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How does the automatic generation of the second load combinations NTC08 work?

AUTOMATIC GENERATION OF THE SECOND LOAD COMBINATION NTC08 OPERATION

During a non linear analysis it is impossible to factor the water because this could generate a model that not corresponds to real conditions.
In this case with the NTC 08, the Eurocodes allow the factorization of the results of the analysis, the actions and their effects [(1)].

DeepXcav performs two series of operations, before and after the calculations: copies a standardization of the parameters of the analysis according to the γ favorable of the soil – which in many SLU combinations is equal to the water's one - and it amplifies the results always with reference to this coefficient. This way the consistency and the reliability of the results is guaranteed.
The following could be interesting also in case of doing a comparison with an analysis performed with Paratie 7.

We examine l'NTC08. So:

γ_{perm} = factorization coefficient of the permanent loads

γ_{var} = factorization coefficient of the variable loads

$\gamma_{terr\ ,\ sfav}$ = factorization coefficient of the soil (**unfavorable**)

$\gamma_{c'}$ = factorization coefficient of the cohesion c'

γ_{Su} = factorization coefficient of the undrained cohesion S_u

γ_{ϕ} = factorization coefficient of the friction angle ϕ

the program steps respecting the prescriptions expected from the normative, are:

Before the analysis

1 – Standardization of the γ coefficient according to the $\gamma_{terr\ ,\ sfav}$ coefficient

$\gamma_{perm\ ,\ std} = \gamma_{perm} / \gamma_{terr\ ,\ sfav}$

$\gamma_{var\ ,\ std} = \gamma_{var} / \gamma_{terr\ ,\ sfav}$

2 – Load ampification

Indicated with q, the load inserted by the user and with q_{calc} the load transmitted to the solution:

$q_{calc\ ,\ perm} = \gamma_{perm\ ,\ std} * q_{perm}$

$q_{calc\ ,\ var} = \gamma_{var\ ,\ std} * q_{var}$

3 – Reduction of the geotechnical strength parameters

$c'_{calc} = c' / \gamma_{c'}$

$S_{u\ calc} = S_u / \gamma_{Su}$

$\tan(\phi_{calc}) = \tan(\phi) / \gamma_{\phi}$

After the analysis: result ampification

$Rd = R * \gamma_{terr\ ,\ sfav}$

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Example

We describe all the combinations prescribed in NTC 08.

These behaviors are expected:

	Variable Load ampification	Permanent Load ampification	Soil resistance reduction	Seismic
Comb. A1+M1+R1	YES	YES	NO	NO
Comb. A2+M2+R1	YES	NO	YES	NO
EQK	NO	NO	YES	YES

Long-term behavior awaited from the normative (NTC 08)

We will see how precise will be the correspondence of the automatic calculations.

Case 1: A1+M1+R1

γ_{perm}	γ_{var}	$\gamma_{terr\ ,\ sfav}$	$\gamma_{c'}$	γ_{Su}	γ_{ϕ}
1,3	1,5	1,3	1	1	1

Applying the formulas seen in the previous paragraph:

$\gamma_{perm\ ,\ std} = \gamma_{perm} / \gamma_{terr\ ,\ sfav} = 1,3 / 1,3 = 1$

$\gamma_{var\ ,\ std} = \gamma_{var} / \gamma_{terr\ ,\ sfav} = 1,5 / 1,3 = 1,15$

$q_{calc\ ,\ perm} = \gamma_{perm\ ,\ std} * q_{perm} = q_{perm}$

$q_{calc\ ,\ var} = \gamma_{var\ ,\ std} * q_{var} = 1,15\, q_{var}$

$c'_{calc} = c' / \gamma_{c'} = c' / 1 = c'$

$S_{u\ calc} = S_u / \gamma_{Su} = S_u / 1 = S_u$

$\tan(\phi_{calc}) = \tan(\phi) / \gamma_{\phi} = \tan(\phi) / 1 = \tan(\phi)$

$R_d = R * \gamma_{terr\ ,\ sfav} = R * 1,3 = 1,3\, R_d$

Case 2: A2+M2+R1

γ_{perm}	γ_{var}	$\gamma_{terr\ ,\ sfav}$	$\gamma_{c'}$	γ_{Su}	γ_{ϕ}
1	1,3	1	1,25	1,4	1,25

Applying the formulas seen in the previous paragraph:

$\gamma_{perm\ ,\ std} = \gamma_{perm} / \gamma_{terr\ ,\ sfav} = 1 / 1 = 1$

$\gamma_{var\ ,\ std} = \gamma_{var} / \gamma_{terr\ ,\ sfav} = 1,3 / 1 = 1,3$

$q_{calc\ ,\ perm} = \gamma_{perm\ ,\ std} * q_{perm} = q_{perm}$

$q_{calc\ ,\ var} = \gamma_{var\ ,\ std} * q_{var} = 1,3q_{var}$

$c'_{calc} = c' / \gamma_{c'} = c' / 1,25 = 0,8\ c'$

$S_{u\ calc} = S_u / \gamma_{Su} = S_u / 1,4 = 0,71\ S_u$

$\tan(\phi_{calc}) = \tan(\phi) / \gamma_{\phi} = \tan(\phi) / 1,25 = \square 0,8 \tan(\phi)$

$R_d = R * \gamma_{terr\ ,\ sfav} = R * 1 = R_d$

Case 3: comb. seismic EQK

γ_{perm}	γ_{var}	$\gamma_{terr\ ,\ sfav}$	$\gamma_{c'}$	γ_{Su}	γ_{ϕ}
1	1	1	1,25	1,4	1,25

Applying the formulas seen in the previous paragraph:

$\gamma_{perm\ ,\ std} = \gamma_{perm} / \gamma_{terr\ ,\ sfav} = 1 / 1 = 1$

$\gamma_{var\ ,\ std} = \gamma_{var} / \gamma_{terr\ ,\ sfav} = 1 / 1 = 1$

$q_{calc\ ,\ perm} = \gamma_{perm\ ,\ std} * q_{perm} = q_{perm}$

$q_{calc\ ,\ var} = \gamma_{var\ ,\ std} * q_{var} = q_{var}$

$c'_{calc} = c' / \gamma_{c'} = c' / 1,25 = 0,8\ c'$

$S_{u\ calc} = S_u / \gamma_{Su} = S_u / 1,4 = 0,71\ S_u$

$\tan(\phi_{calc}) = \tan(\phi) / \gamma_{\phi} = \tan(\phi) / 1,25 = \square 0,8 \tan(\phi)$

$R_d = R * \gamma_{terr\ ,\ sfav} = R * 1 = R_d$

Note

(1) - The analysis results that are amplified are: moment, shear end tieback reactions.