also addressed the potential of repetitive deployment.

In preparing detail design for the lifting davit, two principal schemes were developed. The first detail design, constructed from typical super slim (RMD) units has rapid tie steel bars providing cross bracing for rigidity. The second detail design encompassed a heavy duty lifting davit post with a 180 degree rotation.

During further appraisal both schemes had favourable advantages. However, the critical factors that promoted the selection of the second scheme was the utilisation of the existing lattice frame superstructure to compensate for the over-turning moments and the speed and efficiency of erecting the davit post into position. Figure 2 shows a total deflection of 91.1mm identified at the design stage.

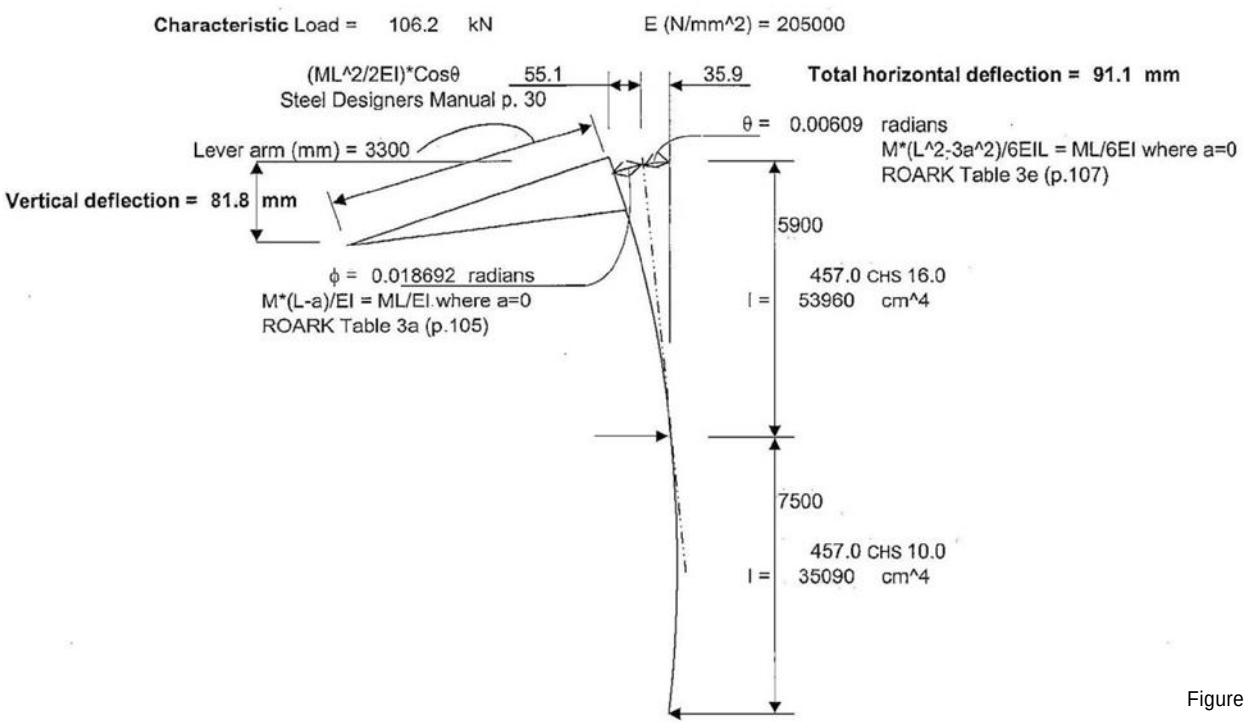

Figure 2

The design team used a number of standards in the development scheme. Of particular note in this option were the following British Standard –

BS 7333:1990 Specification for slewing jib cranes.
BS 6399:Part 2:1995 Loading for buildings. Code of practice for wind loads.
BS 8100-3:1999 Lattice towers and masts. Code of practice for strength assessment of members of lattice towers and masts.
BS 5950:Part 1:2000 Structural use of steelwork in building. Code of practice for design. Rolled and Welded sections.

The design team used this and a number of other sources that met the demands of Scandinavian and European Standards to compile detailed calculations to support the design. This included stress calculations on all individual components to prove that the collective would perform satisfactorily in the field and during the off-site replication. A STADD loading diagram was also used to simulate the stresses placed on the lifting davit and existing superstructure during the lift. All the calculations returned a satisfactory result and the scheme was developed in detail.

The final design provided a number of advantages including working capabilities of up to a wind speed of 11 Metres per second.

5. Regulations

With design and calculations complete the contractor then prepared their methodology to complete the task incompliance with the clients' team. The following regulations are applicable in the United Kingdom and were used as reference points.

Factories Act – 1961 & Subsequent Revisions
Construction Regulations (1960's)
Health & Safety at Work Act 1974
Management of Health & Safety at Work Regulations 1992 (Rev 1999)
Provision and Use of Work Equipment Regulations 1992
Construction (Design and Management) Regulations 1994.
Lifting Operations and Lifting Equipment Regulations 1998.
Work at Height Regulations 2005

Execution

6.1 Stage 1 – Off-site Replication of on-site conditions.

In order to achieve the project goal and to reduce the potential for unforeseen circumstances and to practically demonstrate the feasibility of the preferred option, an off-site replication of on-site conditions was carried out at Zenith's premises in Edinburgh, Scotland. A 20 metre high structure was designed, fabricated and erected onto a purpose constructed foundation. A mock flare tip was fabricated to replicate the profile and weight of the new tip.

Figure 3 shows a drawing of the 20m high replica lattice tower.

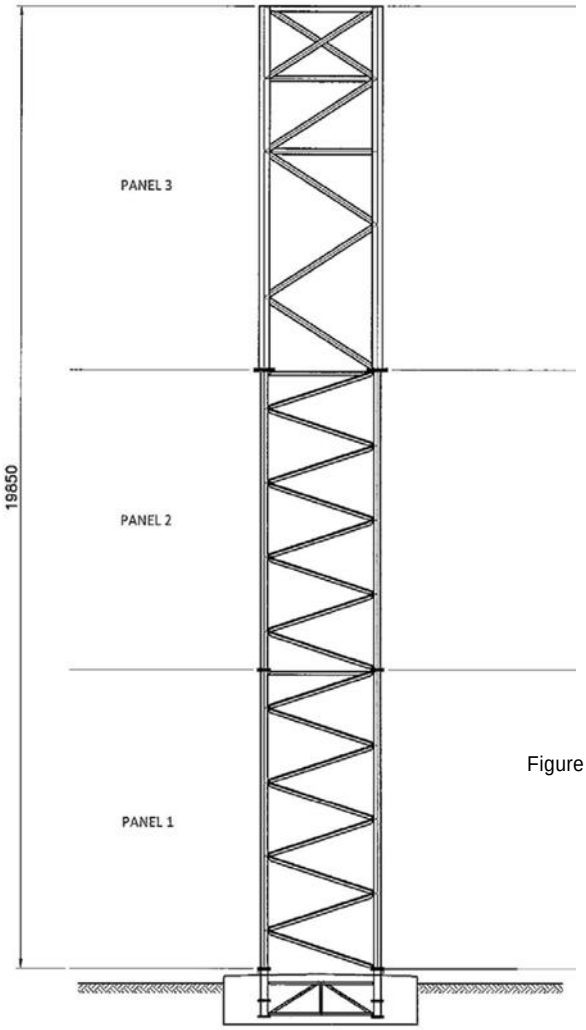

Figure 3

Figure 4 shows the construction of the purpose built foundation used during the off-site replication of on-site conditions.

Figure 4

A lightweight lifting davit was designed, fabricated and winched into position to facilitate the erection of the bespoke heavy duty lifting davit. The heavy duty lifting davit with a capacity of 6700 Kg was designed with 8375 Kg SWL. A slewing ring was incorporated into the design of the bespoke davit giving a rotation of 180 degrees allowing an accuracy of +/- 40mm at the flange mating position.

A number of potential problems were resolved at this stage following which a full demonstration was carried out to the satisfaction of all parties.

Figure 5 shows the erection of the replica tower.

Figure 5

Figure 6 shows the mock tip being erected into position using the purpose made heavy duty lifting davit.

6.2 Stage 2 – On-site execution.

Following the satisfactory conclusion of the off-site demonstration, site work in Norway proceeded as planned. However, due to unforeseen circumstances the project had to be executed within a 3 day period as opposed to the anticipated 5 day window of opportunity. Still, as a result of the experience gained at the demonstration phase, coupled with the wealth of knowledge gleaned from similar projects, Zenith was able to meet the challenge successfully.

Figure 6

Figure 7 shows the new tip being erected into position on-site in Norway.

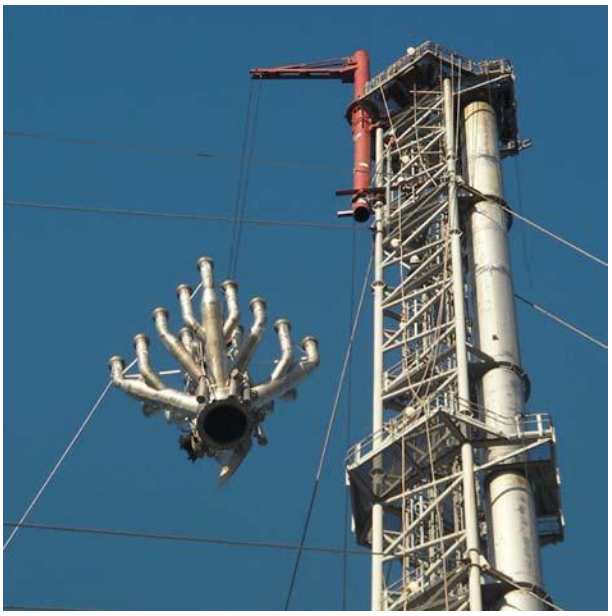

Figure 7

Figure 8 shows the efficiency of the new flare as compared to the obvious environmental impact of the old flare tip.

7. Conclusion

The key factors in preparing a successful scheme of this nature are:-

Understanding the client's goals and brief.
Compiling a competent team with a proven track record.
Communication between all parties.
Experience at all levels.
Planning.
Technical understanding and Superior Design.
Safe Work Procedure and Risk Assessment.
Execution.
Project Review.

Figure 8