Chapter 16

Structural Integrity Assessment and Control of Ageing Onshore and Offshore Structures

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ABSTRACT

Structural integrity assessment and control (SIA & C) are vital for existing ageing as well as newly built offshore and onshore structures. The SIA & C becomes highly sensitive to interventions under a potential loss of structural integrity (SI) especially when there are inherent constraints present in carrying out engineering work in hazardous environments such as petroleum production and process facilities (P&PFs). The challenges have been further exacerbated by the constantly ageing onshore and offshore structures whilst it is the necessity of carrying out life extension at the verge of their design service lives. Local and international regulations demand the implementation of appropriate strengthening, modification and repair (SMR) plans when significant changes in the SI have been revealed. This chapter presents potential simulation approaches that are possible to utilize for SIA&C in relation to prioritization as well as evaluation of current status of a SIA&C organization.

INTRODUCTION

Structural integrity assessment and control (SIA&C) is an increasingly important element of a plant engineer’s role (Bea, 1998; Samarakoon, Lee & Miles, 2013; Ratnayake & Siriwardane, 2013) and becomes vital when a structure has been undergone different loading circumstances for a significant amount of time and/or when it has been in operation beyond its designed service life (COMAH, 2010, Bea, 1998, Engineerlive, 2013, Val and Stewart, 2005). In this context, the SI is defined as “all of the structural aspects necessary to enable an industrial installation to function in accordance with stated duty via protecting health, safety, environment and quality (HSE&Q) performance requirements” (HSE, DOI: 10.4018/978-1-5225-0588-4.ch016
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2009). SI inherently deteriorates due to ‘ageing’ of the existing physical assets (or plant). However, the term ‘ageing plant’ misleads up to a certain extent as it is not related to the age and design life of a plant, system, part of the structure/structural element, or piece of equipment (HSE UK, 2010). The term ‘ageing’ or ‘ageing plant’ is described as (HSE UK, 2006): Ageing is not about how old the structure or structural element under the consideration is, where, it is about its present condition, and how it has been changing over time from the date of the installation. Consequently, ageing is the effect whereby a part of the structure or structural element under the consideration suffers some form of material deterioration and damage (usually, but not necessarily, associated with time in service) with an increasing likelihood of failure over the lifetime (HSE UK, 2006). In this context, the ageing structural element is an element “for which there is evidence or likelihood of significant deterioration and damage taking place since new, or for which there is insufficient information and knowledge available to know the extent to which this possibility exists” (HSE UK, 2006). Moreover, “the significance of deterioration and damage relates to the potential effect” on the “structural element’s functionality, availability, reliability and safety”. For instance, “just because an item of equipment is old does not necessarily mean that it is significantly deteriorating and damaged”. All types of structural elements are susceptible to ageing mechanisms. Hence, “ageing plant is a plant which is, or may be, no longer considered fully fit for purpose due to deterioration or obsolescence in its integrity or functional performance. ‘Ageing’ is not directly related to chronological age. There are many examples of very old plant remaining fully fit for purpose, and of recent plant showing evidence of accelerated or early ageing, e.g. due to corrosion, fatigue or erosion failures” (HSE UK, 2006). Hence, the ageing has direct correlation between integrity assessment and control approaches. Figure 1 illustrates inherent structural integrity declination vs. the result of ad hoc improvements in an isolated fashion (Ratnayake, 2012c).

Figure 1. Inherent structural integrity declination vs. improvements in an isolated fashion
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