JCSS

Joint Committee
on Structural Safety

Workshop on Assessment of Existing Structures

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Potential and Challenges of the Design Value Approach

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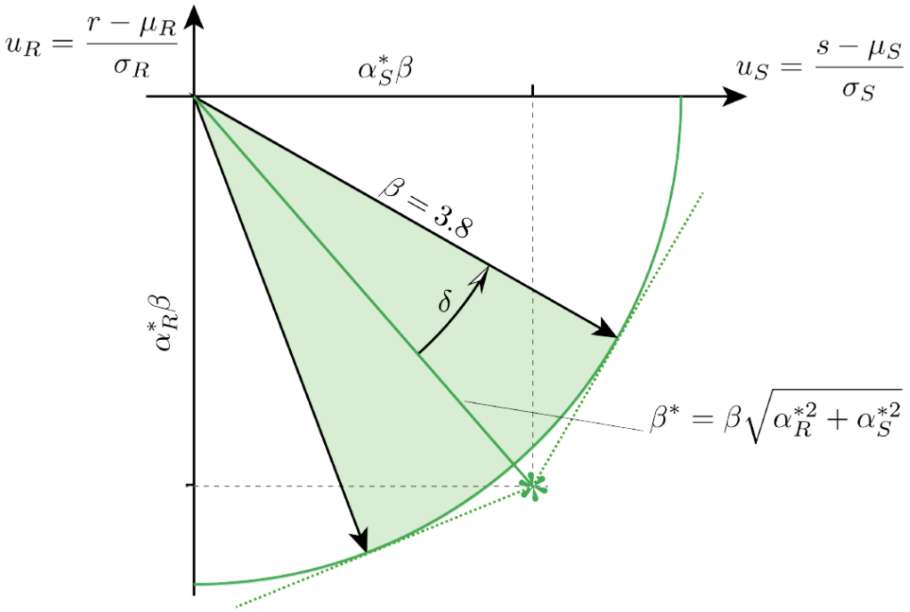
Design Value Format method

- Can be used to estimate partial safety factors (γ_X) based on FORM sensitivity factors (α_X), target reliability (β) and assumed probabilistic representation for a variable (distribution, parameters).
- Apparently separates partial factor estimation.
- FORM sensitivity factors (α_X) are always dependent on the complete reliability problem.

- Pragmatic solution: Standardized FORM sensitivity factors (α_X).

Standardized α-values



- Idea: identify a set of α-values that satisfies the reliability requirement for a range of practical cases
- For the simple $R - S$ problem and $\alpha_S = 0.7$ and $\alpha_R = -0.8$, this range is indicated in green.
- Problems:
  - The range is not very wide.
  - The principle works only if the standardized α-values are applied on both sides.

Indicative Example

Limit state equation:

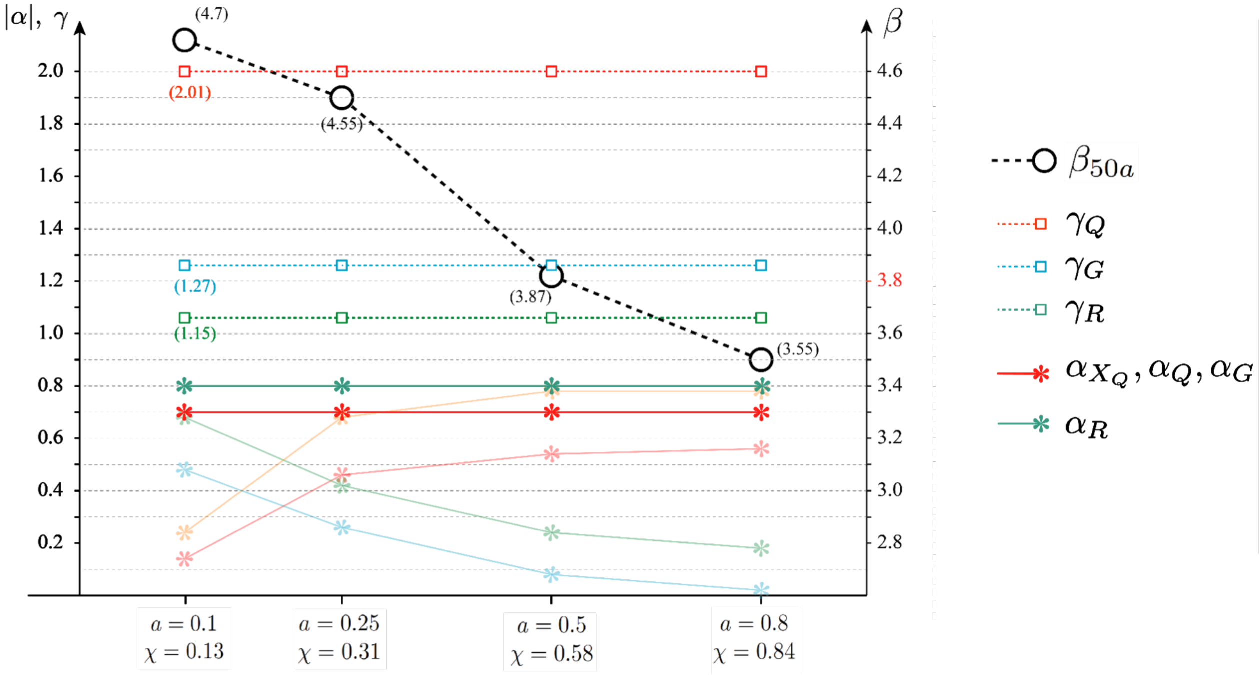
$$H(R, G, Q, X_Q) = zR_i - (1-a)G - aX_Q Q$$

- R_i material strength
- z design parameter
- G permanent load
- Q variable load
- a parameter related to ratio of variable load to total load

	Dist.	μ	V
Material 1	LN	1	0.1
Permanent	N	1	0.1
Variable (50a-max)	G	1	0.15
Model Uncertainty	LN	1	0.3

Indicative Example

- Simultaneous application of the standardised α-values
- Results in a unique set of partial factors
- But a large range of resulting reliabilities (50y reference).
- For a = 0.8 (large contribution of variable load) the requirement is not fulfilled.

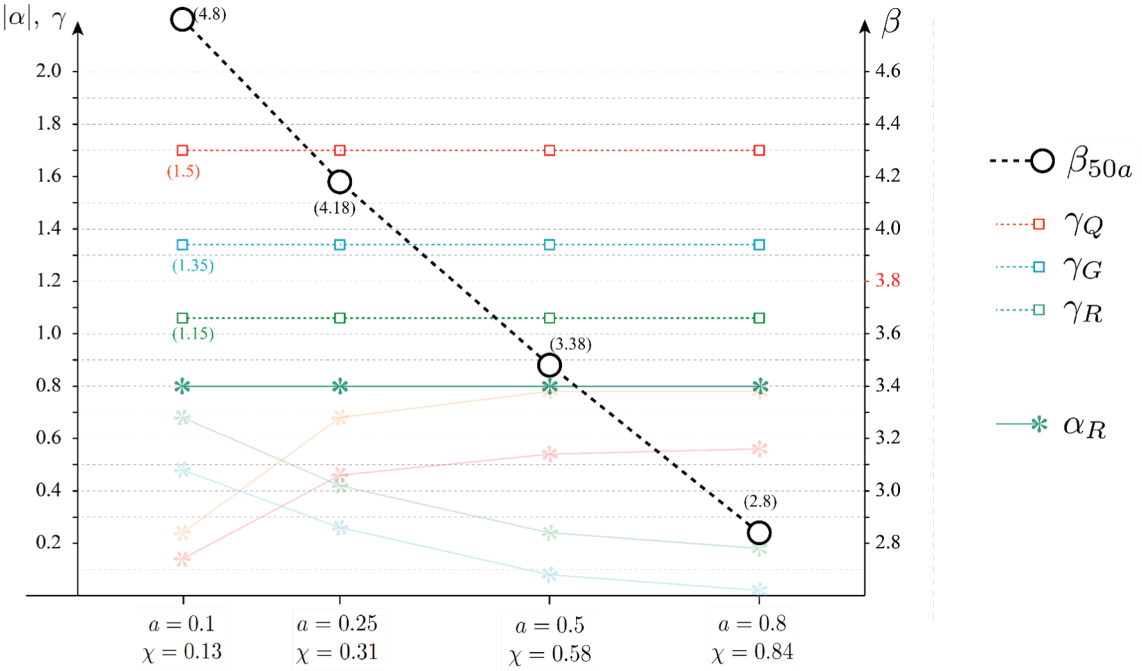


Indicative Example

- If the method is only used for one variable (e.g. resistance)
- …and the partial factors of the other variable are fixed (taken from the design code):

$\gamma_G = 1.35$ and $\gamma_Q = 1.5$

- The range of achieved reliabilities becomes very large
- … and partly far too low!!



Intermediate Summary

- The application of the generalized α-value on single variables in isolation is not effective and the obtained safety levels are partly not acceptable.
  - α-value should be used simultaneously for both loads and resistances.
- The situation is worse for material variables with low variability.
- An alternative to the Design Value Method to be considered.

For the assessment of existing structures the variability between assessment situations is larger than for the design situation.

- The variability of the resistance variable is typically large (also due to statistical uncertainty / small sample size)
- The above observations become even more relevant.
- As the need for alternative more accurate methods.

Proposed Solution

Design partial factors :

- Partial factors for generic variables are suggested based on reliability-based calibration.
- The generic variables for resistance are characterized by distribution type, location and shape parameters.
- The calibration is based on typical load conditions.

Assessment partial factors:

- Partial factors for generic new data sets are suggested based on reliability-based calibration.
- The data sets are characterized by the sample statistics (n, m, s), the assessment partial factor is based on n and $\frac{s}{m}$.
- Assessment partial factor is multiplied with the characteristic value of the data set (EN1990 Annex D) in order to obtain the assessment value.
- The calibration is based on typical load conditions. Load conditions might be classified in order to increase the information level for the assessment.

Possible Implementation

Partial factors for design (values to be agreed on)

	$\boldsymbol{cov_R = 0.1}$	$\boldsymbol{cov_R = 0.15}$	$\boldsymbol{cov_R = 0.2}$	$\boldsymbol{cov_R = 0.25}$
Partial factors γ_R				

Possible Implementation

<u>Partial factors for Assessment (values to be agreed on)</u>

n	$\frac{s}{m} = 0.05$	$\frac{s}{m} = 0.1$	$\frac{s}{m} = 0.15$	$\frac{s}{m} = 0.2$	$\frac{s}{m} = 0.25$	$\frac{s}{m} = 0.3$
3						
5						
7						
10						
15						
25						
50						
100						

Conclusions

- The application of standardized alpha values in design and reassessment should be reconsidered carefully.
  - in some applications the standardized alpha-values result in partial factors that imply too low reliability.
  - in other applications the alpha-values result in too safe and uneconomic structures
  - if the Design Value Format method is used to estimate partial factors for resistance variables then the method also shall be used for load variables and visa versa
  - the Design Value Format method is difficult to apply for climatic loads modelled by a product of time-dependent and time-independent stochastic variables
- Alternative methods should be discussed and agreed on.
- The present concept is seen as a constructive contribution to the required discussion.

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