

Strength of Tubular Members– Numerical Comparison of API RP2A to ISO Codes

N. S. Potty, Z. Nizamani, A. B. Idrus
Department of Civil Engineering, Universiti Teknologi PETRONAS
Bandar Seri Iskandar, Perak Darul Ridzuan, Malaysia

ABSTRACT

Worldwide, currently there are three codes used for offshore jacket platform design i.e. API RP2A WSD, API RP2A LRFD and ISO 19902. Of these, the ISO code is formulated for application all over the world. API RP2A WSD is still being used for jacket platform design, not only in the Gulf of Mexico, but also in most of developing countries. API RP2A LRFD and ISO have introduced limit state design in place of working stress design. The limit state design is followed all over the world for most of the design codes. ISO will introduce environmental load factors for each region, in its appendix. The reliability of jacket platforms is maintained in API RP2A LRFD by setting target safety factor the same as that provided in WSD designs, which means structures designed as per LRFD code will have same reliability as API RP2A WSD (which has already provided safe structures and the best available practice for design). For ISO code, the API RP2A LRFD was based as the base code of design. In this paper, the nine stress equations of the above three codes are compared. The knowledge of the strength equations in the codes is useful for determining resistance factors for code calibration. The resistance formulations are numerically compared and the similarities and differences are determined. The member resistance formulae for local buckling, hydrostatic pressure, interaction formulae for axial compression, bending stress, axial tension and hoop stress introduced in the 6th edition of WSD in 1975, have undergone major changes. In the 11th edition (1980), equations were introduced for allowable hoop stress, a formula for combined effects of axial compression, bending and hydrostatic pressure. When API LRFD version was introduced in 1993, some formulae were modified. Incorporating these, the 21st edition of WSD was published in 2000. ISO 13819 was published in 1998, modified in 2007 (ISO 19902). Some provisions in ISO were directly adopted from API RP2A LRFD while others improved and included.

KEY WORDS: Offshore jacket platform; tubular members; comparison of stresses; API RP2A WSD; API RP2A LRFD; ISO; resistance factor.

INTRODUCTION

API RP2A WSD, API RP2A LRFD and ISO have identical equations

for axial tension, bending and hydrostatic pressure. The equations for tubular members in all the above codes are based on theory of shell buckling. Important dissimilarities are there in the equation for axial compression especially with regard to local buckling and some load interaction equations. The overall column buckling equation used in API WSD is same as the equation in API RP2A LRFD and ISO 19902 but has different coefficients; here ISO gives lower capacity compared to LRFD. For local buckling strength, the WSD and LRFD have same equations which are a function of geometry only whereas in ISO the equations are a function of f_y and f_{xc} . ' f_{xc} ' is a function of geometry as well as yield strength. The interaction equation for tension/compression along with bending in ISO follows the API WSD and is linear but the LRFD equation has a cosine form. For the numerical comparisons, tubular members of different diameters, thickness and lengths are chosen from an earlier analysis and axial, bending and hoop strengths evaluated and compared. For the combined load cases, the stresses were also taken from the earlier analysis and the utilisation ratios for the different codes are determined and compared. The results of the numerical comparisons are reported. This paper reviews and summarises the comparison of the three basic codes for offshore jacket platforms and provide in detail the tubular member resistance statics provided in Bomel (2001). The means and the biases related with different equations available in the literature are reported. The load factors used in API RP2A LRFD and ISO are discussed along with inherent safety factor present in API RP2A WSD. Resistance formulae for the nine main stress conditions are chosen for evaluation and their strengths and weaknesses are compared. Here the steel tubular member components are chosen as they play a very vital role for sustaining the dead, live and environment load coming on the main structure. LRFD and ISO standards are limit state approaches to steel design which involves the partial safety factors which are multiplied with characteristic loads to give design action effects, and partial safety factors multiplied with characteristic resistances to give design resistances. The WSD is allowable strength design approach. The ISO and LRFD use factors which are constant in value for the type of resistance under consideration. ISO has limits of applicability based on geometric slenderness i.e. tubular diameter to thickness ratio should be less than 120 and tubular wall thickness should be greater than 6 mm [Bomel, 2001/084]. ISO also limits the material yield strength and yield ratio (yield to ultimate tensile strength) to 500 MPa and 0.90 respectively [ISO Code 19902, 2007].

OBJECTIVE AND METHODOLOGY