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Detailed Annotation of Cause of Buckling in API 650 Storage Tanks

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Abstract: ***Buckling it's defined as the unwanted distortion in shapes of storages tanks due to which circularity of storage tanks is disturbed, & it's generated when shells plates of tanks are welded. In this analysis all the factors due to which buckling will be created are discussed. From safety point of view the places where buckling is generated have higher chance of formation of cracks, as this places are under high stress due to uneven shapes stops diversion of stress to other points.***

Keywords: API 650 Storage Tanks, Peaking, Banding, Circumference & Plumbing

1. Introduction

Storage Tanks are the cylindrical shape components which are used for storage of any type of fluids (for ex. Water, Fertilizers, Any petroleum products etc) under atmospheric pressure. The results of this paper are derived from an API 650 water storage tank of 20m dia x 15 m height constructed at PUNE . The tank is constructed under tolerance mentioned in API 650 code. But in API 650 there is a correlation of one shell to another shell is done only on the basis of plumb & banding, but for factor like circumference no correlation is mentioned as results of which buckling is generated . In this paper circumference relation of one shell to another shell is discussed.

2. Theoritical Analysis

According to API 650 the circumference of any shell is measured only before the cutting of last vertical joint & after complete welding of all the remaining vertical joints from both the sides .The circumference is calculated by:-

$C = 2\pi R$.

Where,

c = Circumference found.

R= Radius of tank (including shell thickness)

Table 1: Radius Tolerance given in Api 650 10th Ed

Radius (m)	Radius Tolerance (mm)
< 12m	±13mm
From 12 m to 45m	±19mm
From 45 m to 75m	±25mm
>75	±32mm

The maximum & minimum circumference of 20m diameter tank having shell plates of material IS2062 E250 BR is calculated using radius tolerance chart given in Table 1.

Table 2: Calculation of minimum & maximum circumference of each shell of the tank

Shell No.	Radius + plate thickness (mm)	Radius + Radius tolerance+ plate thickness (mm)	Nominal circumference (mm)	Maximum circumference (mm)	Minimum circumference (mm)
S-8	10008	10008 ± 19	62882.11	63001.4	62762.7
S-7	10008	10008 ± 19	62882.11	63001.4	62762.7
S-6	10008	10008 ± 19	62882.11	63001.4	62762.7
S-5	10008	10008 ± 19	62882.11	63001.4	62762.7
S-4	10008	10008 ± 19	62882.11	63001.4	62762.7
S-3	10010	10010 ± 19	62894.68	63014	62775.3
S-2	10010	10010 ± 19	62894.68	63014	62775.3
S-1	10012	10012 ±19	62907.25	63026.6	62787.8

Table 3: Probability of getting highest difference between two consecutive shell circumference

Between two intermediate Shells	Maximum possible Circumference difference (mm)
S-8 & S-7	238.7
S-7 & S-6	238.7
S-6 & S-5	238.7
S-5 & S-4	238.7
S-4 & S-3	226.1
S-3 & S-2	238.7
S-2 & S-1	251.3

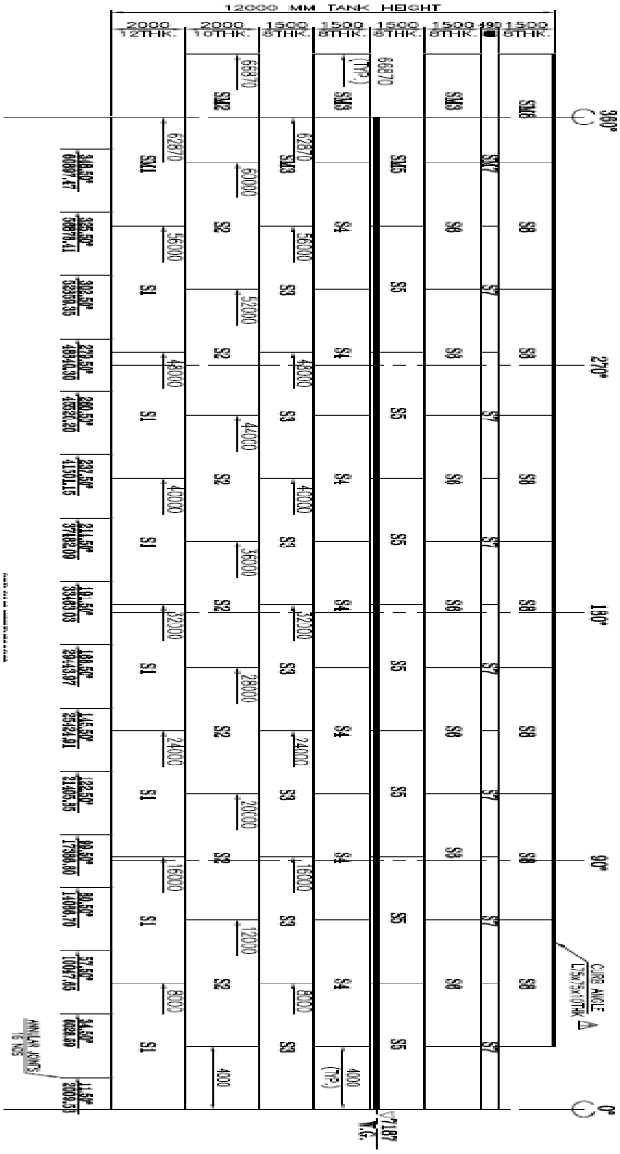

Figure 1: GA drawing of shell plates

3. Procedure for Identification of Buckling

After the welding of the all vertical joints, when horizontal fit-up & alignment of horizontal joint started from one side there unmatched circumference begins to appear between two shells where the horizontal alignment is to end , mostly at the meet points of vertical & horizontal joints known as TEE JOINT. This condition can be seen in Figure 2 & Figure 3, Where they show shell number 7 & shell number 6 (according to GA drawing) appeared to have unmatched circumference. The actual circumference found of shell number 7 is 62878mm & shell number 8 is 62822mm ,hence difference between the circumference appeared to be 56mm,due to this buckling of 56mm in produced during fitup, but both the circumferences are allowed by the code Api 650. Hence permission for welding was given.

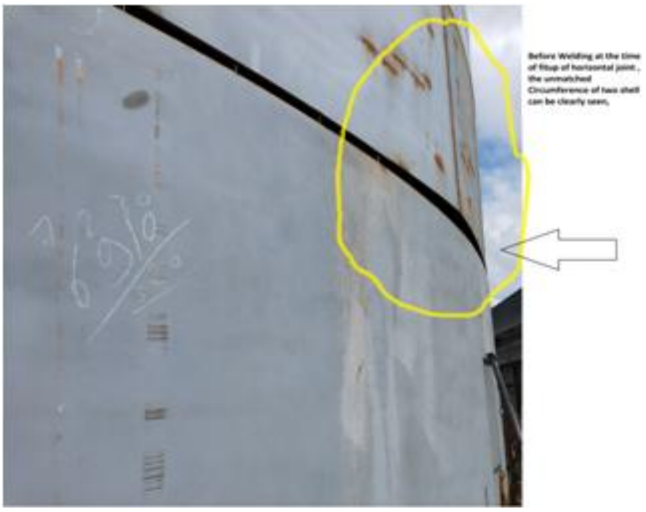

Figure 2: Before welding the unmatched Circumference allowed by Api 650

Figure 3: Before welding the unmatched Circumference allowed by Api 650

Figure 4: After Welding the unmatched Circumference allowed by Api 650

But after the welding of horizontal joint with the unmatched circumference completed, buckling came at the places where horizontal alignment ended. This situation can be seen in figure 4 , where it clearly shows buckling at places where the circumference is unmatched. As this places can’t be cut & weld more than twice (as per API 653) & the more this joint are cut, the lesser are chance of getting it corrected.

4. Rectification

The circumference of next shell of the tank should be increased or decreased by maximum up to 10mm, after that further next shell circumference should be increased or decreased but with same increment as the of previous shell. To be continue increment like this the buckling will not be able pass on to other shell & the required internal diameter Will not lost in bottom most shell as it did in the shell where buckling generated.

5. Results

Due to mismatch Circumference of more than 20mm between the two intermediate shell of 8mm thickness posses a 100% chances of getting buckling. As this range of allowance can be change according to plate grade & thickness of plate. Principal cross section is assumed to be perfect trapezoidal. The complete study is an initiative to establish a needful change in API 650 by adding the circumference correlation factor. This study will help in execute the tank with much more circularity but with less buckling

6. Future Scope

Further it is advisable to conduct test with different range & thickness of material for understanding buckling. .

References

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