

FGI Webinar: Migration from the Simplified Method to the AASHTO Stiffness Method for Internal Stability Design of MSE Walls



Presented by:

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Introduction & Background

This webinar outlined a paradigm shift in MSE wall internal stability design, moving from the traditional Simplified Method to the Stiffness Method codified in AASHTO (2020) and the Canadian Highway Bridge Design Code. Drawing on over 30 years of research, the Stiffness Method provides a mechanically rational and less conservative approach for calculating tensile loads in reinforcement layers under service (operational) conditions.

The Simplified Method often overpredicts loads in geosynthetic-reinforced walls by a factor of two, leading to overly conservative designs and unnecessary material use.

Limitations of the Legacy Simplified Method

- Calculates maximum tensile load T_{max} as: vertical stress $\times$ reinforcement spacing $\times$ empirical K .
- For geosynthetics, K was taken as the active earth pressure coefficient K_a .
- Analysis of instrumented walls showed:
 - Mean bias = 0.43 (overprediction ~100%)
 - COV = 56% (high scatter)

- Did not account for reinforcement stiffness or facing system stiffness, key factors in load distribution.

Fundamentals of the Stiffness Method

- Retains basic T_{max} equation but introduces mechanically derived correction factors.
- Reinforcement stiffness (J) is explicitly included:
 - Defined as secant stiffness at 2% strain from a 1,000-hour creep test.
 - Practical relation: $J(\text{kN/m}) \approx 5 \times T_{\text{ult}}$
- Allows for more accurate, rational load predictions under operational conditions.

Key Influence Factors

- **Reinforcement Stiffness (Φ_{stiff}):** Higher stiffness attracts more load.
- **Facing Stiffness (Φ_{fb}):** Flexible wrapped-face walls attract higher loads; stiffer facings (e.g., concrete block) dissipate stress.
- **Load Distribution ($D_{T_{\text{max}}}$):** Bilinear distribution with depth replaces triangular Simplified Method assumption.
- **Cohesion (Φ_{c}):** Persistent cohesion from mechanical interlock reduces reinforcement loads, converted to equivalent secant friction angle.

Soil Failure Limit State

- Ensures reinforced soil behaves as a coherent gravity structure.
 - Operational strain $\epsilon_{op} = T_{max} / J \backslash \text{varepsilon}_{\text{op}} = T_{\text{max}} / J$ must remain $< 3\%$.
 - Exceeding 3% strain may indicate contiguous soil failure, invalidating working stress assumption.
 - Not applicable to steel-reinforced walls where reinforcement yield precedes soil failure.
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Case Study Validation: SR 18 Wall, Washington

- 11-meter-high geogrid-reinforced wall with concrete block facing.
 - Field-measured loads were significantly lower than Simplified Method predictions.
 - Stiffness Method predictions aligned closely with measured data.
 - All measured strains $< 1\%$, confirming wall operated under working stress conditions.
 - Demonstrated potential material savings using Stiffness Method.
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Advantages and Implementation

- Improved Accuracy: Mean bias = 1.02; COV = 30%
- Mechanical Rationality: Accounts for reinforcement and facing stiffness
- Unified Approach: Applicable to geosynthetic and steel reinforcement
- Efficiency: Optimized, economical designs with reduced conservatism

- Enhanced Safety: Soil failure limit state ensures operational reliability
 - Mandatory for geosynthetic MSE walls in AASHTO (2020) and all MSE walls in Canadian Highway Bridge Design Code
 - Compatible with geotechnical software (GeoStudio, Rocscience) or spreadsheet implementation
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Conclusions

- Stiffness Method represents a major evolution in MSE wall design.
 - Provides rational, accurate, and efficient predictions of reinforcement loads.
 - Enables safer, more reliable, and economical walls by properly accounting for load transfer mechanics.
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Additional Information

- Full recording, slides, and technical papers available on the Flexible Geomembrane Institute website.
- Remaining attendee questions addressed in follow-up podcast.
- Next webinar (August 22) will present three geosynthetics case studies.