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FUZZY RELIABILITY ANALYSIS OF SHEET PILE WALL SEISMIC DESIGN

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Sheet pile wall is a type of retaining wall that is frequently used due to its simple, fast, and easy construction. These structures are most functional in slope stabilization and especially in construction of quay walls.

Uncertainties lead to imprecise analysis and inefficient design of sheet pile walls which result in significant risks. Inaccuracies may occur in input parameters and construction operations simultaneously or separately.

In this research, we investigated the reliability of sheet pile walls penetrating into sand under uncertainties. Figure 1 presents geometric and geotechnical parameters of a sheet pile.

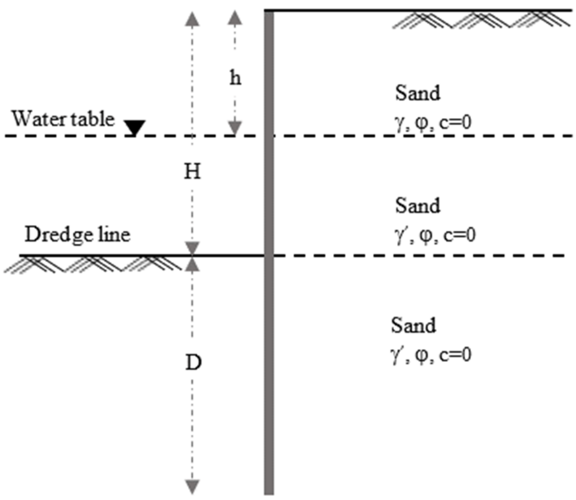

Figure 1. Sheet pile geometric and geotechnical parameters.

We evaluated two parameters considering the overturning and flexural stability criteria (Das, 2016). Overturning safety factor (FSo) is obtained by dividing resisting moment into disturbing moment. Flexural stability is measured by section modulus ratio (SMR), which is the ratio of section modulus of sheet pile profile to minimum section modulus required for sustainability of the wall (Babu et al., 2008).

Seismic impact is considered by Mononobe-Okabe theory and a Fuzzy approach is used to apply uncertainties. The extreme values of the wall safety factor and section modulus ratio are generated by solving an optimization problem using genetic algorithm (GA) (Derakhshani, 2018).

Table 1 displays the design variables and their crisp value, lower bound and upper bound under 5% uncertainty.

Figure 2 shows membership function for overturning safety factor and section modulus ratio under 5% inaccuracy. As can be seen, FSo varies from -56.4% to +44.2% and SMR changes from -49.5% to +71.2%. Results indicate that a small uncertainty of about 5% can turn a safe situation into failure state. Thus, for a safe design it is necessary to investigate uncertainties' influence (Haghighi et al., 2016).

Table 1. Design variables and their crisp and uncertainty values.

No.	Variable	Unit	Uncertainty	Lower boundary	Crisp value	Upper boundary
1	Unit weight (γ)	kN/m^3	5%	14.25	15	15.75
2	Effective unit weight (γ')	kN/m^3	5%	9.50	10	10.50
3	Effective angle of friction (φ)	degree	5%	30.40	32	33.60
4	Depth of dredge line (H)	m	5%	3.80	4	4.20
5	Water table (h)	m	5%	2.85	3	3.15
6	Depth of embedment (D)	m	5%	5.70	6	6.30
7	Section modulus of sheet pile	m^3/m	5%	0.0019	0.002	0.0021

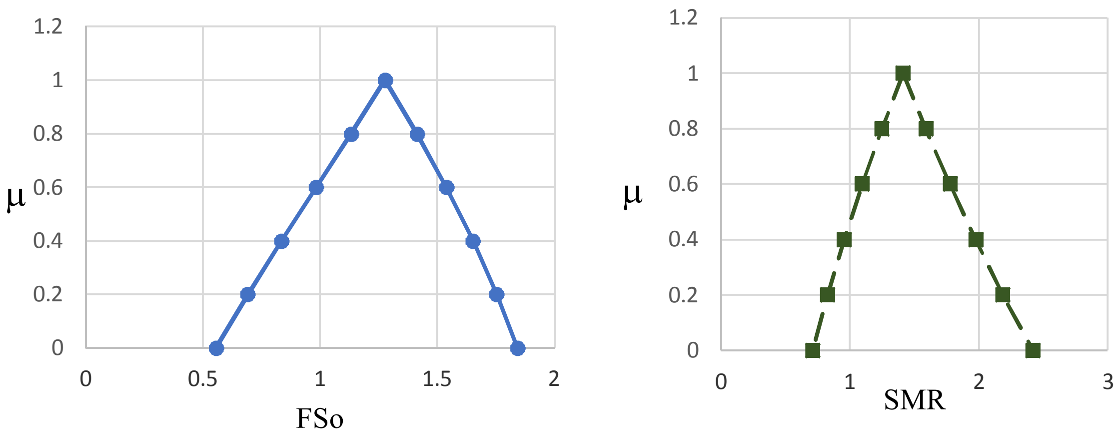

Figure 2. Membership functions of stability criteria.

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