ID: 2016-ISFT-221

A Study on Challenges for Mechanical Handling in a Modularised Project

Mani Ranjitha Sarma[1], Nitesh Patidar[2], Rohit Ranjan[3]

[1,2,3]*Fluor India Pvt. Ltd., Infinity-10B, DLF Cyber City, Phase II, Gurgaon, Haryana, India. 122002*
[1]*mani.r.sarma@gmail.com*

Abstract: *It is a fact that in a plant, all the equipment needs to be maintained at some point of the time and in case of a modularised one, the maintenance may be even more challenging. A plant has equipment ranging from a few kilos to several tonnes and it is the role of Mechanical Handling to provide with versatile and feasible solutions. In case of a modularised plant, the rigging and lifting operations are further hindered by module dimensions which result in lower available head clearances. So selection of the handling equipment has to be based on the best engineering judgement along with some very simple rigging calculations. Based on these calculations Ultra Low Headroom equipments may be used if clearance constraint is there. Usually for handling of plant elements, handling equipments used are port-a-davit, floor crane, runway-beam, pad eyes etc. If the walk-ways provided are obstructed by any plant element, are the walkways wide enough according to the guide lines? Is there sufficient head clearance for a person to pass without getting injured? Is the required rigging height available above the maintainable item? All these problems need to be addressed by Mechanical Handling. Thus space constraints of a module and interface among various disciplines like Piping, CSA and Electrical etc. make this even more challenging. Mechanical Handling offers solutions to a lot of practical problems which can be faced by a worker on-site and is it-self is challenged by module dimension and weight limitations thus making it even more challenging.*

Keywords: *Mechanical Handling, Modularisation, Design, Disciplinary interface.*

1. INTRODUCTION

While modularization is not new, the level of achievable offsite work has significantly increased using the Modular execution strategy. This execution model splits the project into process blocks and moves into designing modules.

Mechanical Handling (MH) can be broadly defined as handling of items weighing more than what a normal person can handle say 25kg or the items which are not easily accessible for a person to operate upon. For example, a 300 kg valve can be lifted by a floor crane of SWL 1000 kg, a 1000 kg valve can be removed when required for maintenance by a runway beam, equipment which is open to sky can be lifted by mobile cranes and a pump can be taken out for maintenance by an A-frame gantry and so on. Although MH is being dealt by piping design in almost all EPC projects, but in the age of Modularization clients want to transport and construct the entire plant in the form of modules, which saves a great deal of on-site labour and results in better quality of plant as well, but this in turn gives rise to a challenging aspect of designing units in a space constraint and hence making the equipments in the unit accessible whenever required which is taken care of by MH. Thus, achieving a module design such that all the handling requirements are met along with the safety is indeed a milestone for Piping and Civil-Structural-Architectural (CSA).

1.1 PROBLEM STATEMENT

In a modularized project, the entire plant is divided into modules having different gratings levels. Sometimes modules are further divided into different parts (Pre-assembled units or PAUs) as per transportation and fabrication constraints. All these equipments irrespective of the unit need to be maintained at some point of the time. The guidelines usually indicate that men should be able to safely carry a load of 25kg if held closely to the body at around waist height.

However, weights at arm's length above shoulder height are reduced to 5kg. The guideline weight for women is reduced with the maximum suggested weight being 16kg at waist [2]. In such cases we need to provide an ergonomic solution for handling such equipment and hence Mechanical Handling comes to play. A plant has equipment ranging from a few kilos to several tonnes and it is the role of Mechanical Handling to provide with safe, versatile and feasible solutions. In case of a modularised plant, the rigging and lifting operations are further hindered by module dimensions which result in availability of lower head clearances. So, it becomes really important to plan the handling arrangements, routes and layout such that those are accessible and do not add to the existing complexity of the module.

1.2 OBJECTIVES OF THESIS:

The two main objectives of this work are following-

i) To study the selection of appropriate methodology or equipment of Mechanical handling to lift different types of elements in modules of a modularized project.

ii) To study the design challenges arising for Mechanical Handling in modules, as a result of interface between various project departments like Piping and Civil-Structural-Architectural (CSA).

2. SELECTION OF MECHANICAL HANDLING METHODOLOGIES AND EQUIPMENTS IN MODULARIZED PROJECTS

There are numerous MH equipments in existence like runway beam, mobile crane, floor crane, padeyes and port-a-davits etc. which broadly come under fixed and portable equipments. All of these equipments have different Safe Working Load (SWL), pros & cons and which of them has to be used for our purpose depends on the best engineering judgement along with some very simple lifting calculations. But as we know that installation of permanent handling equipments would incur extra cost and result in increased weight of module, preference should be given to temporary ones like floor crane and material lift if feasible. Cross hauling shall be considered only when other options are not viable for lifting. Figure-1 shows a basic procedure of selection of Mechanical Handling equipments and table-1 depicts the order of precedence is preferred [1].

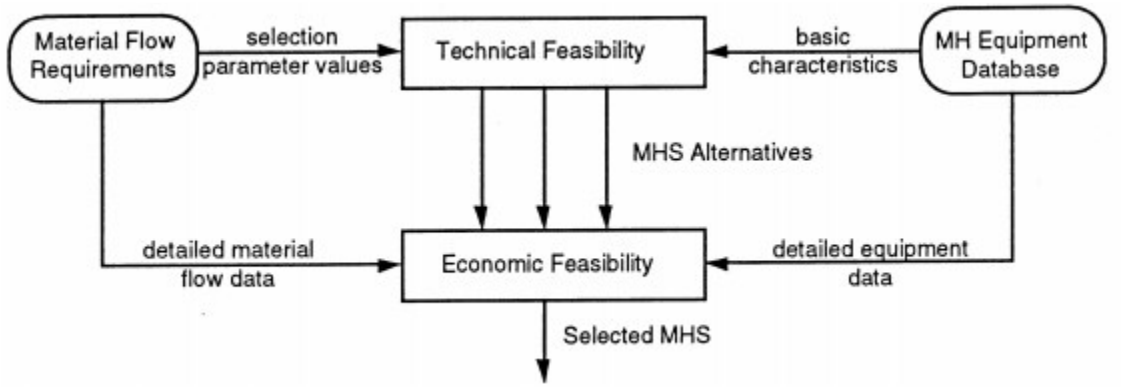

Fig. 1. Procedure for selection of Mechanical handling equipments [1]

TABLE 1: Selection of mechanical handling equipments for different purposes

(a) For Lifting	
<25kg	Manual handling (except in special case)
Up to 1000kg	Mobile & portable lifting equipments
Up to 2000kg	Padeyes & cross hauling
Up to 25000kg	Runway beam
For lifting & transportation	
All situations with access	Mobile crane, Tele-handler, material lift
All internal situation	Overhead traveling crane / gantry crane
Up to 25000kg	Runway beams
For transportation	
Up to 5000kg	Trolleys
>5000kg	Rail mounted trolley

2.1 RIGGING HEIGHT CALCULATION:

Shown below are some of the examples of how the minimum lifting height of any plant equipment (in this case valve) is calculated.

2.1.1 For Padeyes**:** A padeye is a device often found on boats that a line runs through, or provides an attachment point. It is a kind of fairlead and often is bolted or welded to the deck or hull of a boat. An example of padeye height calculation is shown in figure-2.

In a right angle, as shown in figure-2.

$\cos 30^0$ = Base/ Hypotenuse

$\cos 30^0$ = (355+142)/ (Sling length)

Or, Sling length = 497/ $\cos 30^0$ = 574 mm

Chain Pulley = 200 mm

Padeye = 200 mm

Hook and hoist = 150 mm

Therefore, available slinging length = {574-(200+200+150)} mm = 24 mm but, this length is not sufficient.

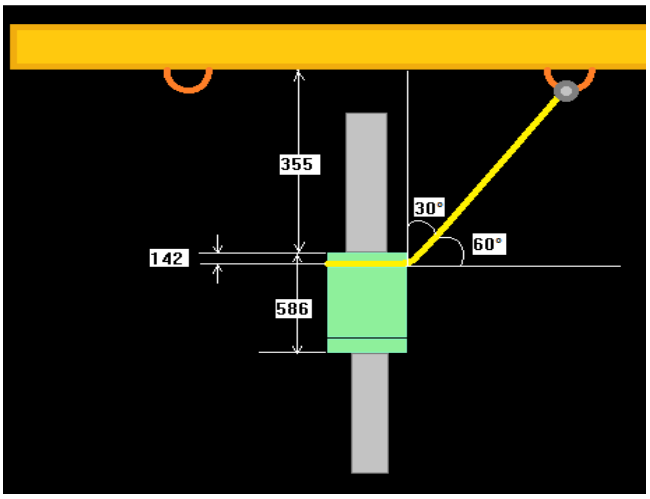

Fig. 2. Rigging height calculation for padeye

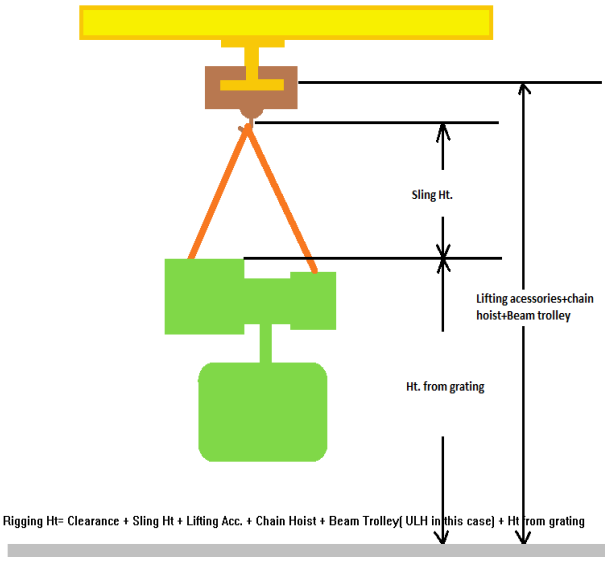

Fig. 3. Rigging height calculation for runway beams

2.1.2 For Runway beams**:** Runway beams are rail columns, beams or any steel member on which crane operates. Figure-3 shows an example of rigging height calculation for runway beams.

Rigging Height = (Clearance)+(Sling Height)+(Beam Trolley)+(Height from Grating)

3. CHALLENGES FOR MECHANICAL HANDLING IN A MODULARIZED PROJECT DUE TO INTERDISCIPLINARY INTERFACES

Communication among all disciplines (i.e. Piping, CSA, And Electrical etc.) during design phase of a modularized plant is a major challenge for resolving Mechanical Handling issues. Sometimes, an MH drawing indicates some special requirements of access ways for equipment transportation from lay down areas to desired location at different elevations of module. This requirement creates an additional work for piping and CSA because of pipe routing changes. Section 3.1 and 3.2 describe various issues which are generally faced during MH interface with Piping and CSA disciplines.

3.1 INTERFACE WITH PIPING:

Mechanical Handling is an essential part of piping design and MH affects piping layout and routing of pipelines because of MH requirements like access ways, head clearance. A snapshot of a model is shown in figure-4 (a,b), a head clearance of space between the item to be lifted by cranes and the top of steel is always to be maintained by piping designers. A clearance is also required in horizontal direction for removal of valves and other low weighing items. As piping in any plant is often subjected to frequent changes it becomes difficult for MH, because every change in piping design leads to a new MH study. So, it is important that MH provides layouts and routes only after the routing of critical pipelines is completed. A constant communication is hence a must requirement in order to avoid major changes in design aspect of module. Also, all the clearance requirements must be thoroughly followed from the beginning itself to avoid interface clashes later.

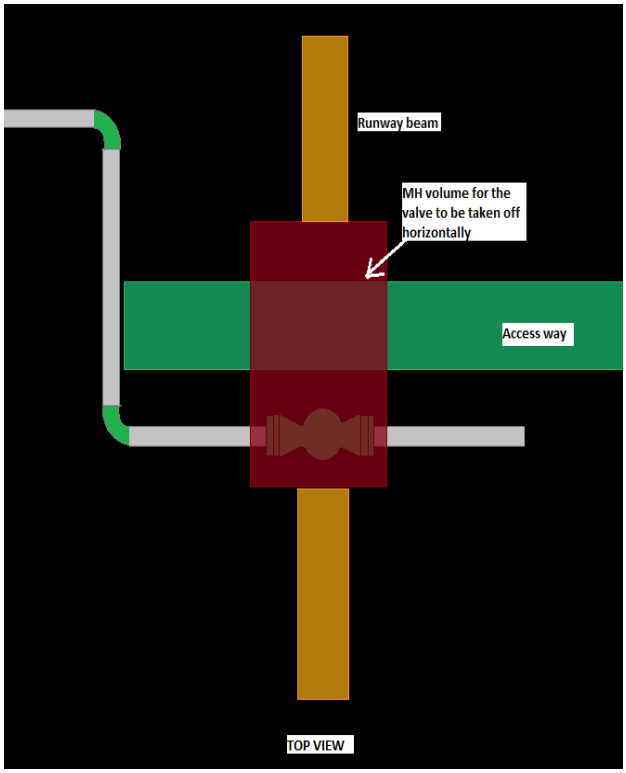

Fig. 4 (a). Top View of MH head clearance requirement for valve removal

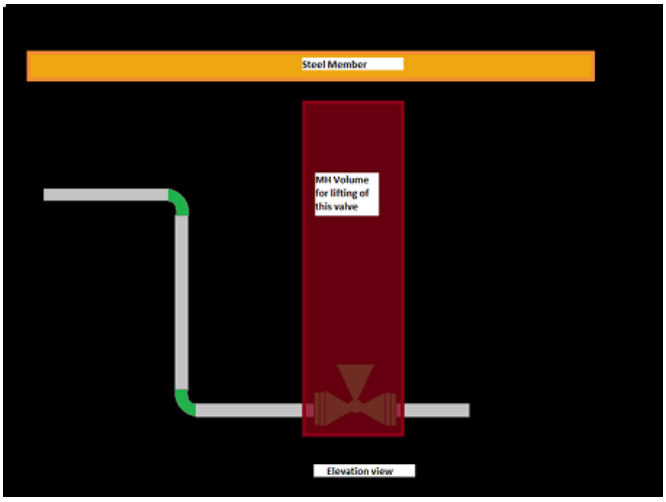

Fig. 4(b). Elevation View of MH head clearance requirement for valve removal

3.2 INTERFACE WITH CSA:

There are two major issues generally faced i.e. (i) Providing transit laydown area in a module from which the items can be handled by mobile crane because it is always a concern as there are a lot of factors affecting it. For instance, a transit laydown at an elevation has to be located at an optimum position; it should be located such that the cantilever of platform protruding outside the module is minimum and not ship-loose.

Also the laydowns at different elevations in a module should have all clear head for the mobile cranes to approach them from the top. (ii) Interface between MH and CSA for providing runway beams for overhead cranes and clash resolution because of additional access ways requirements by MH. Figure-5 depicts these issues in a model snapshot.

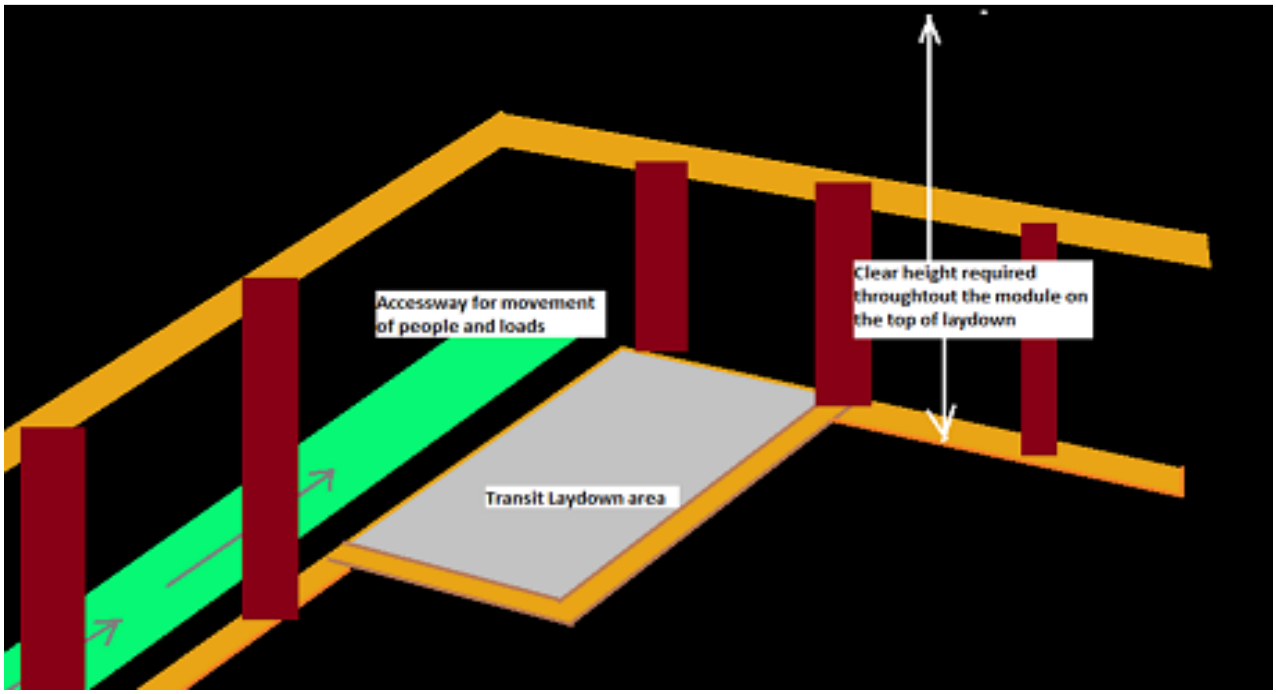

Fig. 5. MH interface with CSA

Mitigation of design challenges in Mechanical Handling for modularized plant: Resolution of MH challenges is always a milestone for Piping, CSA and MH departments. Following are some solutions to mitigate MH issues.

i) Minimizing multiple handling wherever possible in modules.

ii) MH solutions should be standardized wherever practicable and possible.

iii) Mobile Cranes shall only be used to lift from specific access platforms outside the module envelope or from the top of modules.

iv) Handling the equipments at same elevation of modules with a single MH equipment if feasible, might reduce time and labour.

v) Improving inter-department interface by increased level of communication, so that required inputs are available timely.

4. CONCLUSIONS

Mechanical Handling is an inevitable part of any plant, the only thing that varies is the degree to which it is prioritized. With modularisation being the apple of everyone's eye in the market, MH has surely gone up the ladder with more

involvement and participation in the design phase itself. MH studies are just a way of ensuring that the whole plant and its modules are ergonomic and their maintenance is feasible. But still it has a long way to go, as there are not may MH engineers around the globe especially in India where their number is very less, and a job of modularisation surely requires a level of expertise in this field.

ACKNOWLEDGEMENT

The authors would like to acknowledge Fluor Corporation for its consistent encouragement and motivation to its employees for professional presentation and publication of papers in industry and academic forums.

REFERENCES

[1] Material Handling Equipment Michael G. Kay Fitts Dept. of Industrial and Systems Engineering, North Carolina State University, on January 12, 2012, Page No. 65.

[2] Wikipedia.org, 2015. https://en.wikipedia.org/wiki (Accessed on September 10, 2015).