UNIONE EUROPEA
Fondo Europeo di Sviluppo Regionale
Ministero dell'Università e della Ricerca
PON RICERCA E INNOVAZIONE 2014 - 2020
UNIVERSITÀ DEGLI STUDI DELLA BASILICATA 1982

Presentazione e discussione dello stato di avanzamento dei lavori e dei prodotti – *workshop online 4 Marzo 2022*

Partner UniTN

Inquadramento generale dei lavori del Partner UniTN e presentazione sulle attività di ricerca svolte dal Gruppo di Geotecnica

Componenti del Gruppo Geotecnica: A. Gajo, L. Argani, L. Simeoni, F. Ghalamzan

Estratto da: Presentazione e discussione dello stato di avanzamento dei lavori e dei prodotti del progetto MITIGO - Workshop 4 Marzo 2022

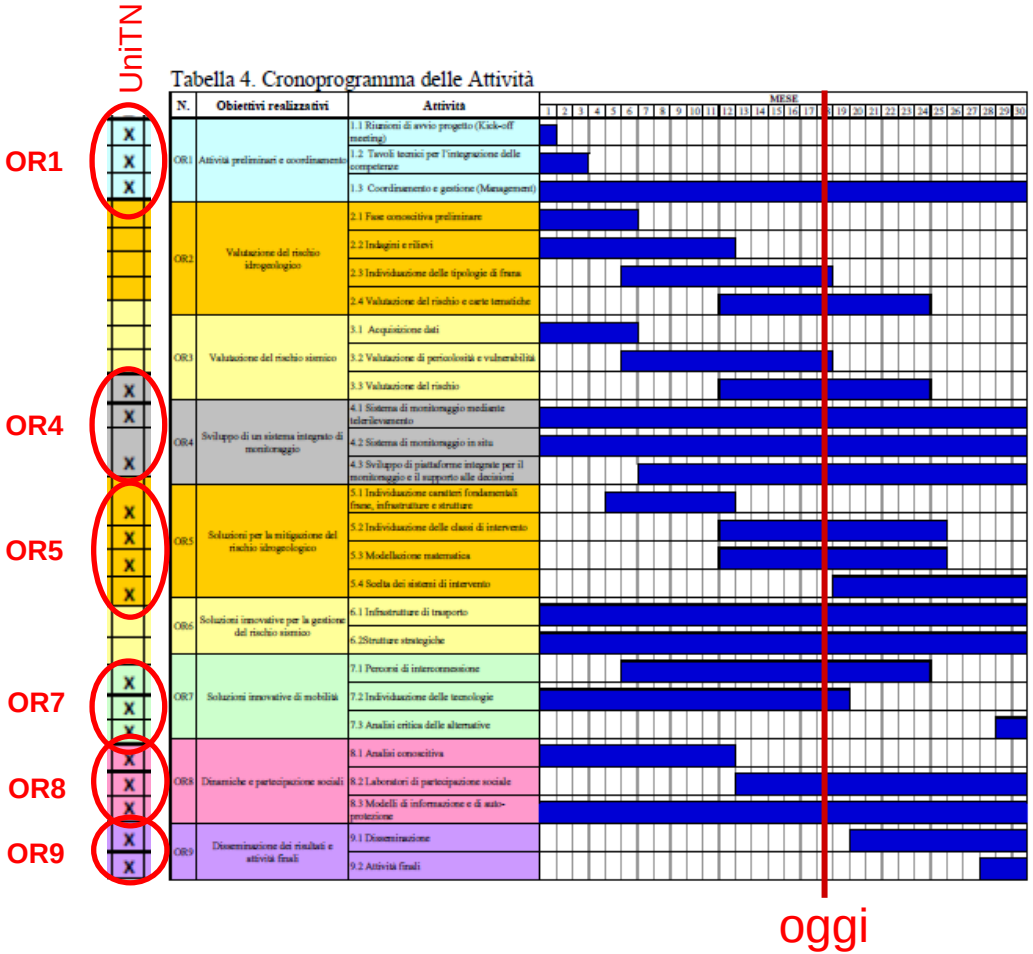
Editrice Universosud – Potenza

ISBN 9788899432829

Pubblicazione realizzata con il cofinanziamento dell'Unione Europea – FESR, PON Ricerca e Innovazione 2014-2020.

www.ponricerca.gov.it

Inquadramento delle attività UniTN all'interno di MITIGO



Gruppo ELEDIA + Strutture

Geotecnica

Strutture

Sociologia

Inquadramento delle attività UniTN all'interno di MITIGO

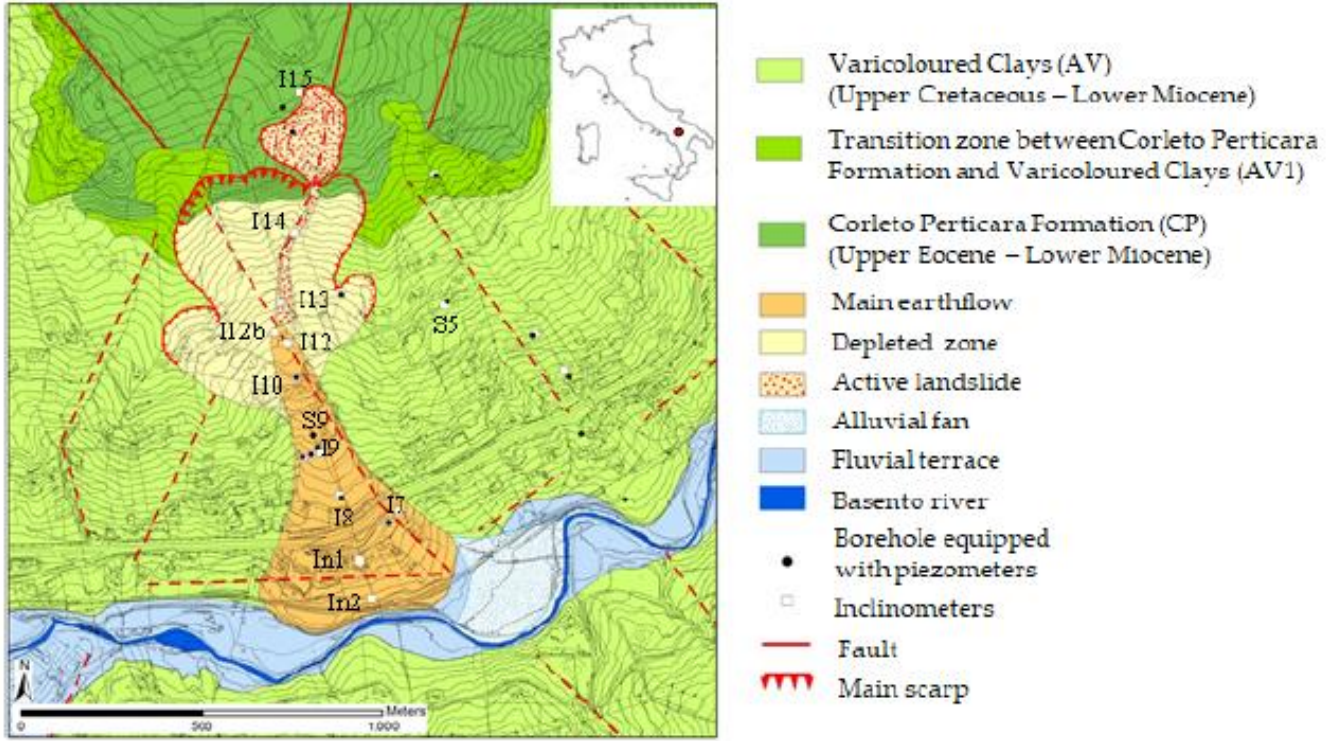
	Spese rendicontate (RI+SPE)						
		SAL01	SAL02	SAL03	SAL04	TOTALE	% effort
3 persone	Geotecnica	14,112	14,785	14,295	12,157	55,349	45.52
4 persone	Strutture	-	1,022	1,191	19,763	21,976	18.76
4 persone	Eledia	7,013	8,853	11,960	13,752	41,578	46.54
1 persona	Sociologia	9,709	14,089	14,289	10,141	48,228	77.72

	Contratti (RI+SPE)				
1 assegno	Geotecnica	-	-	-	2,021
2 PhD	Eledia	-	13,339	12,095	10,863
1 assegno	Sociologia	-	-	1,003	6,856

Inquadramento del gruppo di Geotecnica all'interno di MITIGO

5.3) Modellazione matematica dei processi franosi, dell'interazione terreno/strutture e degli effetti degli interventi di stabilizzazione; monitoraggio/sperimentazione in scala naturale in siti pilota.

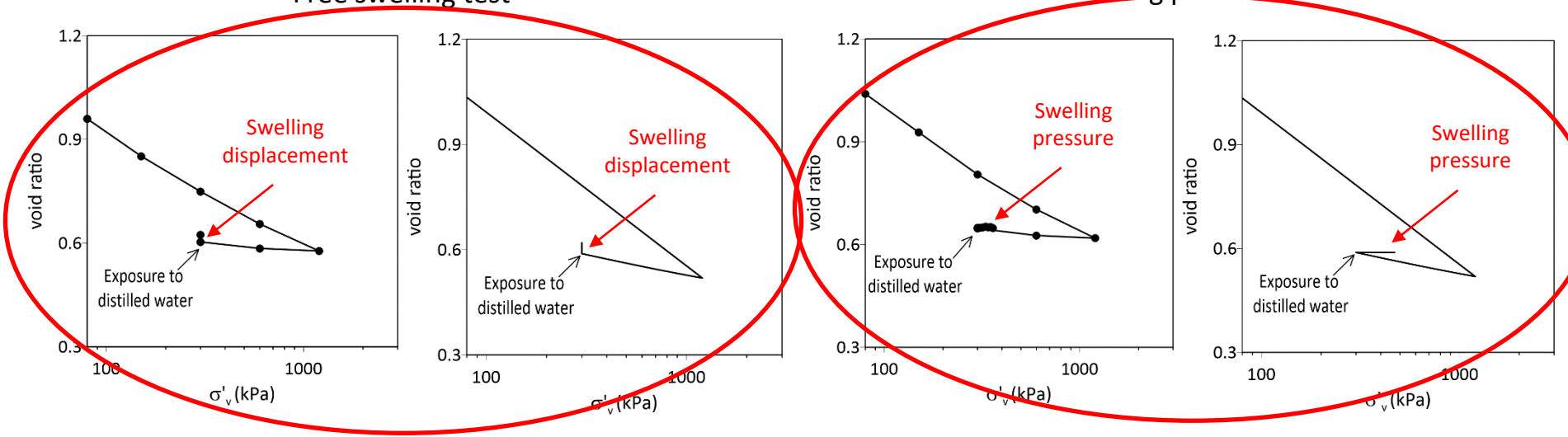
Costa della Gaveta



Constitutive model for simulating swelling and swelling pressure of a sample prepared with 1 mol/l of NaCl

Free swelling test

Swelling pressure test



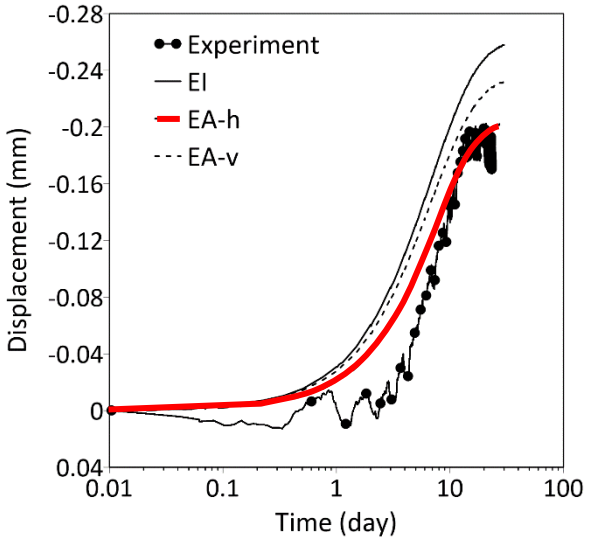
Experiment **Simulation** **Experiment** **Simulation**

Although the amount of swelling displacement is negligible, the amount of swelling pressure is significant.

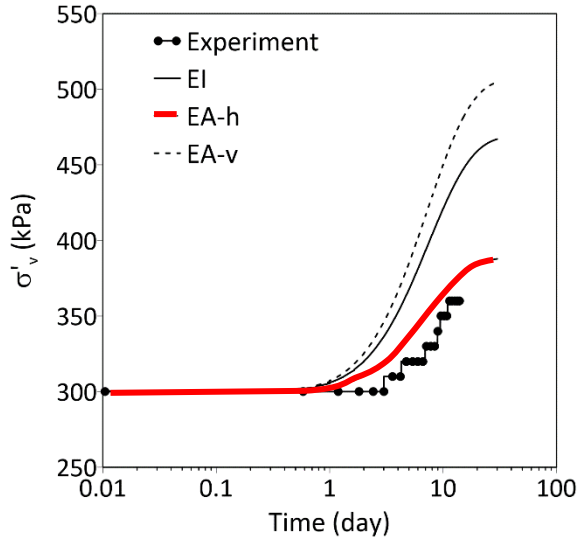
FEM model: effect of fabric tensor anisotropy on swelling behavior

Elastic isotropy **(EI)**
Elastic anisotropy with larger stiffness in the vertical direction **(EA-v)**
Elastic anisotropy with larger stiffness in the horizontal direction **(EA-h)**

- The simulation results of swelling displacement and swelling pressure are more compatible with the experiment when the elastic stiffness is larger in the horizontal direction (EA-h)

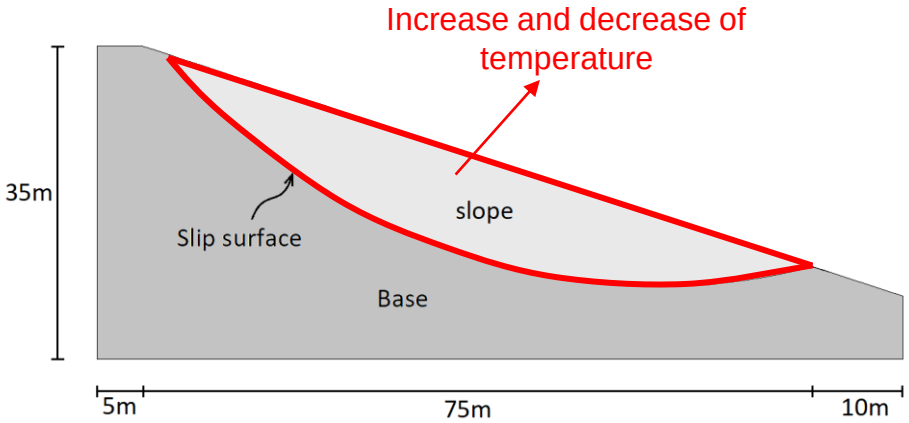


Swelling displacement

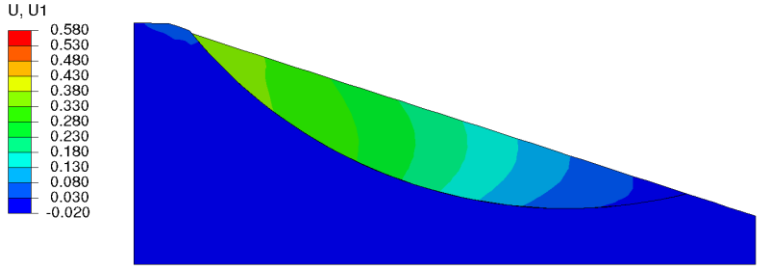


Swelling pressure

Effect of swelling on landslide displacement

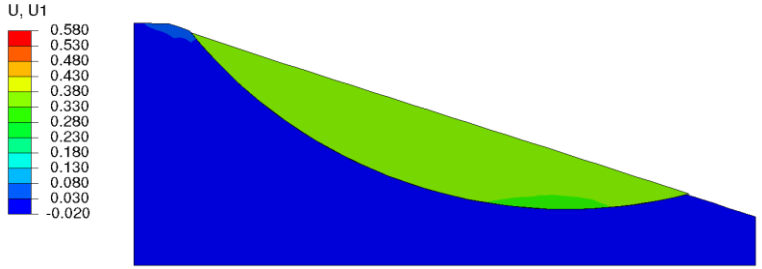


Schematic of 2D model



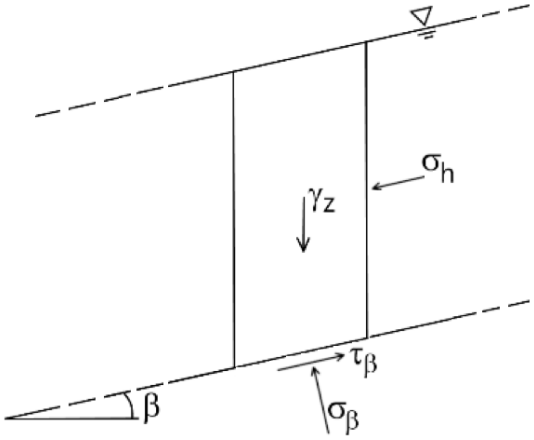
Gravity

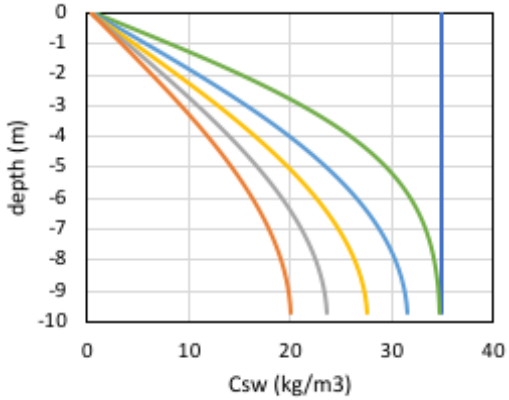
Maximum displacement at the top of the slope

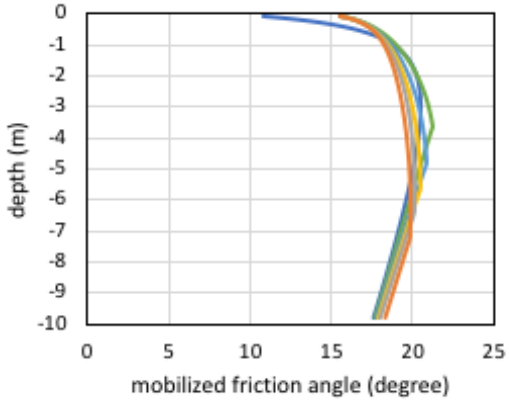


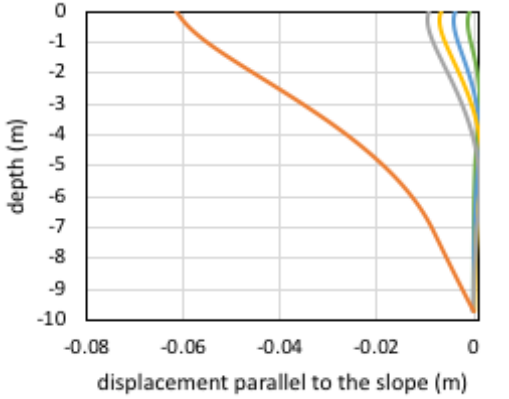
Decrease of salt concentration in the slope induces movement of the slope along the slip surface

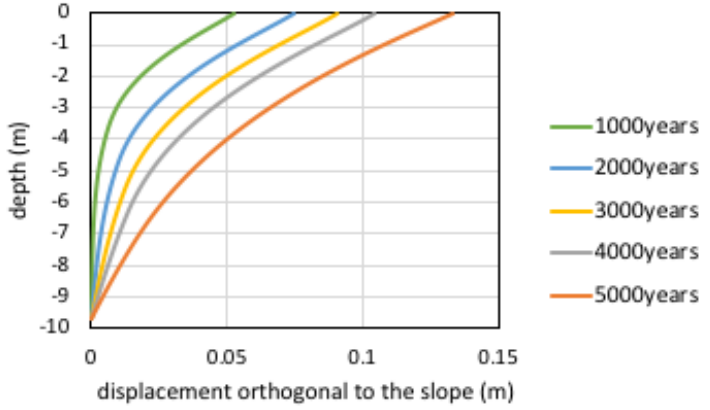
Infinite slope with 10 m depth





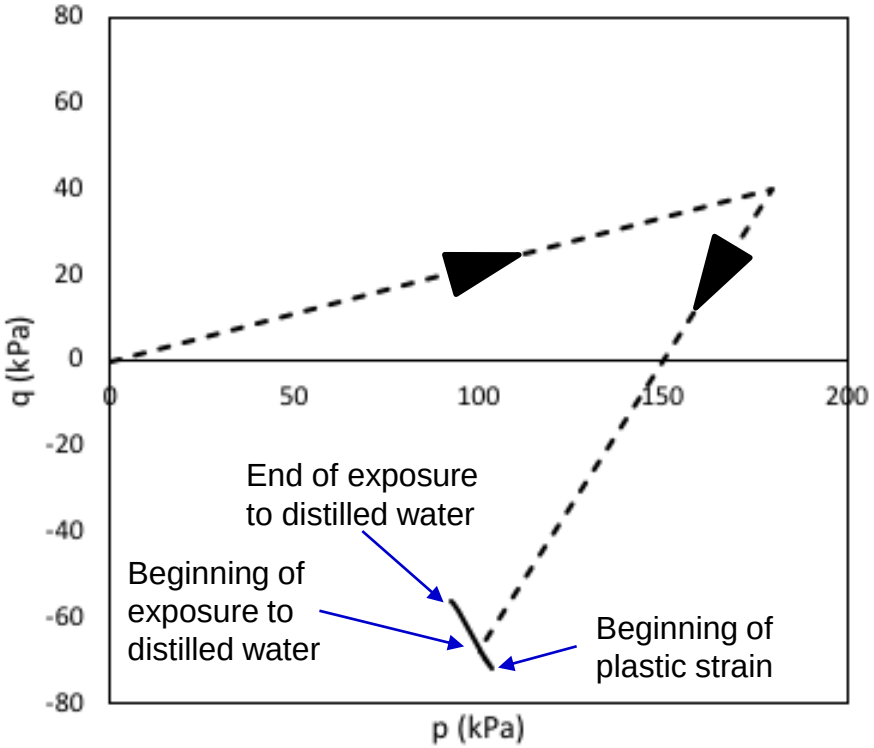


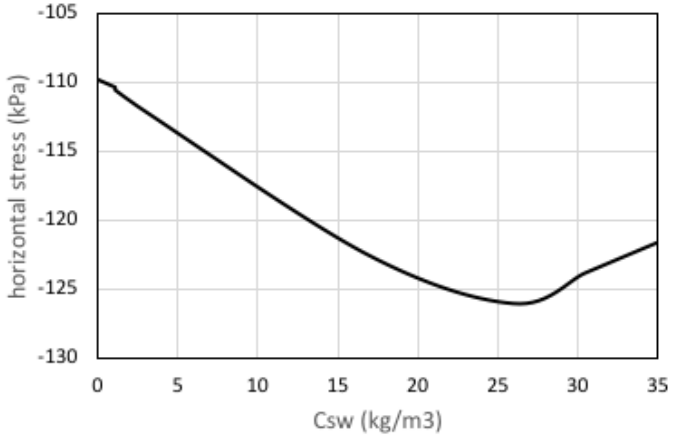


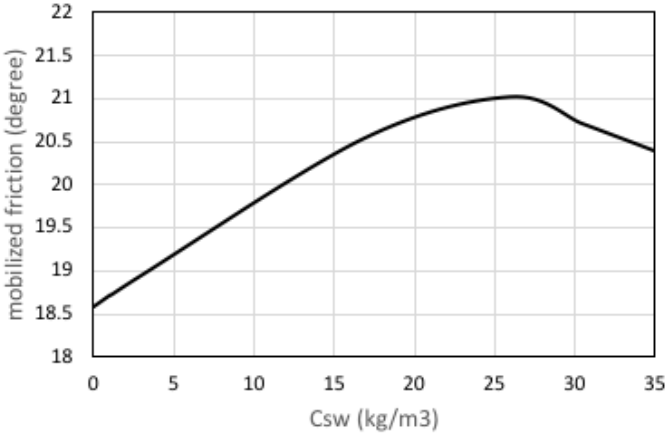


Displacements;
Negative→downward

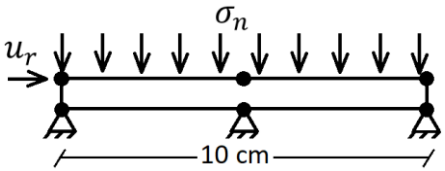
Results of the element at 5m depth

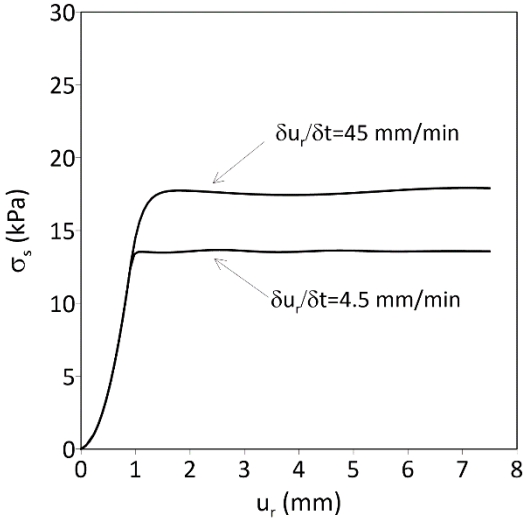




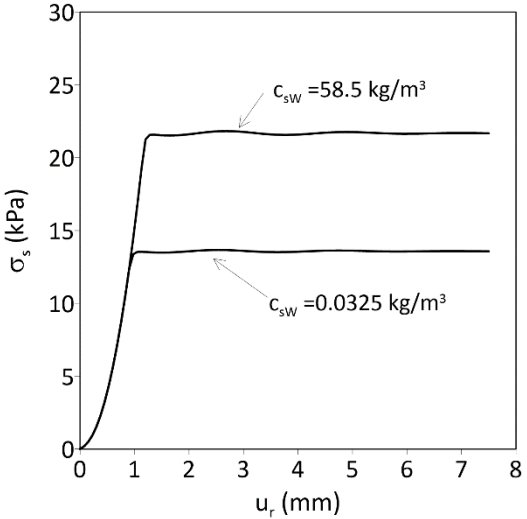


A new contact element: effects of displacement rate ($\frac{\delta u_r}{\delta t}$) and salt concentration (C_{sW}) on the mechanical response

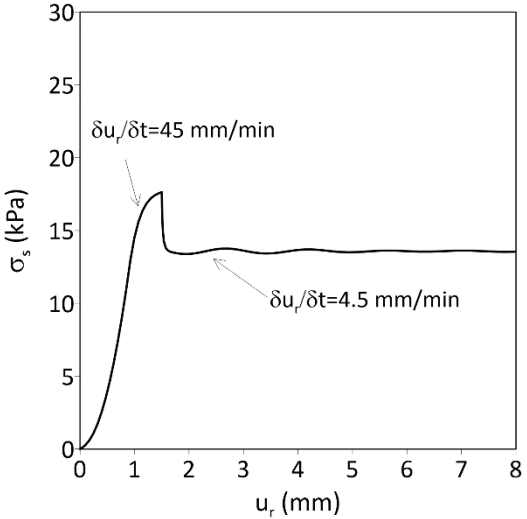




Effect of displacement rate

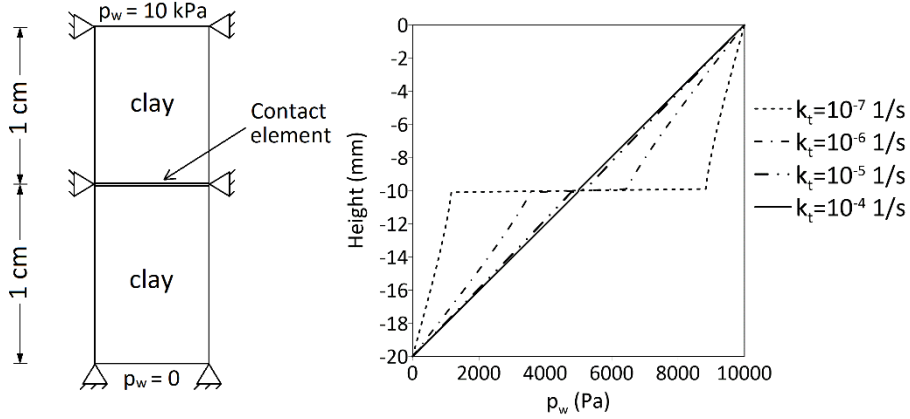


Effect of salt concentration

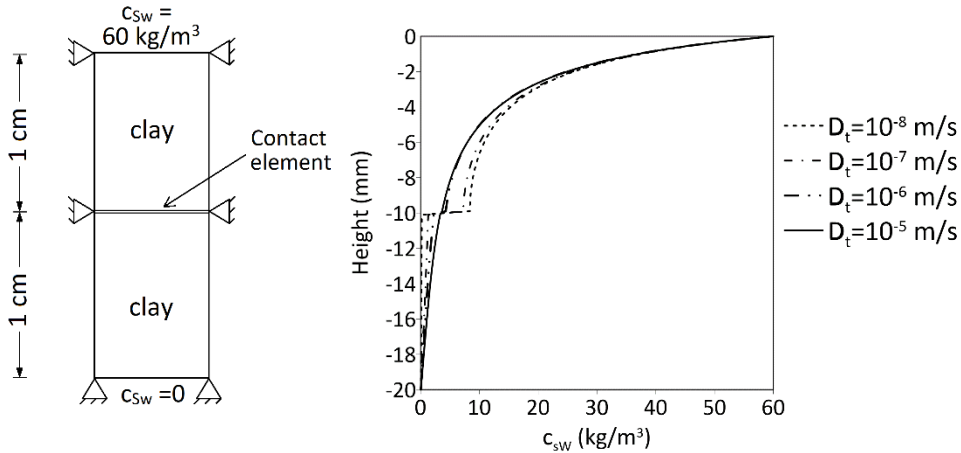


Effect of displacement rate

Flow of water and diffusion of salt in the normal direction of contact element

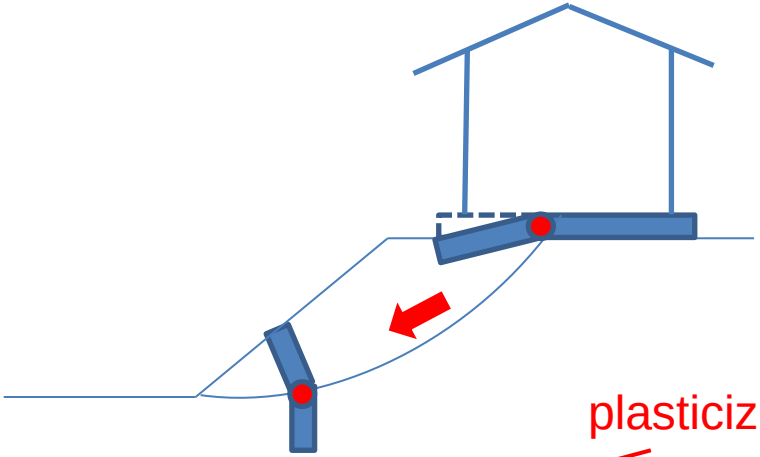


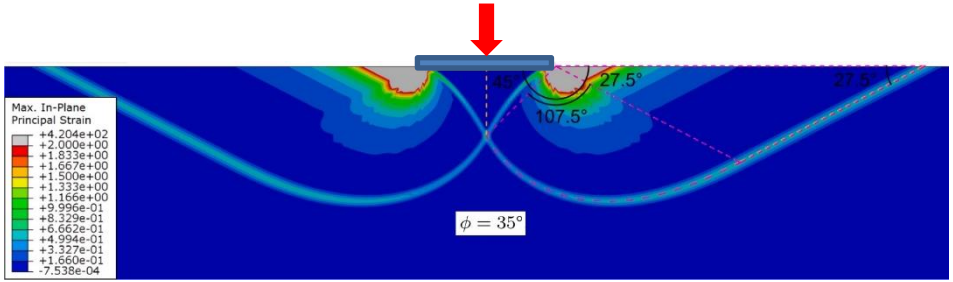
Flow of water when different values of hydraulic conductivity k_t are considered for the contact element in the normal direction



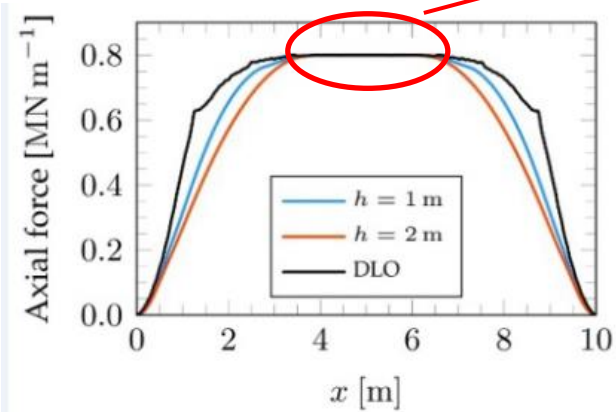
Flow of water when different values of and diffusion coefficient D_t are considered for the contact element in the normal direction

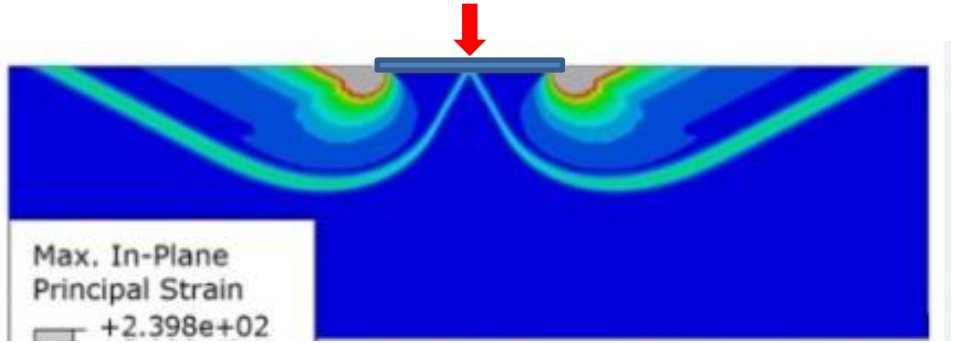
Implementazione di un FEM con MC elastico-perfettamente plastico per analisi degli SLU



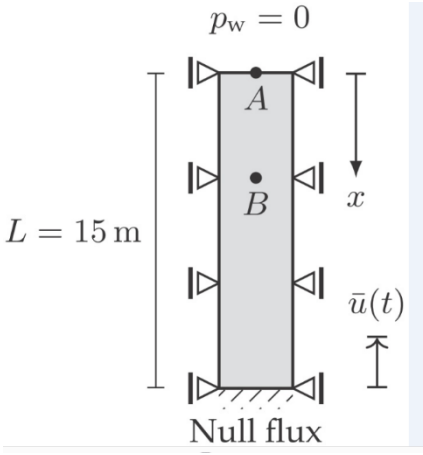


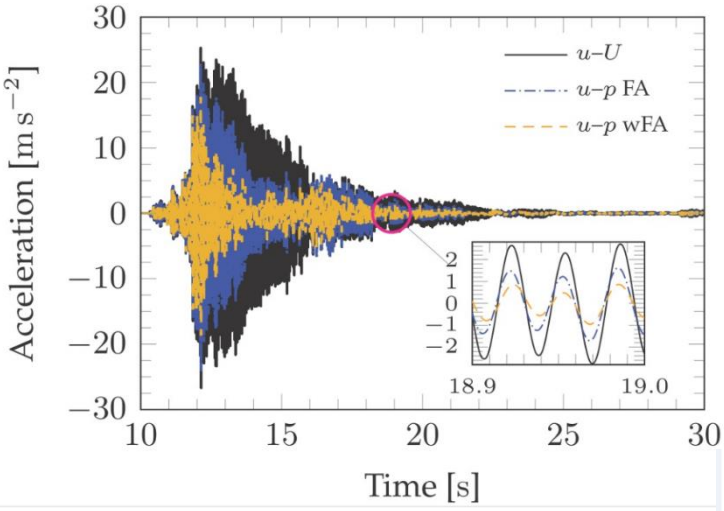
plasticizzazione assiale

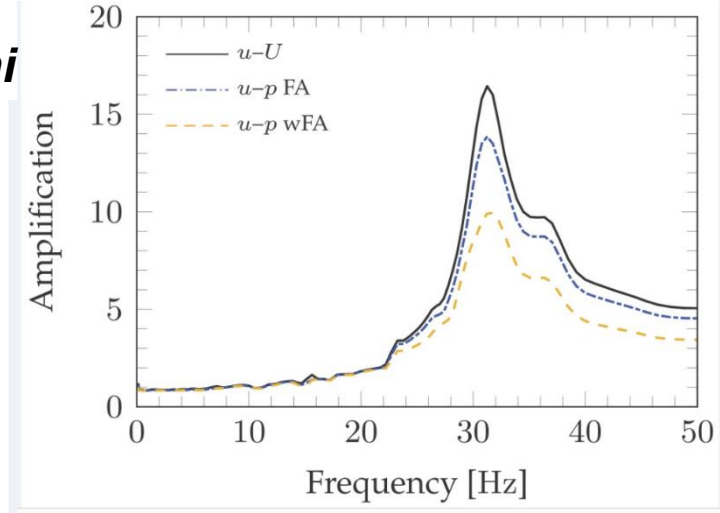




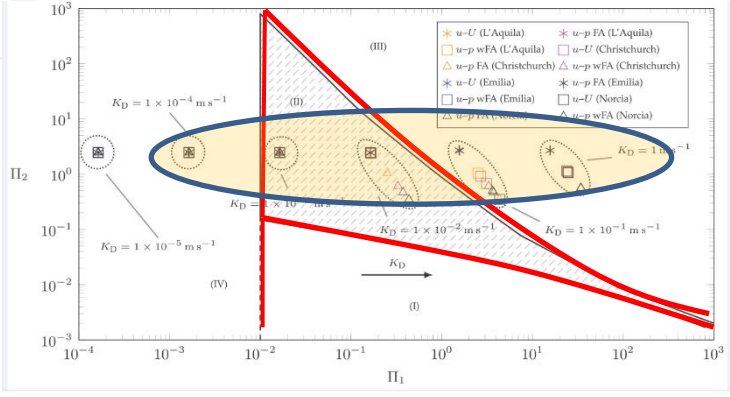
Formulazione u-p per l'analisi dinamica dei terreni







Errori piccoli per $K \leq 10^{-5}$ m/s



Fattibilità di monitoraggio crolli con rilievi LiDAR da veicolo

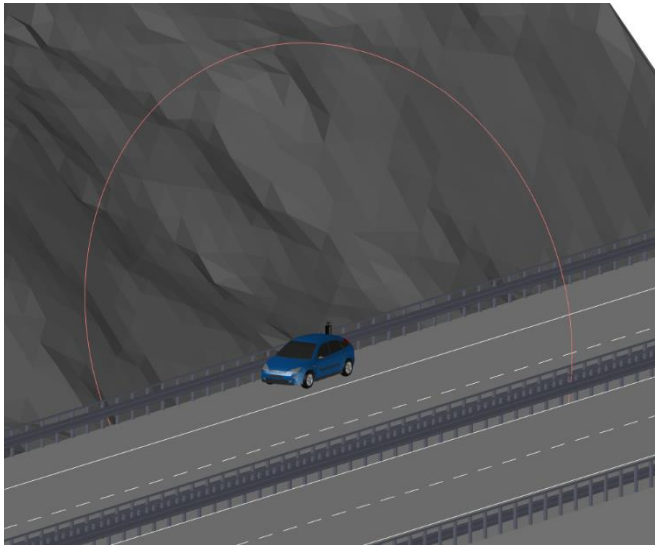
Rilievi tramite droni difficilmente realizzabili a causa di orografia complessa e normative di volo

Possibilità di eseguire rilievi terrestri da autoveicolo in transito sulla corsia di emergenze dell'autostrada in modalità:

- Statica (Stop&go)
- Cinematica (v = 15 km/h)

Per lo **studio di fattibilità teorico (**simulato con **GRASS GIS** e script in **Python)** sono stati utilizzati i seguenti dati:

- Digital Terrain Model (DTM) della Provincia Autonoma di Bolzano
- Ortofoto
- Specifiche tecniche dei LiDAR: RIEGL VUX-1HA per rilievo cinematico e RIEGL VZ-2000i per rilievo statico



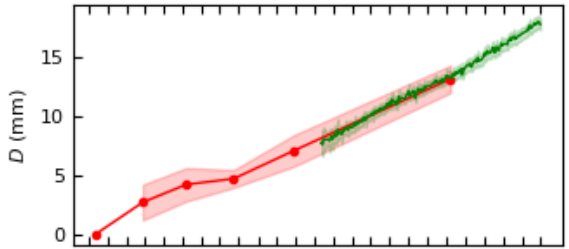
Zone con pendenza > 70°

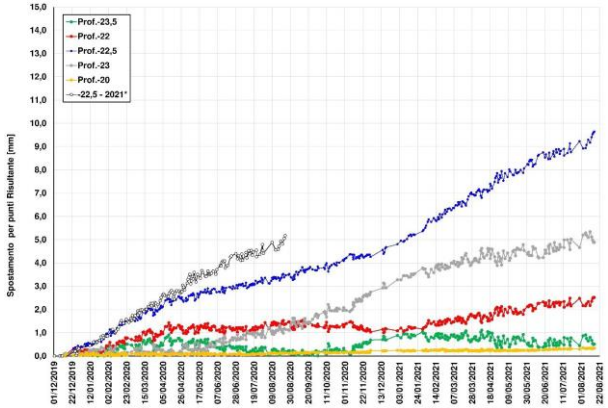
rilievo statico:
- ***90% rilevate***
- ***Densità 400 punti/m2***

rilievo cinematico:
- ***85% rilevate***
- ***Densità 100 punti/m2***

Sperimentazione di un Automatic Inclinometer System in frana estremamente lenta

Circa 1 misura/giorno per 2 anni





Istituto di Ricerca per la Protezione Idrogeologica

GEOHAZARD MONITORING GROUP

Conclusioni e sviluppi futuri

- Simulazione 2D dei fenomeni chemo-meccanici nel pendio
- Simulazione del campo prove con i pali di KCl
- implementazione di una formulazione *u-p-w* per l'analisi dinamica dei terreni

Pubblicazioni con ringraziamenti a MITIGO e/o altri prodotti

Lavori pubblicati

1) Ghalamzan F., De Rosa, J., Gajo A., Di Maio C. Swelling and swelling pressure of clay soils: experimental data and model simulations, *Engineeering Geology 297 (2022), pp. 1-18.*

2) L.P. Argani and A. Gajo. “A novel insight into vertical ground motion modelling in earthquake engineering”. In: International Journal for Numerical and Analytical Methods in Geomechanics 46.1 (2022), pp. 164–186. DOI: 10.1002/nag.3295

3) L.P. Argani and A. Gajo. “A new isotropic hyper-elasticity model for enhancing the rate of convergence of Mohr-Coulomb-like constitutive models and application to shallow foundations and trapdoors”. In: Computers & Geotechnics 132 (2021), p. 103957. DOI: 10.1016/j.compgeo.2020.103957

4) L.P. Argani, A. Gajo, and C.C. Smith. “A new insight into the effects of combined rupture mechanisms of soil and shallow foundations”. In: X Incontro Annuale dei Giovani Ingegneri Geotecnici. Atti del convegno (Pisa (Italy), Sept. 3–4, 2021). Ed. by F. Ceccato, M. Rosone, and S. Stacul. 10th edition of the IAGIG. AGI, 2021, pp. 7–10. ISBN: 978-88-97517-16-0. DOI: 10.13131/unipi/iagig.x.2021/1.2. URL: http://geotecnica.unipi.it/eventi/iagig_pisa/

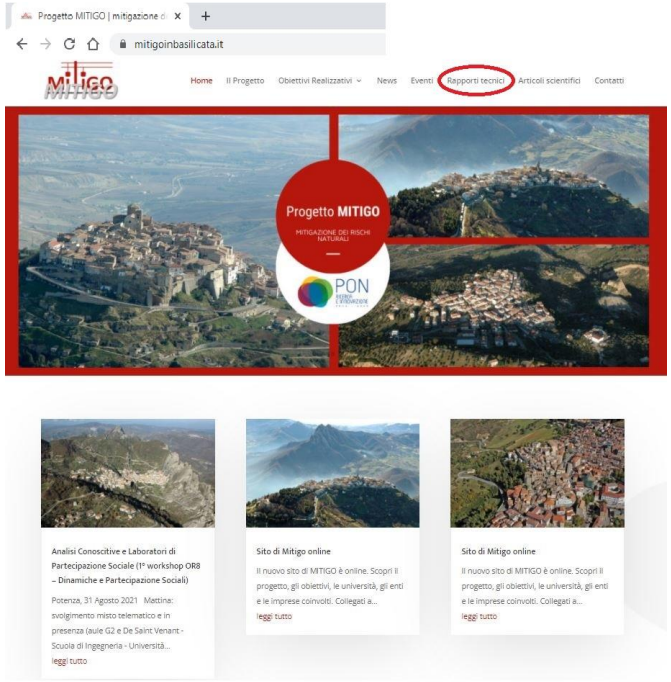
Lavori sottomessi o in preparazione

1) L.P. Argani, A. Gajo, and C.C. Smith. “Combined rupture mechanism of shallow foundations under drained conditions”. In: Acta Geotechnica (2022). Submitted in August 2021.

2) L.P. Argani and A. Gajo. “Finite element analysis of failure loads of shallow non-yielding foundations subjected to complex loading conditions”. Rivista Italiana di Geotecnica (2022). Submitted in March 2022.

3) Allasia P., Ferro E., Godone D., Pasquato A. and Simeoni L. (2022) - Inclinometer measurements with robotized and traditional mobile probes in an extremely-slow landslide, 11th International Symposium on Field Monitoring in Geomechanics - ISFMG 2022, Imperial College of London, September 4, 2022 - September 7, 2022 (in preparation)

Rapporti divulgativi da pubblicare sul sito www.mitigoinbasilicata.it



1. Fenomeni di rigonfiamento nella frana di Costa della Gaveta

Considerazioni sugli effetti del rigonfiamento sulla stabilità dei pendii di Costa della Gaveta