THE RELIABILITY OF THE FOUNDATION SEISMIC DESIGN USING IRANIAN NATIONAL BUILDING CODE

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Conventional design methods in geotechnical engineering generally consider the reasonable global factor of safety. This safety factor is merely a comparison of actual to necessary strength and indicates whether the system is safe or not, which is termed as a deterministic approach. The reliability and design risk level of deterministic approaches proposed by Iranian code is evaluated in various scenarios. The distance of the foundation that whether or not near the crest of the slope has also been considered. A practical probabilistic approach was proposed by Low (1996), which is an extremely fast, precise, and easy method for calculating the first order second-moment reliability index (FORM). This method is based on the perspective of an ellipsoid that touches the failure surface in the original space of the variables, and relevant calculation will be done using an optimization tool of spreadsheet software. This perspective is mathematically equivalent to the widely adopted aspect of a sphere in the space of reduced variables but provides a more intuitive definition of Hasofer-Lind's (1974) reliability index. In conventional solutions, to obtain the reliability index, the variables must be transferred to normal standard space. However, in the practical method, complicated calculations and transfers are not needed, and all the process is performed in the original space (Low and Tang, 2004). The reliability index obtained by the practical approach is shown in Figure 1.

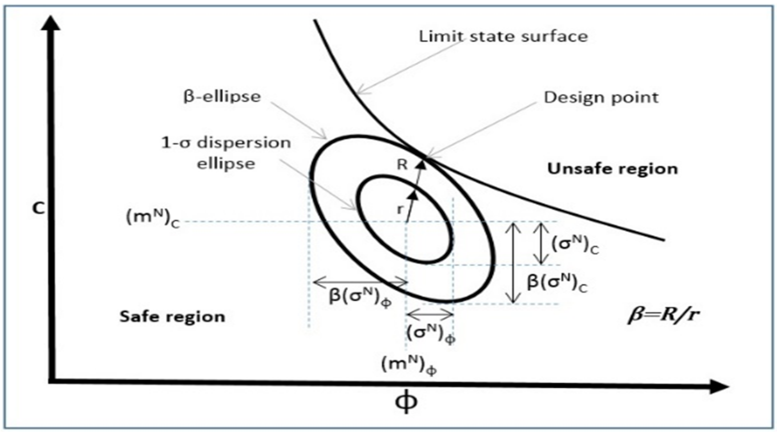

Figure 1. Design point and equivalent normal dispersion ellipsoids illustrated in the plane (Low, 1996).

The matrix formulation of the Hasofer-Lind index β is (Ditlevsen, 1981):

$$\beta_{HL} = \min_{x \in F} \sqrt{(x - m)^T C^{-1} (x - m)} \tag{1}$$

Or, equivalently (Low and Tang, 1997):

$$\beta = \min_{x \in F} \sqrt{\left[\frac{x_i - m_i}{\sigma_i}\right]^T [R]^{-1} \left[\frac{x_i - m_i}{\sigma_i}\right]} \quad (2)$$

where **x** is a vector representing the set of random variables, m the mean values, C the covariance matrix, R the correlation matrix, and F the failure domain.

Three different soil types that would be a good representative of cohesive to granular soils are selected.

Specifications of 1st soil type: $\gamma = 18\ kN/m^3$, C = 20 kPa, Φ = 30°

Specifications of 2nd soil type: $\gamma = 18\ kN/m^3$, C = 50 kPa, Φ = 0° (Cohesive Soil)

Specifications of 3rd soil type: $\gamma = 18\ kN/m^3$, C = 0 kPa, Φ = 40° (Granular Soil)

For instance, foundation circumstances in the 1st soil type are shown in Figure 2.

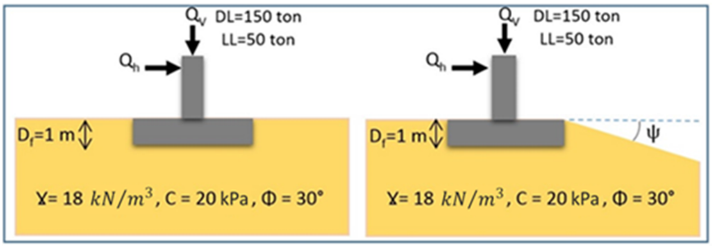

Figure 2. Foundation conditions in 1st soil type.

Table 1. The reliability index of the designed foundations on the 3rd soil type by ASD and LRFD.

Slope Status	Design Type	Kh	Designed Foundation Width (m) LRFD	β LRFD	Designed Foundation Width (m) ASD	β ASD
Flat	Seismic	0.1	2.00	1.32	1.87	1.18
	Seismic	0.2	2.62	1.29	2.46	1.15
ψ = 10	Seismic	0.1	2.87	1.29	2.70	1.15
	Seismic	0.2	3.70	1.26	3.49	1.13
ψ = 20	Seismic	0.1	4.25	1.26	4.02	1.12
	Seismic	0.2	5.38	1.22	5.10	1.10

Table 2. Comparison of the designed foundation's reliability between 1st, 2nd, and 3rd soil type.

1st Soil Type		2nd Soil Type		3rd Soil Type	
LRFD	*ASD*	*LRFD*	*ASD*	*LRFD*	*ASD*
2.30	2.10	2.70	2.55	1.30	1.15

In all soil types, the seismic reliability index in the LRFD method is higher than the ASD method. It seems using the LRFD method in seismic designs is more reliable. The soil type plays an important role in results obtained from the Iranian Code. In granular soils the reliability of designs based on Iranian code is low and this may be a high risk that would be considered. In the studied cases, there is not a good situation for the 3rd soil type (granular soil). In 1st soil type (soil with cohesion and internal friction), the design risk and failure probability will be in a good order (β=3.15). The best circumstances (β=3.40) is related to the foundations that are based on 2nd soil type (cohesive soil).

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