Extending Gulf of Mexico's safety index (β) to other regions for determining regional R_m and γ_E

C Kunte

April 24, 2018

Safety index

Safety index[1] function is given by:

$$\beta(R_m, E_m, V_e, V_r) = \frac{\ln\left(\frac{R_m}{E_m} \cdot \sqrt{\frac{1+V_e^2}{1+V_r^2}}\right)}{\sqrt{\ln\left[(1+V_e^2)\cdot(1+V_r^2)\right]}} \tag{1}$$

Equation 1 can be re-written for R_m as:

$$R_m(\beta, E_m, V_e, V_r) = \frac{E_m}{\sqrt{\frac{1+V_e^2}{1+V_r^2}}} \cdot e^{\left(\beta\sqrt{\ln\left[(1+V_e^2)\cdot(1+V_r^2)\right]}\right)} \tag{2}$$

Corresponding partial action factor (γ_E) may be determined as:

$$\gamma_E = \frac{R_m}{1.37} \tag{3}$$

where,

R_m reserve strength ratio (RSR) mean

V_e, V_r coefficients of variations (COV for the environment and resistance respectively)

γ_E partial action factor for extreme storm

[1] See ckunte.net/2018/reliability for a commentary on this.

Gulf of Mexico

For a target probability of failure (P_f) of 3×10^{-5}/year, β (for a 20 year design life, i.e., $\beta_{20y} = \beta_{GOM}$) was determined to be:

$$\beta_{GOM} = 3.239 \tag{4}$$

Substituting the value of Equation 4 in Equation 2, we get:

$$R_{m,GOM} = R_m(\beta_{GOM} = 3.239, E_m = 0.79, V_e = \sqrt{0.32^2 + 0.08^2}, V_r = 0.05) = 2.15 \tag{5}$$

From $R_{m,GOM}$, partial action factor γ can be determined as:

$$\gamma_{E,GOM} = \frac{R_{m,GOM}}{1.37} = 1.57 \tag{6}$$

Other regions

With $R_{m,GOM}$ and γ_{GOM} known, extending Gulf of Mexico's safety index to determine R_m and γ for other regions is as follows.

Northern North Sea

$$R_{m,NNS} = R_m(\beta_{GOM} = 3.239, E_m = 0.81, V_e = \sqrt{0.265^2 + 0.08^2}, V_r = 0.05) = 1.91 \tag{7}$$

$$\gamma_{E,NNS} = \frac{R_{m,NNS}}{1.37} = 1.4 \tag{8}$$

Central (and Southern) North Sea

$$R_{m,CNS} = R_m(\beta_{GOM} = 3.239, E_m = 0.84, V_e = \sqrt{0.212^2 + 0.08^2}, V_r = 0.05) = 1.72 \tag{9}$$

$$\gamma_{E,CNS} = \frac{R_{m,CNS}}{1.37} = 1.26 \tag{10}$$

Australian Northwest Shelf

$$R_{m,AUS} = R_m(\beta_{GOM} = 3.239, E_m = 0.78, V_e = \sqrt{0.33^2 + 0.08^2}, V_r = 0.05) = 2.18 \tag{11}$$

$$\gamma_{E,AUS} = \frac{R_{m,AUS}}{1.37} = 1.59 \tag{12}$$