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Τα Νέα της Ε Ε Ε Ε Γ Μ

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Οδοντωτός

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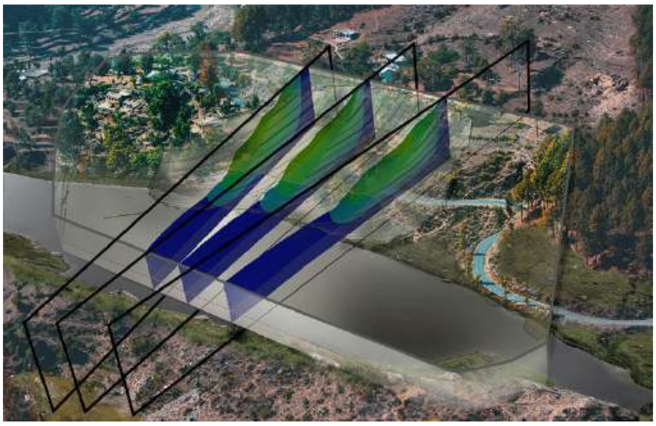
Για μα θυμηθούμε τα μαθηματικά μας:

$$\sqrt{1-(|x|-1)^2} = -3\sqrt{1-\sqrt{\frac{|x|}{2}}}$$

Λύστε την εξίσωση. Η απάντηση στο επόμενο τεύχος.

ΑΡΘΡΑ

Implement Deep Foundation Resistance while performing Slope Stability Analysis



Deep Foundations Institute recently hosted the virtual conference S3: Slope, Slides, and Stabilization on August 5th, 2020, and the Rocscience Team was represented by Dr. Sina Javankhoshdel and Jeff Lam in the software discussion panel as part of the event. This gave us the opportunity to highlight the features and showcase the application of our software programs to a specific slope stability analysis problem, with the goal of advancing the state of practice.

This year's discussion was focused on the correct implementation of deep foundation resistance in slope stability analysis. As will be seen, Rocscience took a novel approach to the problem by using five of its software programs - Slide2, RSPile, RS2, Slide3, and RS3 with Slide2 serving as the fulcrum for other analyses beyond the commonly used 2D limit equilibrium. This follows on the best practice of verifying results using a different analysis method (limit equilibrium vs. finite element) as well as comparing 2D results with a 3D analysis to determine the significance of 3D effects. It also showcases how these Rocscience programs can be used in cooperation with each other for a comprehensive and realistic analysis result.

The Problem

The Trunk Highway in Crookstone, Minnesota was the subject of this year's discussion, where a landslide took place on a slope in 2003; the same location that was subject to a landslide that took place 70 years before in 1933. This landslide history is prominent in the baseline conditions defined in the problem that addresses the common practice of applying the full shear strength of the structural material as a resisting force whereas reality is that the deep foundation element often reaches a different failure mode before mobilization of its full shear strength

A snapshot of the provided model is shown in Figure 1 while Table 1 below shows the material properties for the baseline analysis.

For the baseline problem, the goal is to analyze the slope, including stabilization, using three rows of 8.0-ft diameter drilled shafts, as shown in Figure 2.

The provided model also identifies the location of the drilled shafts, which are spaced at 40 ft apart in the plane of the cross-section and 24 ft in the out-of-plane direction. The shafts are socketed 16 ft into the Red Lake Falls Formation, meaning that the length of each row is slightly different because of changing ground surface elevations. Table 2 below gives additional structural properties of the drilled shafts, while Table 3 provides the recommended parameters for defining p-y curves for the lateral pile analysis.

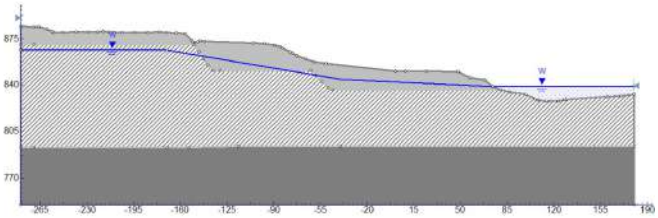


Figure 1. Baseline problem, cross-section A

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface
Alluvial Deposits		125	Mohr-Coulomb	0	35	Water Surface
Huot Formation Clay		112	Mohr-Coulomb	0	15	Water Surface
Red Lake Falls Formation		142	Mohr-Coulomb	0	40	Water Surface

Table 1. Baseline problem material properties

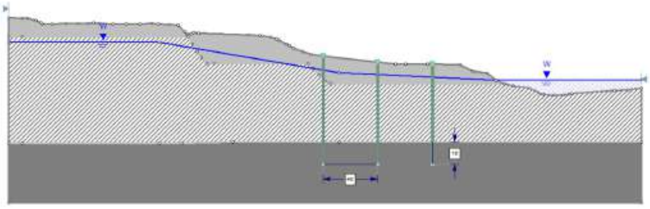


Figure 2. Baseline problem, stabilized configuration

Property	Description
Concrete Strength	f'_c = 5,000 psi
Transverse Reinforcement	No. 7 GR60 hoops spaced at 6 in vertically on-center; 6 in clear cover from edge of shaft to edge of bar
Longitudinal Reinforcement	27 No. 18 GR 60 bars (ρ = 1.49%)

Table 2. Drilled shaft structural properties

Material		Unit Weight (pcf)	Model	Friction Angle (deg.)	Initial Modulus of Subgrade Reaction	Strain Factor	Undrained Shear Strength
Alluvial Deposits		125	API Sand	34	140 pci	-	-
Huot Formation Clay, Undrained		112	Soft Clay	-	-	0.01	Consistent w/ Table 1
Huot Formation Clay, Drained		112	Sand (Reese)	15	10 pci	-	-
Red Lake Falls Formation		142	Mohr-Coulomb	40	200 pci	-	-

Table 3. Recommended p-y parameters

Analysis and Results

Rocscience has taken a six-step approach to the problem where five Rocscience software programs are used interoperably for a comprehensive and detailed analysis:

Step 1. Using Slide2 to determine the FoS for existing conditions of the baseline problem for a 2D limit equilibrium analysis

As the starting point for the problem solution, the provided baseline model (Figure 1) is imported into Slide2 using its powerful geometry import and cleanup capabilities. The material properties are then defined for the model, as shown in Table 1. A non-circular critical slip surface search is then conducted to determine the FoS of the baseline model using Cuckoo Search coupled with Surface Altering Optimization (SAO). SAO is a powerful tool unique to Rocscience programs that yield lower FoSs by modifying the geometry of a given slip surface. The resulting FoS (using the Spencer method) is 1.11, as shown in Figure 3.

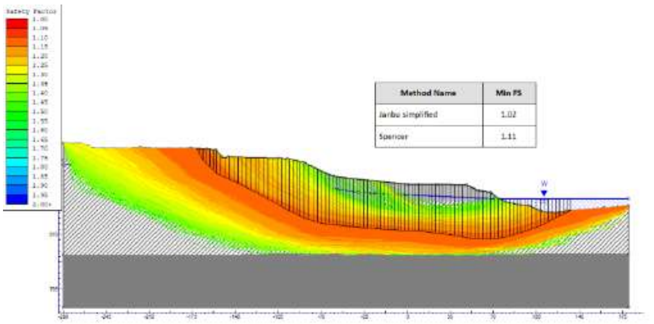


Figure 3. Resulting FoS of the baseline problem (unreinforced)

Step 2 – Using RSPile to determine the allowable soil displacement that will produce the nominal drilled shaft structural mobilization

In this step, the Slide2 model is first set up with reinforcing elements as shown in the provided drilled shaft design (see Figure 2). A lateral analysis is then set up in RSPile using the provided drilled shaft structural properties (Table 2) and p-y parameters (Table 3).

The structural mobilization along the pile length vs. a range of soil displacements is then checked to see how much deformation the pile can handle. Figure 4 below shows the structural mobilization of the pile at a 1″ displacement while Figure 5 shows the maximum pile mobilization vs. a range of soil displacements.

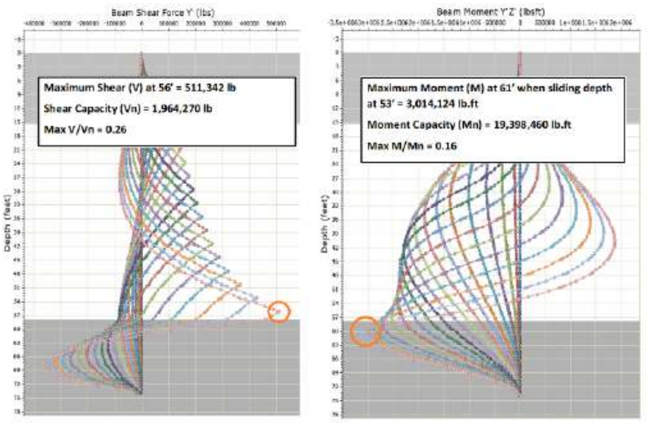
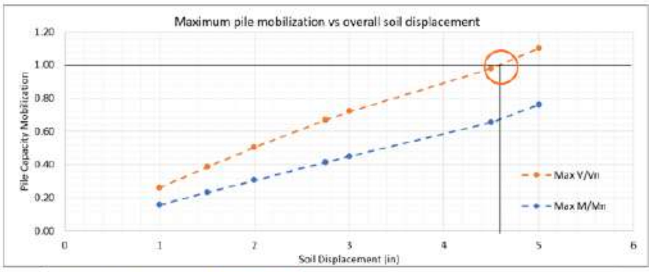


Figure 4. Structural mobilization of pile at a 1″ displacement

Step 3 – Using Slide2 and RSPile to determine the FoS of the reinforced slope

Once the pile's structural mobilization is calculated, the RSPile files are linked into Slide2 for the slope stability analysis using Slide2's automated integration with RSPile. Once the files are linked, the pile resistance envelope for each pile stratigraphy is generated and used by the searching algorithm in Slide2 to determine the critical sliding surface. At a soil displacement of 1″ (Figure 6), the FoS is 1.3. If this is the target FoS, it is the geotechnical stability of the system that governs since there is still structural capacity left in the piles. To see what it takes to get a FoS of 1.5, the soil is allowed to continue to displace up to 2.75″, as shown in Figure 7.



Shear Capacity (lb)	1,964,270						
Moment Capacity (lb.ft)	19,398,460						
Displacement (Soil) (inch)	1	1.5	2	2.75	3	4.5	5
Max Displacement (Pile) (inch)	1.4	2.1	2.7	3.9	4.2		7
Max V/Vn	0.26	0.39	0.50	0.67	0.72	0.96	[illegible]
Max M/Mn	0.16	0.23	0.31	0.41	0.45	0.65	0.76

Figure 5. Structural mobilization of the pile vs. overall soil displacement

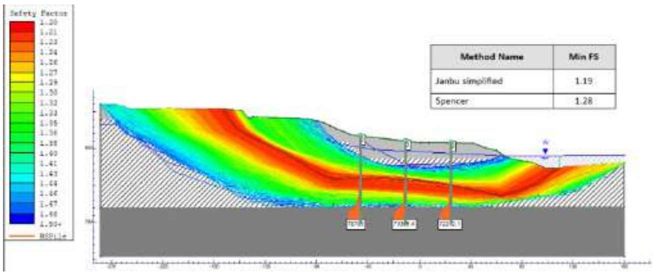


Figure 6. Slope stability analysis with a 1″ soil displacement

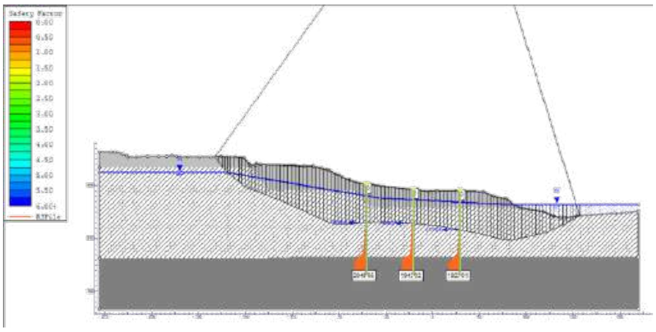
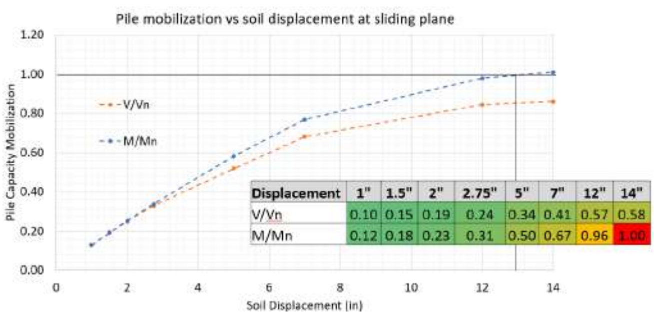


Figure 7. Slope stability analysis with a 2.75″ displacement

The analysis is then taken further by running additional analyses in RSPile to see how the pile will perform as displacement along the critical sliding depth is increased until hitting full structural mobilization (Figure 8).



Displacement	1"	1.5"	2"	2.75"	5"	7"	12"	14"
V/Vn	0.10	0.15	0.19	0.24	0.34	0.41	0.57	0.58
M/Mn	0.12	0.18	0.23	0.31	0.50	0.67	0.96	1.00

Figure 8. Structural mobilization vs soil displacement along the sliding surface

The conclusion from the results is that the flexural capacity of the pile will be reached first when only 58% of the nominal shear capacity is mobilized.

Step 4 – Using RS2's SSR capability to analyze FoS of the Slope

Since best practice dictates that results are checked using a different analysis method, a comparable finite element analysis is conducted for comparison purposes. Model materials are imported as MC, and a plastic model is used for the soils where the residual strength is equal to peak strength. Pile parameters of E and Moment of Inertia are calculated from the provided pile parameters (Table 2 and Table 3), and the pile is modeled as a simple liner with no slip.

The first step in the analysis is to compare the unreinforced case to ensure that a) a comparable FoS and b) a comparable critical surface are obtained. The reinforced model is then analyzed with a failure surface going through all the piles to produce a strength reduction factor (SRF) of close to 1.5, which is similar to our 2D limit equilibrium results (Figure 9).

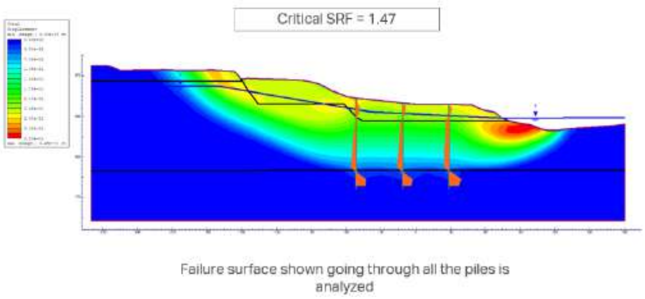
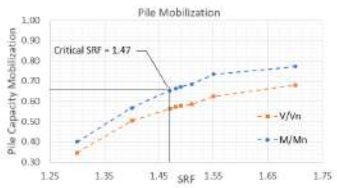


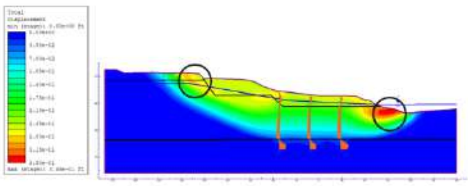
Figure 9. Slope stability with piles

RS2 automatically generates the steps to calculate the strength reduction factor (SRF) with an SRF and indicates whether the pile (liner) has reached its structural capacity. The results are presented in the table in Figure 10 and Figure 11 below, with the results being in agreement with the RSPile model that the pile is mobilizing more moment as the soil continues to deform.



SRF	1.3	1.4	1.47	1.48	1.49	1.51	1.55	1.7
Max Pile Displacement (inch)	3.2	4.8	6.9	7.4	7.8	8.6	11.7	27.3
V_{max} (lb)	682,752	992,112	1,110,960	1,125,456	1,136,976	1,153,728	1,227,528	1,338,240
V/Vn	0.35	0.51	0.57	0.57	0.58	0.59	0.62	0.68
M_{max} (lb-ft)	7,781,688	11,033,640	12,687,576	12,870,168	13,040,856	13,305,552	14,241,648	14,970,648
M/Mn	0.40	0.57	0.65	0.66	0.67	0.69	0.73	0.77

Figure 10. Full structural mobilization of the pile (1)



SRF	1.3	1.4	1.47	1.48	1.49	1.51	1.55	1.7
Max Pile Displacement (inch)	3.2	4.8	6.9	7.4	7.8	8.6	11.7	27.3
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V/Vn	0.35	0.51	0.57	0.57	0.58	0.59	0.62	0.68
M_{max} (lb-ft)	7,781,688	11,033,640	12,687,576	12,870,168	13,040,856	13,305,552	14,241,648	14,970,6
M/Mn	0.40	0.57	0.65	0.66	0.67	0.69	0.73	0.77

Figure 11. Full structural mobilization of the pile (2)

It is also shown in the figures that, at our critical SRF of 1.47, the geotechnical stability of the soil governs.

Step 5 – Using Slide3 to determine the significance of 3D effects with a 3D limit equilibrium analysis

To perform a proper analysis of the influence of support (piles) on the slope stability, full 3D models of the problem were created in Slide3 to compare with the 2D results. The models were created using the provided elevation contours together with the boreholes to create a second geometry, which was more accurate since actual elevation contours were used.

The results of the unreinforced 3D limit equilibrium analysis can be seen in Figure 12.

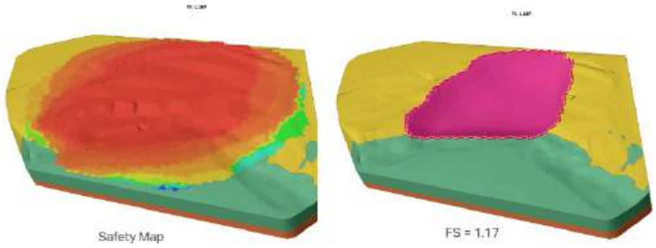


Figure 12. Results of the unreinforced 3D limit equilibrium analysis in Slide3

Step 6 – Using RS3 to compare the results obtained from the Slide3 analysis

The next and final step in the problem solution is to take geometry from Slide3 into RS3 for comparison with the 3D limit equilibrium analysis. To create the reinforced model, the capacity and the piles for the 2.7" displacement are exported as user-defined supports. The pattern is similar to the 2D, H-spacing of 24 ft, and V-spacing of 40 ft for the region. The analysis is first performed for the reinforced case, obtaining a FoS of 1.6, which is slightly higher than the 2D reinforced case, which is as expected. The model and results are presented in Figure 13 and Figure 14 below.

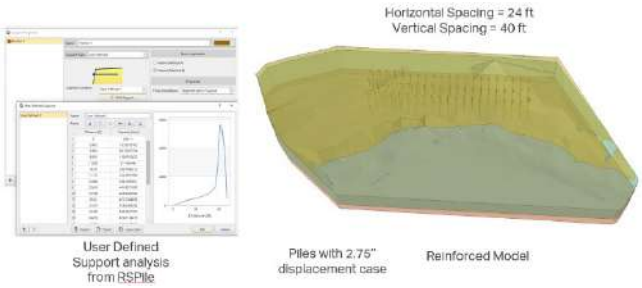


Figure 13. 3D reinforced model in RS3

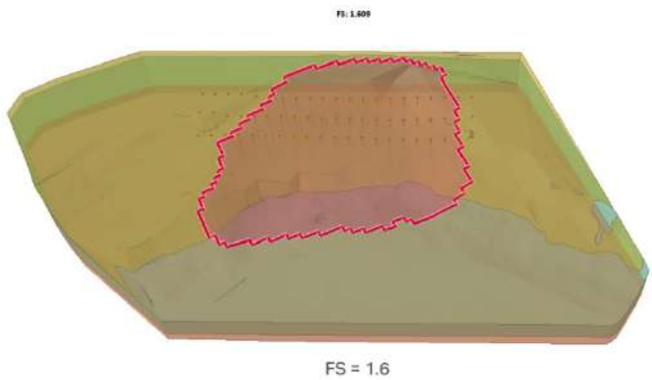


Figure 14. 3D reinforced model results in RS3

Summary of Results

To summarise the results of the analyses:

- Slide2 yielded two different FoS based on soil displacement.
- A strength reduction factor (SRF) of close to 1.5, which is similar to our 2D limit equilibrium results was achieved when the Slide2 results were verified using RS2.
- The result of the analysis in Slide3 was verified with that of RS3 with the FoS being 1.6.

Conclusion and Takeaway

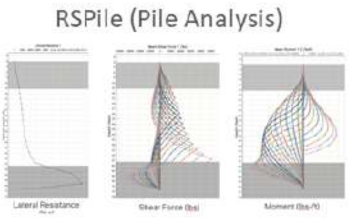
Rocscience has taken a broad approach to the problem by

using five of its software programs (Slide2, RSPile, RS2, Slide3, and RS3) in collaboration. Slide2 was chosen to serve as the fulcrum for other analysis methods due to the general popularity and widespread acceptance of the 2D limit equilibrium method. The results from the analysis indicate that 2D LEM (Slide2) combined with pile analysis software (RSPile) will yield comparable results when compared to other more sophisticated methods such as 2D FEM (RS2), as long as the material parameters are comparable and the failure mechanisms are modeled correctly. For example, all analysis models correctly indicate that the piles will mobilize its full flexural capacity before shear occurs along with the critical sliding surface, and it is the flexural capacity that governs over the range of soil displacements analyzed,

A comparison of 2D and 3D results indicate a marginal increase (6%) in FoS when the problem is analyzed in 3D. The difference is due to the limitations of a 2D model, which incorrectly assumes a plane strain failure surface, and neglects confinement forces.

For the analysis of the subject pile reinforced slope, the engineer can choose from multiple analysis methods to compute the FoS. The decision of which method to use would ultimately depend on the amount of soil strength data available, resolution of topographic data, budget, time, and the engineer's experience with the corresponding method.

https://www.rocscience.com/about/news-events/rocscience-at-dfi-s3-2020-slide2-as-the-fulcrum-for-implementing-correct-deep-foundation-resistance-in-slope-stability-analysis



Software	Soil Displacement	Result
RSPile (Pile Analysis)	1″	V/Vn = 0.10 M/Mn = 0.12
	2.75″	V/Vn = 0.24 M/Mn = 0.31
Slide2 (2D LEM)	1″	FoS = 1.3
	2.75″	FoS = 1.5
Slide3 (3D LEM)	2.75″	FoS = 1.6
RS2 (2D FEM)	non-uniform	FoS = 1.5 V/Vn = 0.57 M/Mn = 0.65

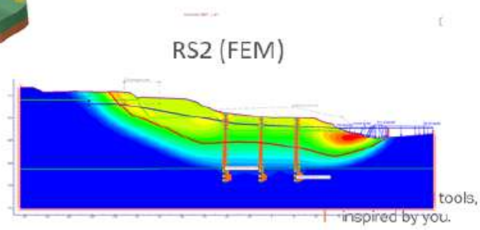


Figure 15. Summary and comparison of results of all analyses

Effects of Pile Rigidity and Soil Stiffness on the Settlement of Piles

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This article is intended to show how RSPile is useful in research and parametric study.

Introduction

One of the likely benefits of having RSPile on your computer is conducting side research to have a better expectation to how your pile will behave. The following simple research work on RSPile will show you how we can optimize the stiffness of the pile to consume more of the skin resistance capacity and get shorter piles rather than having long stiff piles. Hence, this may lead to significant cost saving especially if the settlement was within the acceptable limits.

In the following example, different piles of two diameters 0.9 m and 0.3 m having the same length of 15 m are analyzed in addition to a series of piles of 0.9 m diameter but with a shorter length of 10 m. Piles have different modulus of elasticity varying from very stiff (rigid piles) of 2M MPa to only 200 MPa. The piles are analyzed embedded in three different soil layers with varying stiffness having skin resistances of 60 kPa, 90 kPa and 120 kPa, respectively. The user defined relative T-z curves are kept the same for the three soils to know exactly how the stiffness of the soil varies among the three cases.

The results will be discussed and presented to show how the piles are expected to behave under different stiffness conditions and how to use RSPile in handling such research work.

It is found that the stiffer the pile and the weaker the soil, the skin friction tends to be uniform along the depth with a smaller percentage of its ultimate capacity consumed. As the soil becomes stiffer or the pile becomes more flexible, the mobilized skin resistance approaches the ultimate values at the top parts of the pile and attenuates rapidly with depth leaving a long part of the pile useless. An introduction of the idea of effective length is then clearly noticed.

Defining the Soils

The soils used in the analysis are Soil 1, Soil 2, and Soil 3. To study the effect of soil stiffness and pile stiffness distinguished, the soil stiffness should not be dependent on pile size or length. That is why it is better to choose the user defined T-z curves instead of other models that are built in RSPile. The user defined T-z curves defines the soil skin friction mobilization level based on the "absolute displacement" of the soil instead of relative displacements. In this approach we can get different stiffness for the soil depending only on its ultimate skin resistance with reference to the same displacement value.

The soil T-z curve chosen following the points given in Table 1 and the relation is plotted in Fig.1.

Table 1. T-z curve defining points for the soils used in the study

Soil Displacement (mm)	Ratio of Mobilized (f_s/f_{sult})
0	0
5	0.5
10	0.75
15	0.9
20	1

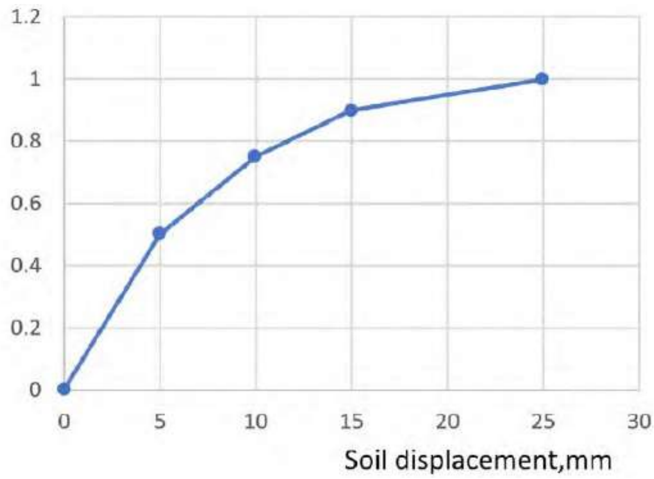

Figure 1. T-z curve defined for the soils in the study

All the three soils were set to have no tip resistance (end bearing capacity = 0). This will help to distribute the skin friction properly without interference of base to the load distribution. As mentioned in the introduction, the soils are given ultimate skin resistances of 60 kPa, 90 kPa, and 120 kPa, respectively.

The software needs to be run three times changing the soil type. Instead, a simple trick is followed here to define three zones of soils that are different from each other. Maximum diameter size used is 0.9m with a depth of 15 m. The soil is extended to 21 m to make sure no issues occur at the pile base. The trick is to define transition zones between the three soils where no piles will be installed. This is done using 18 boreholes to define the main zones where the piles are installed and the transition zone.

Fig.2 shows how the 18 boreholes are used to define the required soil zones to run the program one time for all cases. Boreholes 1–6 contain the zone for soil 1, 7–12 for soil 2, and 13–18 for soil 3, while the intermediate zones are transition zones to change the soils easily by defining zero thicknesses for the other soils and 21 m for the soil assigned to that zone. So, the soil layers are given thicknesses of 21 m as per the numbers of the boreholes in the sequence above and zero thicknesses for the other layers.

Piles Distribution

The piles are distributed in diameters lengths and loads to adequately study the stiffness effects on settlement. Forty-five piles are used with two diameters, 0.9 m and 0.3 m. The axial (vertical) load given to the 0.9m diameter piles is 300kN. To keep the same effect of length and perimeter on skin friction, a load of 100 kN is applied at pile heads of the 0.3 m diameter piles. Hence, we can study the effect of rigidity easily. Piles are divided to five levels of Young's modulus

2E10, 2E8, 2E6, 2E4 and 200 kPa from very stiff piles (almost fully rigid compared to the soils) to extremely flexible. Two rows of piles installed in each soil are given 15 m lengths. The third rows have shorter lengths of 10 m. The pile numbers and their properties are listed for all cases in Table 2.

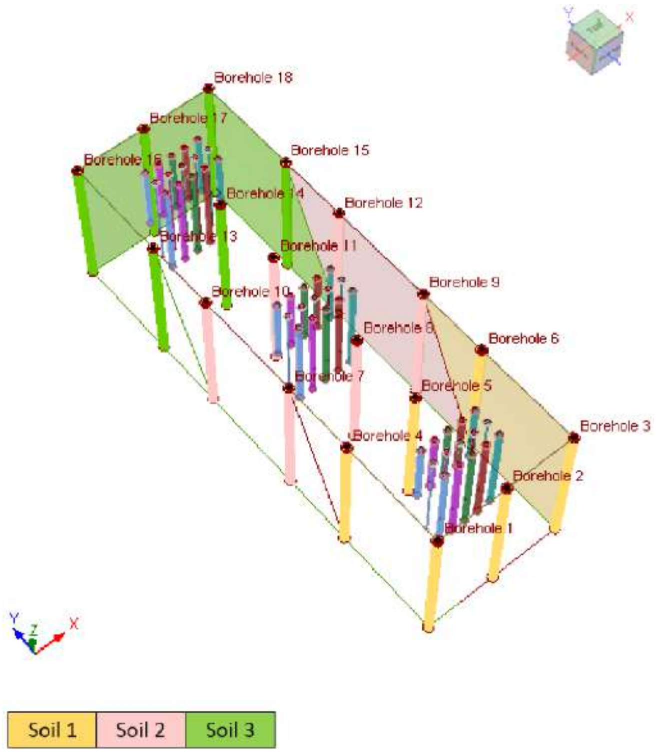

Figure 2. The distribution of the 18 boreholes to zone the soils

The piles are spaced at 2 m for convenience. There is no interaction between them according to RSPile individual pile analysis. The piles layout is shown in Fig.3.

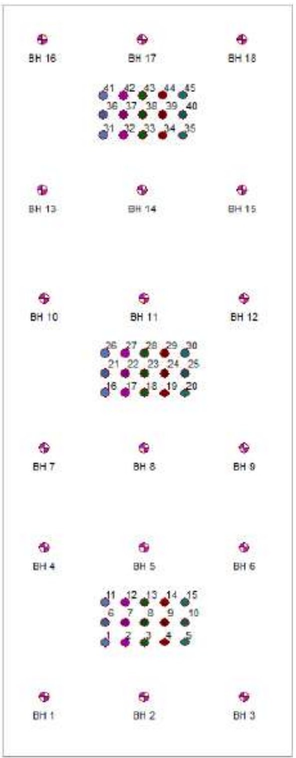

Figure 3. Piles and boreholes

Table 2. Dimensions, properties, and locations in soil zones of the piles in the study

Soil Zone	Pile Number	Diameter	Length	Young's Modulus	Axial Load
		m	m	kPa	kN
Soil 1	1	0.9	15	2.00E+10	300
	2	0.9	15	2.00E+08	300
	3	0.9	15	2.00E+06	300
	4	0.9	15	2.00E+04	300
	5	0.9	15	2.00E+02	300
	6	0.3	15	2.00E+10	100
	7	0.3	15	2.00E+08	100
	8	0.3	15	2.00E+06	100
	9	0.3	15	2.00E+04	100
	10	0.3	15	2.00E+02	100
	11	0.9	10	2.00E+10	300
	12	0.9	10	2.00E+08	300
	13	0.9	10	2.00E+06	300
	14	0.9	10	2.00E+04	300
	15	0.9	10	2.00E+02	300
Soil 2	16	0.9	15	2.00E+10	300
	17	0.9	15	2.00E+08	300
	18	0.9	15	2.00E+06	300
	19	0.9	15	2.00E+04	300
	20	0.9	15	2.00E+02	300
	21	0.3	15	2.00E+10	100
	22	0.3	15	2.00E+08	100
	23	0.3	15	2.00E+06	100
	24	0.3	15	2.00E+04	100
	25	0.3	15	2.00E+02	100
	26	0.9	10	2.00E+10	300
	27	0.9	10	2.00E+08	300
	28	0.9	10	2.00E+06	300
	29	0.9	10	2.00E+04	300
	30	0.9	10	2.00E+02	300
Soil 3	31	0.9	15	2.00E+10	300
	32	0.9	15	2.00E+08	300
	33	0.9	15	2.00E+06	300
	34	0.9	15	2.00E+04	300
	35	0.9	15	2.00E+02	300
	36	0.3	15	2.00E+10	100
	37	0.3	15	2.00E+08	100
	38	0.3	15	2.00E+06	100
	39	0.3	15	2.00E+04	100
	40	0.3	15	2.00E+02	100
	41	0.9	10	2.00E+10	300
	42	0.9	10	2.00E+08	300
	43	0.9	10	2.00E+06	300
	44	0.9	10	2.00E+04	300
	45	0.9	10	2.00E+02	300

Discussion of Results

Four points should be remembered before discussing the results.

1. The total mobilized skin friction must be equal to the applied axial load.
2. The settlement of a pile which mobilizes the skin resistance at any depth is the summation of the elastic shortening of the pile (the sum of the shortening in all pile segments above that level) and the rigid body movement of the pile due to the settlement of the surrounding soil.
3. The mobilized unit skin friction is a function of the soil movement (settlement of the soil regardless of the elastic shortening in the pile).
4. The main results that need to be looked at are the settlement, pile axial force distribution through the length, and the soil resistance distribution (skin friction).

Effect of Pile Stiffness on the Settlement:

Piles 1–5 have different Young's modulus. The results of these piles are shown in Fig.4. Piles 1–3 are plotted together while Pile 4 results are plotted in a different graph to get appropriate scaling as the settlement of Pile 4 increases tremendously due to the low rigidity of the pile. Pile 5 exceeds practical range of settlement and it is considered as a failed pile. It can never hold the load of 300 kN.

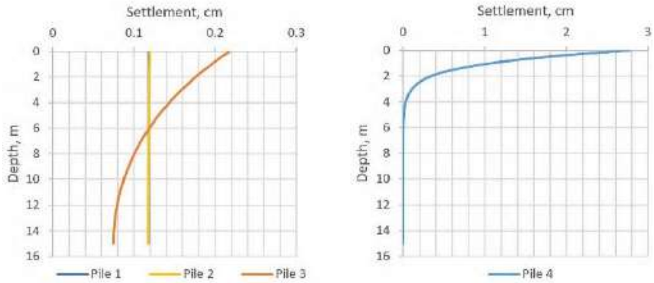

Figure 4. Settlement of Piles 1–4

It can be clearly noticed that although Piles 1 and 2 have 100 times difference in modulus the change in settlement can barely be noticed. These piles act rigid compared to soil stiffness. Hence the settlement will tend to be uniform along the depth and the skin friction as well. Skin friction in this case will be far away from reaching its ultimate values, as seen in Fig.5.

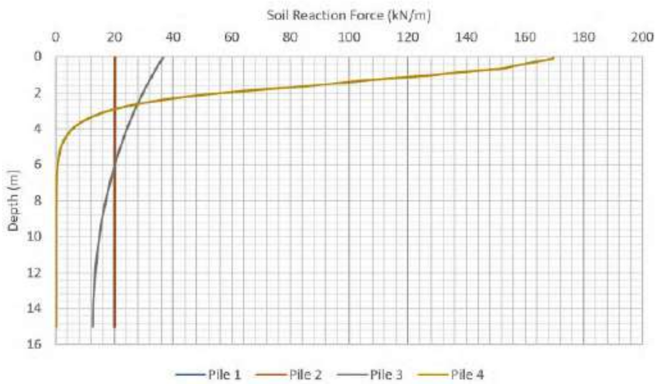

Figure 5. Distribution of skin friction along the depth, Piles 1–4

In Piles 1 and 2, the skin friction is around 20 kN/m * 15 m = 300 kN, the applied load. The uniform skin friction along the depth indicates a rigid body movement instead of having elastic shortening in the pile. Again when the rigidity decreases and the pile becomes flexible such as Pile 3 or 4—the skin friction gets consumed at the top part and the displacement stops at the bottom part of Pile 4, while in Pile 3 there is still some rigid pile movement participating to the settlement and the settlement tends to be uniform at the very bottom of the pile. Settlement in Pile 4 attenuates to zero at around 6m depth and similarly the skin friction goes down to nil. This length is the effective length of the pile where there is real resistance. Increasing the load will push this distribution down and the effective length increases for the same modulus of pile.

Effect of Pile Diameter

The second row of piles, Pile 6–10 are having lesser diameter of 0.3 m with similar variation in modulus. The results are compared with row 1. Piles 1 and 6, and Piles 3 and 8, are plotted in Fig.6. The resulting skin friction along the piles is illustrated in Fig.7.

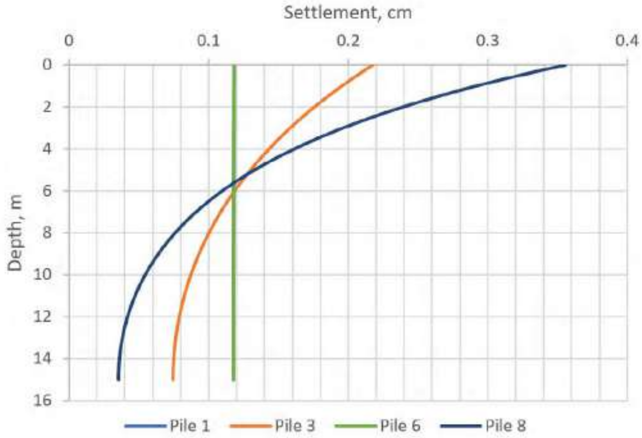

Figure 6. Settlement of Piles 1, 3, 6, and 8

Figure 7. Distribution of skin friction along the pile length for Piles 1,3, 6, and 8

From these figures, it can be seen that pile modulus will not be the only factor that affects the settlement even if the soil stiffness and the load to perimeter ratio are the same. The real factor that affects the settlement response is the rigidity of the pile EA. Piles are the same length, hence, the diameter has a role here. Having less diameter, Pile 8 consumes more unit skin friction at the top than Pile 3 (divide the values 20 kN/m and 37 kN/m by the corresponding perimeters). This means the effect of elastic shortening of the pile is more in the smaller diameter pile (having less rigidity) and accordingly the settlement of Pile 8 is more than the settlement of Pile 3. This effect decreases as rigidity values compared to soil stiffness gets high enough for Pile 1 and 6 where the settlement becomes almost equal due to the dominating rigid body movement. That is also why the skin friction at Pile 6 is one third the skin friction of Pile 1 (the load on Pile 6 is 100 kN while on Pile 1 is 300 kN). As the pile rigidity diameter decreases, the skin friction mobilized more rapidly at the top than for a larger pile due to the increased elastic shortening of the pile with less diameter. Remember that elastic shortening of a pile segment is directly related to EA/L, where L and E are the same for both piles in comparison.

Pile 9 has the same modulus as Pile 4 but of course lower by 100 times than Pile 3 and Pile 8. Fig.4, showed that the skin friction at the top of Pile 4 reached 170 kN/m which means the unit skin friction reached its ultimate value (169.65/0.9/pi= 60 kN/m^2). In fact, following the result table it is found that only the first pile segment (out of 100 segments) arrived at the ultimate skin resistance level, while Pile 9 in Fig.8 shows that a longer part at the top is at the maximum ultimate skin resistance. This is a confirmation of the discussion above. The settlement increases markedly in Pile 9 reaching 6.94 cm.

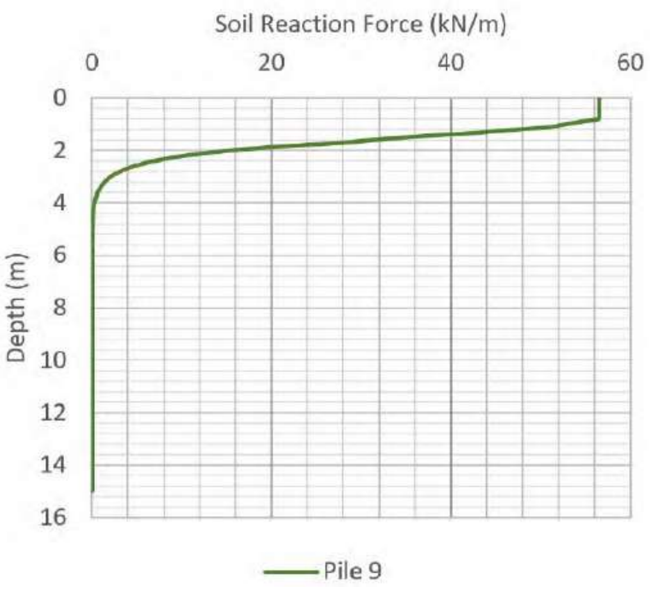

Figure 8. Skin friction along Pile 9

Note that although the skin friction decreases to zero at about 4.2 m, this length cannot be considered as an effective length for design as the pile failed at the top already.

Effect of Pile Length

To check the effect of length on settlement, Piles 11–15, 26–30, and 41–45 are given a 10 m length instead of 15 m. These piles are all similar to Piles 1–5 in diameter and modulus and all subject to a vertical load of 300 kN.

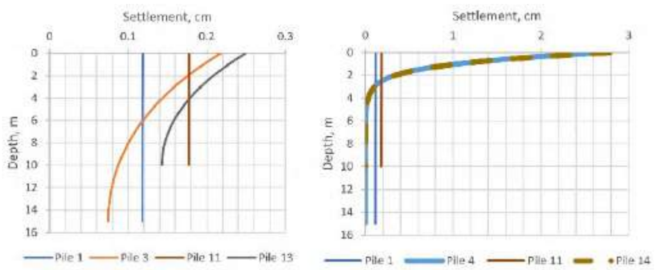

Figure 9. Settlement of Piles 1, 3, 11, 13, 4, and 14

The settlements of some of these piles are plotted against depth in Fig.9. The behavior in the short Pile 11 gives uniform movement along its depth but the value of settlement is higher than the rigid Pile 1 which is longer having a length of 15 m. This is attributed to how more skin friction is mobilized along Pile 11 than in Pile 1 to balance the applied load of 300 kN. **Increase in skin friction increases the settlement of a rigid pile regardless of the length of the pile**.

Decreased rigidity in Piles 3 and 13 showed tendency of the settlement of the shorter pile, Pile 13, to become closer to the settlement of the longer pile although the longer pile still has less settlement. In the right side the comparison between Piles 4 (15 m long) and 14 (10 m long) shows that the settlement curves of the two piles coincide. The effect of elastic shortening of the pile (piles having lesser modulus) governed the skin friction mobilization.

Decrease of rigidity EA after a certain limit will control the skin friction distribution regardless of length of the pile provided that the length available is greater than the effective length. It can be seen from the curves of Piles 4 and 14 that the effective length did not change, but in both piles it is still less than the pile length. Piles 5 and 15 both fail, and the settlement exceeds the practical range. See Fig.10 for the skin friction distribution.

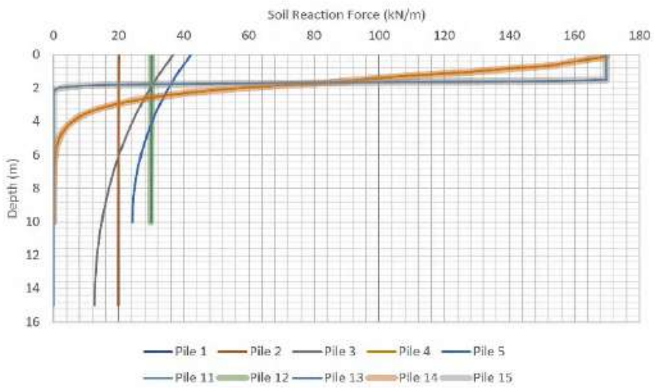

Figure 10. Distribution of skin friction along the depth of Piles 1–5 and Piles 11–15. The shown curves are coinciding for Piles 1 and 2, Piles 11 and 12 (rigid piles), and curves of Piles 13, 14, and 15 are coinciding with the first 10 m of Piles 3, 4 and 5.

Effect of Soil Stiffness

Additional series of piles from Pile 16–45 were added in a similar way to Soil 2 and Soil 3, see Table 2. These two series are executed to compare with rows in Soil 1 to depict the effect of soil stiffness on the settlement of piles having different rigidity. Soil 2 and Soil 3 have the same T-z (normalized for T as T/T_{ult}) curves as Soil 1. The soils differ in their ultimate skin resistance; hence, their stiffness will change as the level of friction will increase for the same displacement with increased ultimate values.

Some of the results may be enough to understand the differences. Note that the behavior among the piles of the same series are in line with what has been discussed above for piles installed in Soil 1.

Settlements of Piles 2, 3, and 4 are plotted against depth in the three graphs of Fig.11 along with their corresponding piles of similar modulus installed in Soil 1, Soil 2, and Soil 3.

Pile 2 is relatively still rigid, but the rigidity becomes less in Soil 2 and even lesser in Soil 3. Still, the change in settlement is insignificant, Fig.11 (a). An interesting coincidence occurred between settlements of Piles 2, 7, and 27 as for this specific case the ratio of lengths 10/15 equal the ratio of fs_{ult}(Soil 1)/fs_{ult}(Soil 2) and all are almost rigid piles. The soil stiffness effect can be clearly found in Fig.11 (b) where the piles are in the intermediate flexibility. The piles show less settlement in stiffer soils and the behavior of 0.3 m diameter piles is obviously different than the behavior of 0.9 m diameter piles where the effect of the elastic shortening takes a role in shaping the skin friction distribution per meter length of the pile.

Fig.11 (c) collects the piles of high flexibility where the settlement exceeds the acceptable usual limits although the stiffer the soil the less the settlement. The reason is that the effective length shortens in stiffer soils causing less elastic shortening of the pile.

Similar to previous sections, the soil reaction (the mobilized skin friction per meter length of the pile) is plotted against the depth for all piles in two scales in Fig.12. Again, the increase in soil stiffness decreased the settlement and decreased the effective length, while for the highly rigid pile the effect of soil stiffness was insignificant.

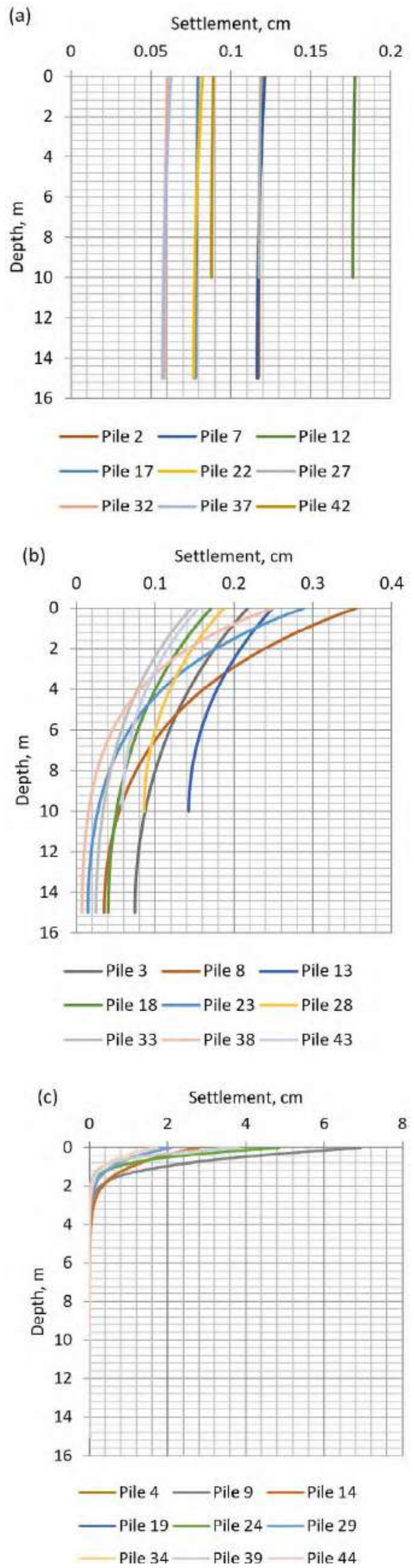

Figure 11 (a, b, c). The effect of soil stiffness on the pile settlements

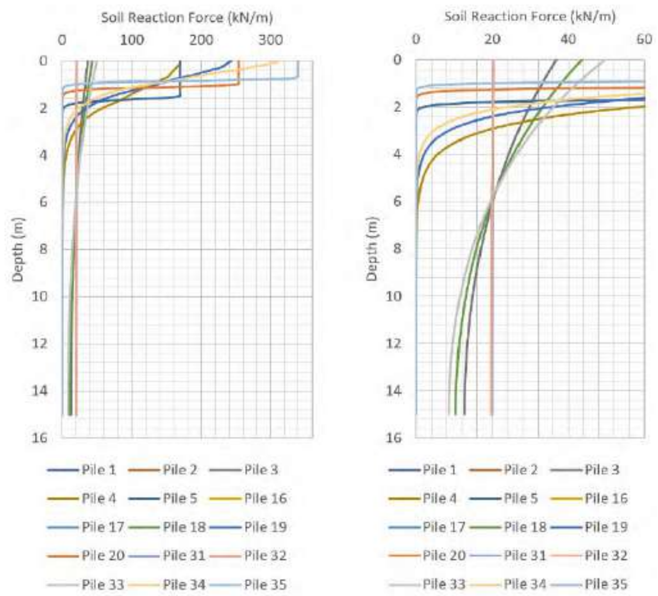

Figure 12. The skin friction distribution in kN per unit length of pile for the piles A and C of 15 m length (first rows of each series)

Concluding Remarks

A tricky way to represent zones of different soils in one RSPile model is presented. Piles of different rigidity, diameter, and lengths have been studied to show how the rigidity of a pile may affect the settlement and skin friction distribution in soils of different stiffness.

The article showed how rigid piles distribute the skin resistance uniformly along the pile depth.

The idea of the effective length was presented at which the mobilized skin friction attenuates practically to nil. The more flexible the pile the shorter the effective length is.

The skin friction and settlement of relatively flexible piles may not be affected significantly by the length of the piles provided that the piles are longer than the effective length.

The use of absolute displacement T-z curves may cause confusion in the values of settlement for equal load/diameter ratio. The reason is that the elastic shortening depends on the area and not the diameter. It is possible that some soil-pile interactions may follow normalized displacement z/D instead of z only.

As expected, it is found that the stiffer the soil, the more skin friction accumulates at the top yielding shorter effective length and less settlement.

(https://www.rocscience.com/about/news-events/rspile-effects-of-rigidity-and-soil-stiffness-on-the-settlement-of-piles)

Underground cities

Olivia Webb

We're used to infrastructure being buried underground, but could leisure and housing be about to follow too?

The London Underground may have been built in the 1860s but there's evidence of underground cities dating back millennia. Derinkuyu, an underground city constructed around 800 BC, extends to around a depth of 60 meters across multiple levels which would have been large enough to shelter 20,000 people together with their livestock and food stores. The use of the space eventually shifted. It became the domain of transport, sewage, water and electrics – dark neglected places that were only fit to travel through at high speed.

In more recent years, however, the use of underground space has undergone yet another metamorphosis. Underground train stations have expanded to include shopping centers and eateries like that of Canary Wharf in the UK. In other countries networks of subterranean tunnels connect offices, residential districts, universities and hotels, like those of the Underground City Montreal – the tunnels themselves being expanded to incorporate vast commercial sectors that exist solely underground. The renaissance of subterranean space is even extending to the way that we eat with Tokyo Metro opening-up underground farms growing lettuce.

We are seeing more work being published on this topic. This year's first *Civil Engineering* special issue covers underground construction and in 2018 we published a book on underground spaces. Written by an engineer and an urban planner, *Underground Spaces Unveiled* is an award-winning guide to designing the cities of the future.

Whilst building underground could help combat climate change, particularly in terms of food miles, the use of subterranean space poses its own unique sustainability issues. It's interesting to see how the worldwide engineering community are responding to these issues, with the creation of new sustainability frameworks developed specifically for urban underground space as well as through the exploration of the challenges of underground construction and possible solutions. Underground spaces have huge potential, as long as we continue to address the unique issues they pose.

(ICE Virtual Library, 14 July 2020, https://www.icevirtuallibrary.com/page/ice-news/109-underground-cities)

Green Construction: A Growing Global Trend

How to build green today and what to expect tomorrow

1. Introduction

Buildings and the process of constructing them accounts for over 30% of total global energy use.[1] This isn't necessarily a black mark on construction, though—in fact, it highlights a great opportunity for the industry to make positive changes. It's an opportunity that many in the construction industry have noted and are acting on. Green building is no longer just a trend; it is a revolution that is here to stay. Construction firms that ignore this are at risk of getting left behind.

2. Understanding Green Construction

Green construction refers to optimizing the building process to minimize negative impacts on the environment and its inhabitants while maximizing the positive aspects of the finished structure. This doesn't end when construction wraps up. Proper planning and design can help a structure qualify as green while it's in use and even during the eventual demolition of the structure.[2]

2.1. Construction's Environmental Impact

The process of constructing anything from a simple single-family home to the biggest infrastructure megaproject can impact the environment in multiple ways, including:

- Direct destruction of ecosystems due to mining, logging and other techniques for extracting raw materials
- Waste, water and air pollution and high energy use required for building material manufacturing processes, with estimates that anywhere from 5% to 8% of global CO_2 emissions come from cement production alone[3]
- Erosion and runoff on the construction site that can damage local waterways and affect plant life
- Air pollution through the use of heavy machinery that runs on emissions producing diesel or gasoline engines
- High levels of CO_2 emissions when materials and equipment are transported long distances
- Spills or other accidents that directly contaminate soil, air and water with toxic chemicals

These issues can threaten the bottom line of every part of the supply chain. Building material manufacturers who reduce waste don't just help the environment; they're also likely to see increased profits by taking advantage of every last scrap of raw material.

2.2. Essential Components of Green Construction

The hundreds of methods that make construction more environmentally friendly can be summed up in six major categories.

a. **Energy efficiency:** Structures built with green methods require less energy during construction and during occupation. Layout adjustments, insulation amounts, land siting and alignment and even the color of the exterior materials can all improve energy efficiency.

b. **Reduction of waste:** With better planning, constructing a new structure can generate practically no wasted materials at all.

c. **Low-impact building materials:** On-site waste reduction directives matched with the use of building materials that produce less waste during manufacturing significantly reduces the impact of construction. Not all of these low-impact building materials are new and unfamiliar; many are the same standard materials (such as dimensional lumber for framing) simply manufactured to tighter standards.

d. **Indoor air quality:** Careful material selection does more than just reduce waste and improve the profit margins on a project. Interior finishing materials that release little to no volatile organic compounds (VOCs) result in healthier environments for their residents.

e. **Site impact:** Placement of a structure on the site can be optimized to take advantage of natural light and passive heating and cooling opportunities to reduce energy use. Proper placement and preparation of the raw land also reduces the chances of erosion, water damage to the foundation and many related problems. Careful siting that saves existing trees doesn't just enrich the local environment, it can also keep the building cooler thanks to shading.

f. **Water use:** Minimizing water waste and controlling excess water outside the building can be achieved with green construction techniques. Buildings use 14% of all potable water consumed globally, but a few small adjustments can make a big difference in saving safe drinking water for more important uses than flushing and washing.[4]

2.3. Moving toward Standardization

Green construction initiatives started in the 1980s and 1990s, but early attempts at optimizing building techniques and materials were piecemeal and suffered from a lack of standardization.[5] Standards for green construction are essential, so different techniques can be selected based on their proven merits. The Leadership in Energy and Environmental Design (LEED) rating system developed in the late 1990s was an early attempt at standardizing the green construction process, but now there are multiple choices in most countries for quantifying the efficiency of any particular structural design.

3. Best Practices for Implementing Green Construction

A commitment to embracing green construction practices is just the start. In order to get good results and attract new environmentally minded clients, construction firms need to follow the best practices for implementation of green construction concepts. Here are five of the best practices for going green as a construction firm, regardless of the size of the business or the sector of the construction industry served.

a. Going Green Internally

Turn a critical eye to internal business practices. From paperless office filing systems to energy-efficient lighting and low-flow water fixtures, going green internally demonstrates a construction firm's commitment to the process goes beyond lip service.

b. Staying on Top of Local and Global Developments

Construction practices considered to be the pinnacle of green building today can quickly go out of style, be replaced, or be proven ineffective. Keeping abreast of green construction techniques takes a lot of work but is essential to stay competitive. Designate a team within the firm that is responsible for tracking the latest developments and determining which are right for the company. If an entire team of green specialists is impracticable, find at least one member of each major department who can determine which green construction innovations are right to embrace.

c. Choosing a Rating System

Trying to appeal to all clients looking for green construction is simply too much for even the biggest and most experienced companies. Firms that are still expanding into green construction should start with a popular rating system or design modality and build their familiarity with it before moving on to a new one. Globally, LEED is one of the most popular green building evaluation systems, with over 90,000 commercial buildings participating in the program as of 2018 and is a good starting point for most firms.[6] Training to meet the specific requirements of a popular rating system helps fill in any gaps in existing approaches.

d. Investing in Training

Green construction often requires hundreds or even thousands of small adjustments to the building process to reach the goals of the finished structure. As a result, construction workers may need comprehensive training to become familiar with current techniques. Simply specifying the use of the new methods and not training the workers on them will only lead to low rates of adoption and a return to the familiar work processes. All the design improvements in the world can't make a structure green if the workers constructing it are failing to follow the specifications due to a lack of belief in its value.

An alarming study from Virginia Tech found that green construction sites actually experienced a higher rate of worker injuries than traditional ones largely due to unfamiliarity with new techniques and equipment, indicating the need for additional employee training.[7]

e. Embracing Construction Technology

Green building methodologies significantly increase the complexity of every stage from planning to construction, so powerful construction technology is vital. Cloud-based apps, like PlanGrid, offer seamless sharing of the latest drawings and plans. Now everyone from the project manager down to individual workers can stay abreast of project information, including the green techniques currently in use on a project. Modeling software is also essential for creating designs and building plans that perform as promised after construction wraps up.

4. The Future of Green Building

The global market for green construction is projected to reach $364.6 billion USD by 2022.[8] Not only will demand for this kind of low-impact building grow over the next 25 years, it will also change dramatically. Looking ahead into the future of green construction will help construction firms plan their next moves.

Smart Cities and Integrated Buildings

For millennia, cities have developed organically and hap-hazardly, but tomorrow's cities will be smart and designed carefully from the bottom up. Smart cities integrate the Internet of Things to make urban environments responsive to the needs of their residents. As buildings integrate more and more advanced technology, demand for improved green construction methods will accelerate.

New and Stricter Certifications

Green construction remains primarily optional on a global level, but many regions already require some kind of green certification for new construction. In the United States, California has a mandate that all new commercial construction must achieve a zero net energy rating by 2030.[9] China has its own green building standards based heavily on LEED certification and has mandated that at least 50% of new urban construction will meet this standard by the end of 2020.[10] These requirements will only grow and spread in the next quarter century.

Overhauls for Existing Structures

The two sectors of new construction and renovation are likely to overlap more in coming years as existing structures require more advanced remodeling than in the past. New construction is obviously the prime time for optimizing for green performance, but older and aging buildings will need plenty of attention to bring them up to speed as well. Construction firms that once found renovation work too time-consuming or less profitable than new construction will likely expand as budgets for remodeling grow to compensate for the need for green technologies.

Greater Reliance on Big Data

Embracing construction technology to analyze and model designs is a requirement for today's green construction, but future building techniques will rely on big data as well. Within 25 years, every new construction project will begin with a sampling of data showing everything from the projected impact on surrounding structures to the latest demands of the expected residents. Embracing data is likely to streamline the green construction process in ways that are impossible to imagine today.

Conclusion

Green construction isn't going anywhere, so it's time for construction firms in all sectors of the industry to embrace it. As construction technology continues to grow and evolve, it will be interesting to see how green construction changes and grows alongside it. Thankfully, going green during the building process is easier than ever, thanks to the proliferation of powerful construction technology tools available today.

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Lessons learned from the Mount Polley disaster

Concerns persist over mines' wet tailings ponds

When a tailings pond dam at the Mount Polley copper-gold mine collapsed in 2014, it was one of the worst mining disasters in recent memory in Canada.

But it was only one of four such dam failures around the world that year, including one in Brazil that killed two workers. In 2019, there were six tailings pond failures, including one in Brazil that killed more than 250 people.

On average, there have been two or four tailings pond ruptures every year around the world over the last decade, with a relatively high number of them occurring in places like Myanmar, Brazil and China.

And with even more mines to be built in the coming decades to meet the demand for minerals and metals from a world switching to renewable energy and electric cars, that raises the spectre of increased tailings pond failures around the world, according to Safety First a new report by Earthworks and MiningWatch Canada.

"Tailings facilities, which contain the processed waste materials generated from mining metals and minerals, are failing with increased frequency and severity," the report warns.

The report calls for alternatives to wet tailings ponds or, where that is not feasible, better dam designs.

"The safest tailings facility is the one that is not built," it states.

Whenever possible, wet tailings pond dams should be avoided by using filtered tailings storage, otherwise known as dry-stack tailings, the report recommends.

But there can be environmental trade-offs with filtered tailings, which are mine tailings that have been "dewatered" to create a semi-solid. They are not really dry, but more like a moist material like partially dried cement.

The whole point of storing mine waste (finely ground rock left over after valuable metals have been extracted) under water in a tailings ponds is to avoid acid rock drainage, which can occur when metals in waste rock are exposed to air and then water. Acid and toxic compounds can then drain into local waterways when it rains.

So, filtered tailings may avoid the loss of life and property that can result from a wet tailings pond rupture, but in regions with high precipitation, it can pose additional challenges with managing acid rock drainage.

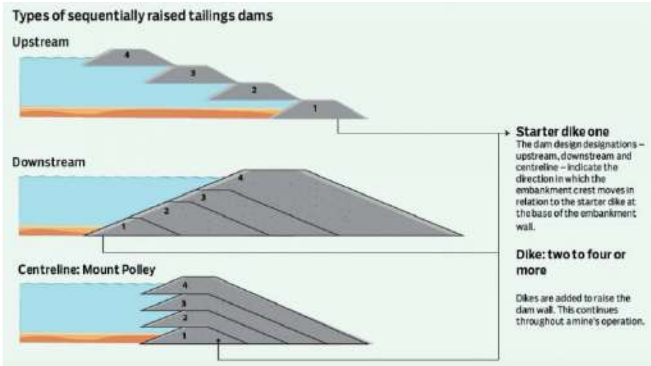
Even so, when an expert panel was struck to investigate the Mount Polley tailings pond failure, it recommended the use of filtered tailings for future mines.

"They said there's no overriding technical impediments to more widespread use of filtered technology," said Jan Morrill, Earthworks' international mining campaigner. "So, yes, it does require additional engineering considerations, but the expert panel that looked directly at Mount Polley said filtered tailings should be used more widely in order to promote safety."

She added that it would be difficult to implement filtered tailings at an existing dam like Mount Polley. But for all future mines, the report recommends filtered tailings.

When filtered tailings are not an option, at the very least better dam construction needs to be required by regulators, Safety First states.

There are three types of designs: upstream, downstream and centreline. This refers to the orientation of the dam embankments not the physical location of the tailings pond in relation to the mine, community or lake. The upstream design is considered the least secure.



Three tailings dam designs. MiningWatch Canada and Earthworks argue that all upstream tailing dams should be banned. The Mount Polley dam was a modified centreline design

"The use of upstream dams must be banned in favour of centreline and downstream dams, which are much less vulnerable to all mechanisms of dam failure," Safety First recommends.

The Mount Polley Tailings pond was a modified centreline design.

When the Mount Polley mine was first being designed, Imperial Metals (TSX:III) CEO Brian Kynoch said drystack tailings were considered. But he said a water dam had to be built anyway, because large amounts of water are needed for the milling process. So the company decided it might as well use it for tailings storage.

Kynoch said the best solution would have been to pump the tailings into Quesnel Lake, which is North America's third deepest lake.

Despite the relatively "clean" geochemistry of the ore, the prospect of putting mine waste in a lake would have been met with a public outcry.

"Most experts, I'd say, would tell you that that's probably the best thing to do. But it's a very hard-to-permit solution," Kynoch said.

However, that's what happened anyway: tailings at the bottom of a lake and a public outcry.

According to the expert technical panel that investigated the Mount Polley incident, the dam's design wasn't so much the problem as the foundation it was built on. It might have still collapsed, regardless of how the embankments were built.

The tailings pond dam sits on a layer of glacial till, which is consolidated everywhere except under the portion where the dam collapsed. In that area, the glacial till was less consolidated and was therefore unstable.

Even though the volume of water built up behind the dam was not deemed to have caused the collapse, it did exacerbate the damage.

Imperial Metals had expressed concerns to B.C.'s Ministry of Environment over the volume of water that had built up behind the dam. It had been asking for a water discharge permit to reduce pressure on the dam, and even warned the ministry in January 2014 that, without being able to discharge water, "there exists a three-year timeframe during which storage will become geo-technically problematic."

The company warned that pressure was building up behind the dam, risking overtopping.

"Six years to get a discharge permit," Kynoch said. "Six years of study, and then they gave us a permit that wasn't big enough."

That is, the permit did not allow enough water to be discharged to attain a negative water balance in the dam.

An expert panel investigating the dam's failure concluded that the collapse was the result of a weak, soft layer of glacial till that had not been detected by engineers when the dam was first designed and built in the mid-1990s.

That may explain why Imperial Metals was never charged for the dam's failure, and why the engineering firm responsible for the dam's design and maintenance eventually settled out of court after Imperial Metals sued it for $108 million. Three engineers who had been responsible for the dam's maintenance are facing disciplinary hearings.

Just last week, a report commissioned by the BC First Nations Energy and Mining Council noted that the regulatory environment around tailings ponds in B.C. have improved since the Mount Polley incident, but warns that more needs to be done to avoid future dam failures.

It even suggests some mines should be shut down.

The report notes there are a dozen new mine proposals in B.C. and raises particular concerns over the massive KSM mine proposal, which the report says would place a massive tailings pond dam above the Bell Irving-Nass watershed.

"While transparency of decisions by mine operators has been improved by recent regulatory reforms and stakeholders now have more access to information than in the past, more needs to be done to enable direct community involvement regarding design, management and monitoring to ensure tailings dam safety," the report states.

"But in spite of B.C.'s mine law reforms after Mount Polley, the elephant in the room still remains: should the B.C. government allow the development of new tailings dams upstream of communities and should those that currently exist be closed down?"

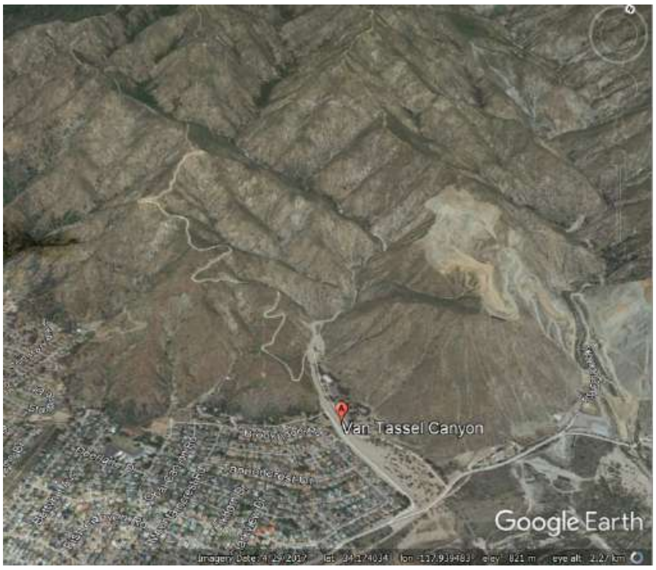
(Nelson Bennett / BUSINESS VANCOUVER, August 10, 2020, https://biv.com/article/2020/08/lessons-learned-mount-polley-disaster)

Landslides after wildfires

It is well established that one of the lingering effects of wildfires is increased sensitivity of the landscape to landslides. The primary cause is considered to be the loss of vegetation, although the actual mechanisms through which this generates increased landsliding are complex. Notable examples include the 2018 Montecito mudslides in California, but similar events can be found in many places,

In a paper just published in the journal Landslides (Rengers *et al.* 2020), which is open access, the occurrence of landslides following wildfires in Southern California is investigated. The authors have looked at a 70 km² area of the San Gabriel Mountains in Southern California, which was burned in the 2009 Morris fire, the 2014 Colby fire and the two wildfires that are collectively known as the 2016 San Gabriel Complex fire. None of the fires burned all of the study area, but some parts were burned by more than one of the fires.

The authors observed debris flows in the first year after a fire in the area that had been burnt. The example below, the Van Tassel watershed, highlighted by Rengers *et al.* (2020), underwent extensive debris flow activity in early 2017 having been burnt the year before:-



Google Earth imagery showing the Van Tassel watershed after a wildfire in 2016, as highlighted by Rengers *et al.* (2020). The area has undergone extensive debris flow activity, as evidenced by the deposits at the mouth of the canyon.

But the pattern of landslides in time is quite complex. Whilst debris flow activity was indeed high in the first year after a fire, triggered by heavy seasonal rainfall, debris flow activity rapidly declined with time. Three years after a fire, the primary type of landsliding had transitioned to shallow slips, with failures being triggered on both unburnt and burnt slopes. The density of landslides was highest in areas that had been burnt three years previously, whilst areas that had been burnt five years beforehand had a low density of landslides, similar to areas had not been burnt.

Where a second fire affected a previously burnt area, the density of landslides did not increase. A really interesting aspect of the landslides is they mostly occurred on slopes facing towards the south. Rengers *et al.* (2020) suggest that this may be because slopes facing away from the sun (i.e. to the north) in this semi-arid area regenerated vegetation quickly, reducing the likelihood of landslides. This is an important finding.

The study by Rengers *et al.* (2020) shows that wildfires do indeed lead to increased susceptibility to landslides triggered by rainfall. However, the response is more complex than might have been anticipated both in terms of the types of slides triggered and their spatial patterns. In this case the affect is quite shortlived. It is important to stress that this effect will be strongly controlled by local factors such as the topography, the geology and the climate, so responses in other locations might differ. I hope that this study will inspire similar investigations in other environments.

Reference

Rengers, F.K., McGuire, L.A., Oakley, N.S. *et al.* 2020. Landslides after wildfire: initiation, magnitude, and mobility. *Landslides* (2020). https://doi.org/10.1007/s10346-020-01506-3

(Dave Petley / THE LANDSLIDE BLOG, 11 August 2020, https://blogs.agu.org/landslideblog/2020/08/11/california-wildfire-research-1/)

Landslides after wildfire: initiation, magnitude, and mobility

Francis K. Rengers, Luke A. McGuire, Nina S. Oakley, Jason W. Kean, Dennis M. Staley & Hui Tang

Abstract

In the semiarid Southwestern USA, wildfires are commonly followed by runoff-generated debris flows because wildfires remove vegetation and ground cover, which reduces soil infiltration capacity and increases soil erodibility. At a study site in Southern California, we initially observed runoff-generated debris flows in the first year following fire. However, at the same site three years after the fire, the mass-wasting response to a long-duration rainstorm with high rainfall intensity peaks was shallow landsliding rather than runoff-generated debris flows. Moreover, the same storm caused landslides on unburned hillslopes as well as on slopes burned 5 years prior to the storm and areas burned by successive wildfires, 10 years and 3 years before the rainstorm. The landslide density was the highest on the hillslopes that had burned 3 years beforehand, and the hillslopes burned 5 years prior to the storm had low landslide densities, similar to unburned areas. We also found that reburning (i.e., two wildfires within the past 10 years) had little influence on landslide density. Our results indicate that landscape susceptibility to shallow landslides might return to that of unburned conditions after as little as 5 years of vegetation recovery. Moreover, most of the landslide activity was on steep, equatorial-facing slopes that receive higher solar radiation and had slower rates of vegetation regrowth, which further implicates vegetation as a controlling factor on post-fire landslide susceptibility. Finally, the total volume of sediment mobilized by the year 3 landslides was much smaller than the year 1 runoff-generated debris flows, and the landslides were orders of magnitude less mobile than the runoff-generated debris flows.

https://link.springer.com/article/10.1007/s10346-020-01506-3

A dam big problem

Warren Cornwall

Summary

Countries and mining companies around the world are confronting a crisis over what to do with growing lakes of toxic mud generated by mines. Often stored behind earthen dams that can rise nearly 300 meters tall, dam failures in recent years have killed more than 100 people, buried ecosystems, and sent local communities, scientists, regulators, miners, and environmentalists searching for solutions. The problem is daunting: As many as 21,000 tailings dams dot the globe, and they are growing larger as miners excavate more waste rock for each kilogram of valuable metals. Engineers and other researchers are tackling the problem through a mixture of new technology and more rigorous procedures for designing and building the dams.

(*Science* 21 Aug 2020: Vol. 369, Issue 6506, pp. 906-909, DOI: 10.1126/science.369.6506.906, https://science.sciencemag.org/content/369/6506/906)

(βλέπε και «Catastrophic failures raise alarm about dams containing muddy mine» wastes σε επόμενη ενότητα)

Choosing the Best Tunnel Boring Machine for Mountainous Conditions

Detlef Jordan
Robbins Europe GmbH, Germany

Geology in high cover tunnels is often complex and Tunnel Boring Machines (TBMs) have proven themselves in deep tunnels worldwide as a fast, safe, and cost-effective solution that can be customized to project conditions. This article will explore the advantages of mechanical excavation, what types of TBMs are best suited for certain ground, and important considerations for ground support in high cover conditions.

In mountainous tunnels under high rock cover, the true ground conditions can be difficult to predict, even with information collected from an exploratory tunnel. Factors like squeezing, fault zones, caverns, and water can all be missed with a full-sized tunnel and a meter-by-meter analysis of ground conditions is often impractical if not impossible. When one considers the excavation method required for such varied unknown conditions, many factors need to be evaluated such as versatility and investigational methods like continuous probe drilling and pre-grouting.

Main Beam TBMs

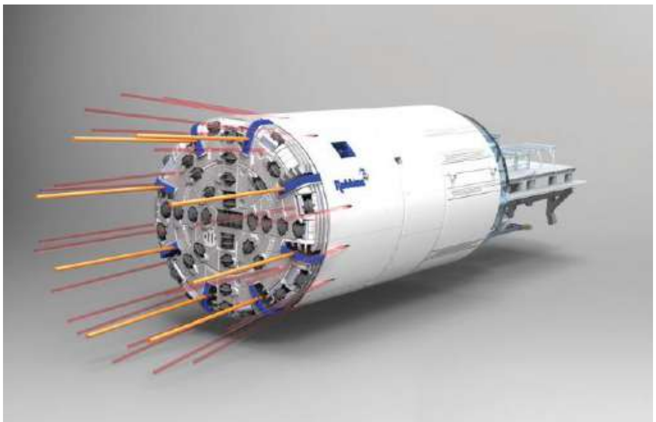
In even the most extreme ground conditions, Main Beam TBMs (also known as "open-type" machines) can be efficient and safe. Features such as open access behind the cutterhead for ground support and consolidation, unrestricted probe drilling, and the absence of a shield are all-important attributes in extreme conditions. In ground exhibiting squeezing-convergence and rock bursting, open-type machines often fare better than shielded machines, as they are less likely to get stuck. They can also utilize the McNally Support System, in which the curved finger shield plates are replaced for a curved assembly of pockets with rectangular cross-sections. In swelling-slacking ground Main Beam TBMs also allow for immediate ground treatment behind or over the top of the cutterhead. Open-type machines are capable of operating in ground with occasional to continuous water as long as a mitigation strategy combining grouting to stem flows, as well as pumps to remove the water, is employed.

Shielded Hard Rock TBMs

Most shielded TBMs line the tunnel either simultaneously with or directly after a TBM stroke, resulting in an earlier useable date for the tunnel. Shielded machines also have the very beneficial advantage of providing a limited section of non-heavy support; i.e., the distance from the cutterhead to the grouted lining. Shielded TBMs can also have difficulty in faulted rock, as the working area for ground consolidation can somewhat restrict good face coverage. There are two types of shielded hard rock TBMs: Single Shield and Double Shield.

Single Shield TBMs are shorter in length and can therefore be launched from a shorter starter tunnel, and are typically utilized in non-self-supporting rock, as the machine advances by reacting against the concrete tunnel lining rather than unstable tunnel walls. They have the disadvantage of not having grippers, which allow greater pull, thrust and jogging of the cutterhead.

Double Shield TBMs are ideal in self-supporting rock, and some non-self-supporting rock, or in combination ground since they can react against either tunnel walls or segments. The shield also provides protection from rock falls and other problems, making it ideal in hard, blocky ground as well. In addition, in squeezing ground Double Shield TBMs can be used with compressible material as backfill or special segments to accommodate squeezing conditions. Both types of machines can be successfully utilized in a wide range of conditions—even in squeezing ground and significant water inflows—if properly designed. A host of technology, termed Difficult Ground Solutions (DGS), can be used on these machines, from multi-speed gearboxes that enable excavation in fault zones to shield lubrication and breakout thrust/torque for squeezing and collapsing ground.



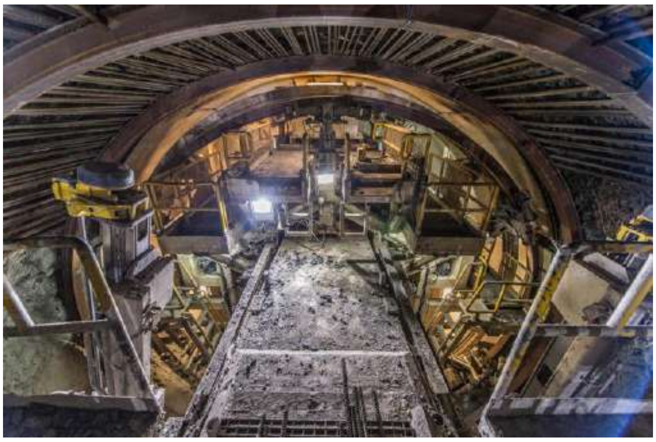
Probe drilling is equally important in both shielded and open-type machines. Enhanced probe drilling on shielded machines allows for more trajectories.

Advancements in ground support

Squeezing/Convergent Ground

For squeezing or converging ground, over-boring is often necessary. The only practical solution to over boring is to pre-mount extra gage housing in the periphery of the cutterhead. In the over-bore zone, yielding type structures should be erected if using an open-type machine. These structures can include yielding steel arches, steel arches in conjunction with yielding jacks, shotcrete structures with yielding rock anchors, or combinations of the above supports. Such support needs to be placed with assistance of the ring beam erector or some other mechanical means. The most desirable location to place such support is immediately behind the cutterhead—a problematic situation with a shield type machine. The machines also must be equipped with very high torque to overcome the squeezing effect.

If using a shielded machine erecting segments, certain features such as a convergence measuring system—a hydraulic cylinder mounted on top of the machine and connected to the machines computer system (PLC)—can detect when squeezing conditions are present. Having a machine designed with the shortest possible shield length, and a stepped (tapered) shield if necessary can be immensely helpful. As mentioned previously, shield lubrication and emergency thrust can get a machine through a situation where it might otherwise become trapped.



Rock Bursting

In rock bursting conditions wire mesh with rock bolts, yielding rock anchors, steel arches, ring beams or combinations of all the above may be required. Such support can be placed with rock drills, a ring beam erector, and a shotcrete system. It is important to hold the rock in place to control and limit the disturbance of the rock to as great an extent as possible. Rock bursting could also be contained with TBMs in association with special lining.

With modern open-type TBMs, ground support such as the McNally Roof Support System can be used to allow lining to be extruded from the machine as it advances—a very safe option in these conditions. Today's TBMs are also equipped with all of the same tools and techniques that are used in drill & blast operations to excavate through difficult rock conditions. With sophisticated probing techniques installed on the TBM, the operator can predict what is ahead of the tunnelling operation more quickly than drill & blast and react appropriately. On a shielded machine, probe drilling is equally important. The machine's shield provides safety against rock bursting events.

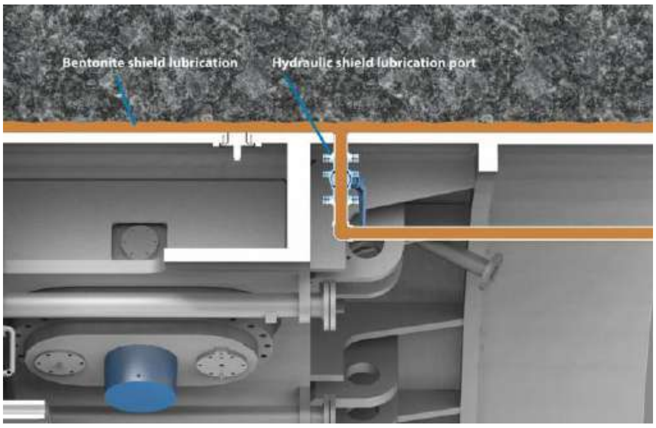
Swelling/Slacking Ground

In swelling and slacking conditions an effective ground treatment is shotcrete applied immediately behind the cutterhead, for both open-type and shielded machines. In extreme conditions, over-boring may be required and measures for rock support in squeezing ground may be needed. The support can be a combination of shotcrete, rock drills and ring beams on an open-type machine. The difficult question, however, is to predict the extent of swelling and squeezing. This is a very important consideration when considering the use of concrete segments in such conditions. Because of the difficulty of predicting the extent of swelling, two-pass lining systems have been used such as in the large diameter Niagara Tunnel Project in sedimentary rock. This large diameter (14.4 m) tunnel utilized initial ground support followed by a slipform concrete liner and a waterproof membrane.

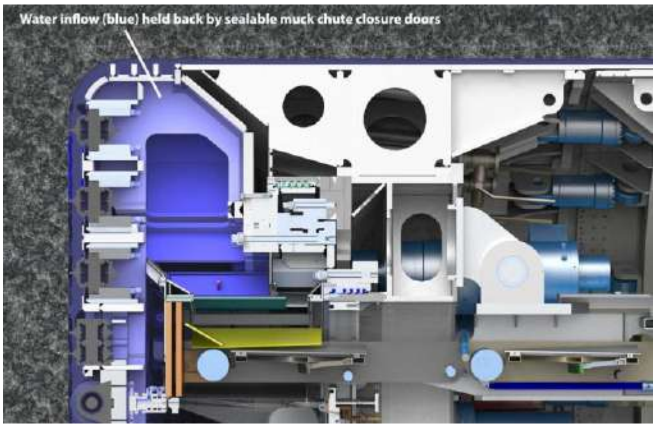
Fault Zones & Water Pressure

Fault zones can be the most difficult condition to encounter, especially when associated with water under pressure. They are also the most difficult conditions for predicting expected advance rates.

In all conditions, advance probe drilling is recommended 30 to 40 meters in advance of the face with a 10 m overlay. This is especially important when fault zones or water are expected. When a fault zone or water is encountered, the extent of the zone should be explored prior to TBM boring within 10 – 20 meters of the zone. Drilling should be done on a 360-degree basis. First, the zone should be grouted to stop water inflows. After grouting, ground consolidation additives should be injected into the unstable rock or soil material. It may be necessary to inject such material into the face at short intervals of 2 to 4 meters, and advance at shorter intervals. The support of geologists experienced in predicting and treating fault zones, and of ground conditioning experts, is highly recommended when fault zones are encountered.



In squeezing or blocky ground, shield lubrication allows a shielded rock machine to get through geology where it might otherwise become stuck.



When significant water inflows occur, a guillotine gate can seal off a shielded machine to allow crews to safely control the water (sealed area in blue).

For passing through fault zones, grout and ground conditioning holes are required. After ground treatment, ground support such as spiling or forepoling through the front shield over the cutterhead may be necessary for safe and predictable advance. It is preferable to carry on this drilling as close to the face as possible to ensure good face coverage. These methods are all possible whether an open-type or shielded machine is used.

When water is present in a hard rock tunnel, it can be pumped away from the face and out of the tunnel (even fairly significant water inflows). However, if there is a possibility of significant pressures and/or a massive inrush of water, then a shielded machine with DGS features is recommended. In the event of a large inrush of water, a guillotine gate on the muck chute can effectively seal off the muck chamber to keep the crew safe as well as keep the machine from becoming flooded out. Additional inflatable seals can seal the gap between the telescopic shield and outer shields of a Double Shield TBM to keep everything watertight. This system is termed "passive" water protection because the TBM is stopped in place (not actively operating). During that time the crew can then work to grout off water inflows and dewater the chamber to control the flow before they begin boring again.

Blocky or Jointed Rock

In blocky or highly jointed rock, the McNally system to hold the rock in place has been proven very effective in open-type machines. If the rocks are held in place then this can prevent or lessen the condition of cathedralling over the cutterhead and fallout in front of the face; it will also reduce cutterhead damage. The ground support should be placed as close as possible to the cutterhead. Rock supports for the McNally system can be prefabricated rebar, wood/metal slats, or wire mesh in conjunction with rock straps and rock bolts. In a shielded machine, DGS features previously mentioned including shield lubrication, tapered shields, and hydraulic shield breakout—where radial ports in the machine shield can be made to inject pressurized hydraulic lubricants to free a shield that has already become stuck—are all useful.

maintworld
magazine for maintenance & asset management professionals
https://www.maintworld.com/Applications/Choosing-the-Best-Tunnel-Boring-Machine-for-Mountainous-Conditions

ΝΕΑ ΑΠΟ ΤΙΣ ΕΛΛΗΝΙΚΕΣ ΚΑΙ ΔΙΕΘΝΕΙΣ ΓΕΩΤΕΧΝΙΚΕΣ ΕΝΩΣΕΙΣ

SIMSG ISSMGE

International Society for Soil Mechanics and Geotechnical Engineering

ISSMGE News & Information Circular August 2020

https://www.issmge.org/news/issmge-news-and-information-circular-august-2020

1. Webinars

The ISSMGE is pleased to announce a new webinar "Machine Learning in Geotechnical Engineering" to be delivered by Professor Pijush Samui, on the 19th August at 12:00 am (GMT).

Webinars recently added to the ISSMGE educational resources available from the website:

- Prof Mark Jaksa: 2nd John Burland Lecture: Reflections on Some Contemporary Aspects of Geotechnical Engineering Education - From Critical State to Virtual Immersion
- Prof. Rodrigo Salgado: Forks in the Road: Rethinking Modeling Decisions that Defined Teaching and Practice of Geotechnical Engineering
- Prof. Susan A. Ambrose: Prior Knowledge, Learning and Common Instructional Practices Grounded in Evidence
- Prof. Luciano Picarelli: The Classification of Landslides in Soils in a Mechanical Perspective.
- Prof. Fumio Tatsuoka: Geosynthetics-Reinforced Soil Structures - Developments from Walls to Bridges.

2. Federation of International Geo-Engineering Societies (FedIGS)

The Federation of International Geo-Engineering Societies (FedIGS) is a collaborative association of international professional societies in the field of "Geo-Engineering" and serves to facilitate cooperation among them. It has launched its revamped website, which can be viewed at https://geoengineeringfederation.org/.

The cooperating societies forming the FedIGS Board are:

- International Society for Soil Mechanics and Geotechnical Engineering (ISSMGE)
- International Society for Rock Mechanics and Rock Engineering (ISRM)
- International Association of Engineering Geology and the Environment (IAEG)
- International Geosynthetics Society (IGS)

FedIGS also has a number of Joint Technical Committees:

- JTC1 Natural Slopes and Landslides
- JTC2 Representation of Geo-Engineering Data
- JTC3 Education and Training

Further details about the FedIGS can be found at www.geoengineeringfederation.org.

3. Corporate Associates Presidential Group:

The May 2020 update of Corporate Associates' varied and exciting activities around the world can be found here https://www.issmge.org/corporate-associates/corporate-associates-presidential-group. Why and how to join as a Corporate Associate are detailed in https://www.issmge.org/corporate-associates/why-how-to-join.

4. Bulletin

The latest edition of the ISSMGE Bulletin (Volume 14, Issue 2, June 2020) is available from the website https://www.issmge.org/publications/issmge-bulletin/vol-14-issue-3-june2020

5. ISSMGE Online Library – Open Access

The ISSMGE Online library (https://www.issmge.org/publications/online-library) is in continuous development – please note the following additions:

- 1st (2007) and 7th (2019) International Symposium on Geotechnical Safety and Risk
- 10th International Symposium on Field Measurements in Geomechanics (FMGM2018)
- 25th European Young Geotechnical Engineers Conference

6. ISSMGE Foundation

The next deadline for receipt of applications for awards from the ISSMGE Foundation is the 30th September 2020. Click here for further information on the ISSMGE Foundation.

7. Conferences

For a listing of all ISSMGE and ISSMGE supported conferences, and full information on all events, including deadlines, please go to the Events page at https://www.issmge.org/events. However, for updated information concerning possible changes due to the coronavirus outbreak (ie. postponements, cancellations, change of deadlines, etc), please refer to that specific event's website.

As might be expected, many events have been rescheduled and we update the Events page whenever we are advised of changes.

The following are events that have been added since the previous Circular:

Non-ISSMGE Events

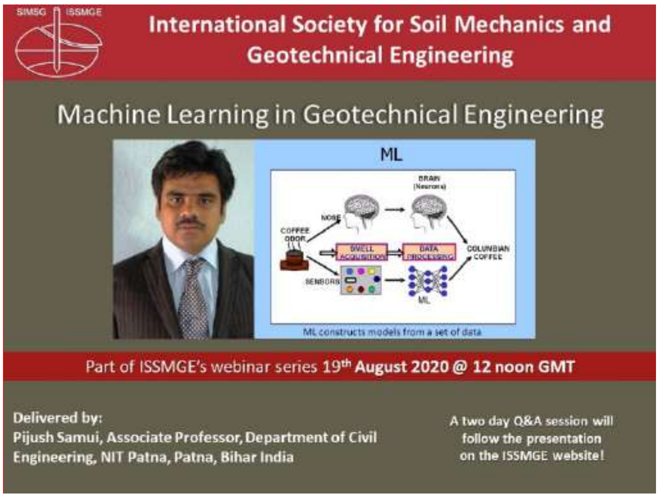
FIFTH INTERNATIONAL CONFERENCE ON NEW DEVEL-

OPMENTS IN SOIL MECHANICS AND GEOTECHNICAL ENGINEERING - 27-05-2021 - 29-05-2021 - Atatürk Cultural and Congress Center Near East University, Nicosia, Northern Cyprus; Language: English; Organiser: Turkish Society of Soil Mechanics and Geotechnical Engineering and Near East University; Contact person: Cavit ATALAR; Address: Near East Boulevard; Phone: 0090392 223 6464; Email: zm.2020@neu.edu.tr; Website: http://zm2020.neu.edu.tr;

Machine Learning in Geotechnical Engineering

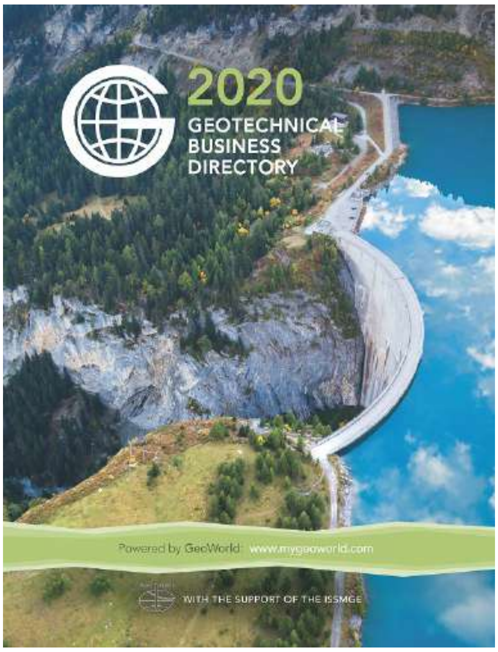
Presenter: Prof. Pijush Samui
Launching Date & Time: August 19 2020 12:00pm GMT

https://www.issmge.org/education/recorded-webinars/machine-learning-in-geotechnical-engineering



Announcing the Publication of the 2020 Geotechnical Business Directory

https://www.issmge.org/news/announcing-the-publication-of-the-2020-geotechnical-business-directory



Geoworld, the network for geotechnical engineers, has just published the 2020 Geotechnical Business Directory. The directory is published with the support of the International Society for Soil Mechanics and Geotechnical Engineering. This is **the sixth year for the Geotechnical Business Directory, the most comprehensive directory in the geotechnical engineering field!**

This truly unique directory is available in **three** formats:

(a) an Online Interactive Platform,

(b) an e-book, and

(c) in-print through Amazon

The 2020 index has grown significantly since last year and includes **20,00+ members**, and **900+ geo-companies** and **geo-organizations** from a total of **157 countries**. It is expected to reach 50,000+ professionals through various media channels. The online platform of the directory allows visitors to search for professionals or companies based on location, experience, expertise, industry and other parameters. **There is no other such directory in geotechnical engineering**. The directory is also a "live" publication in the sense that as more members join and complete their profiles, the publication will become more comprehensive.

The online platform of the directory, which is updated daily, has increased search functionality compares to the e-book and printed version.

GeoWorld's team is already working on the 2021 Business Directory that is expected to include 21,000+ individuals and 1,000+ companies and organizations.

Income generated from the Geotechnical Business Directory is also directed as a donation to the ISSMGE Foundation.

If you are not a member of GeoWorld, visit the website and join at no cost, so that you can be part of the 2021 Geotechnical Business Directory.

The Young Members Groups of the Tunnelling Association of Canada and of the Greek Tunnelling Society organized a joint event - Online Webinar - on Thursday, August 13th 2020.

The lecture on "Eupalinos Tunnel - First Tunnel to be excavated simultaneously from both ends in the 6th century B.C." was delivered by Prof. Nicholas Vlachopoulos (Royal Military College of Canada).

The Eupalinos Tunnel is considered one of the most significant engineering achievements of antiquity as it involved simultaneous excavations from both ends of the tunnel 2500 year ago. This was the first time in history that anyone had ventured to undertake a project of such a magnitude without an analogous reference (see http://www.eupalinos-tunnel.gr/, the website which is maintained by the Greek Tunnelling Society).

The International Tunnelling & Underground Space Association (ITA-AITES) declared, in 2015, the Eupalinos Tunnel as an "International Tunnelling Landmark" (WTC 2015 - Dubrovnik, Croatia).

Presentation Abstract

The **Eupalinos Tunnel** is considered one of the most significant engineering achievements of antiquity as it involved simultaneous excavation from both ends of the tunnel. This was the first time in history that anyone had ventured to undertake a project of such a magnitude without an analogous reference. The tunnel was constructed in the 6th century B.C. (between 550 and 540 B.C.) on the Greek island of Samos and had an overall length of 1036 m. The tunnel measured approximately 1.8 m width with a 4 m deep, parallel trench system that contained a clay water pipe as part of the aqueduct system. The tunnel took approximately 10 years to construct and was in use for approximately 1100 years. This presentation summarizes the instrumentation challenges and techniques that were utilized in order to achieve such an engineering feat. Also included is the historical background, an assessment of the main geological features associated with the tunnel construction, the various tunnel design types and the relevant tunnel construction techniques that were utilized in order for the tunnel to meet within the intended tunnel alignment (within 1.8% accuracy). Applicable lessons learned utilizing ancient techniques (which are also utilized and are still very relevant today) will also be summarized as well as the presenter's own on-site assessment of the tunnel in its current state. These findings can serve to aid (and inspire) current tunnel engineers and practitioners in the way that they approach their unique tunnel and excavation project requirements. To this day, the acknowledgement by the American Society of Civil Engineers (ASCE) as an international heritage site, and declared by the International Tunnelling Association (ITA-AITES) as an "International Tunnelling Landmark".

Young Members Group

Introduction to the Emerald Book (FIDIC Conditions of Contract for Underground Works)

On Friday 28th August, BTSYM and Tunnelling Association of India Young Members will host Matthias Neuenschwander (http://www.neu-ce.ch), one of the industry leaders in dispute avoidance and resolution, for an introduction to the FIDIC Emerald Book.

Based on the enquiries on international best practice in contracting of tunnelling and underground construction works conducted by the ITA-AITES during the last fifteen years and on the ITA-AITES Report 006 ("The ITA Contractual Framework Checklist for Subsurface Construction Contracts", April 2011), these General Conditions of Contract have been specifically drafted by a joint FIDIC – ITA Task Group for use in underground works.

When : Friday, 28th August at 12:00 BST [UTC+1]

Streaming Link : https://youtu.be/nAUtPQOgRcI

Implementation of Tamoios Highway

Brazilian Tunnelling Committee a Young Members and BTYSYM will jointly host **Pedro Soares dos Anjos** (Project Engineer, Construtora Queiroz Galvão) for a for a webinar on 3rd September 2020.

Situated in Brazil's São Paulo state, the Tamoios Highway is a transport corridor upgrade scheme connecting existing highways of national significance.

Passing through remote rural areas, 85% of which lies within an environmental reserve, the works - that include a combined 13 km of NATM tunnels - span sedimentary plains and steep mountainous terrain composing of crystalline rock; whilst resulting in wide range of technical, environmental and logistic challenges.

The scheme also incorporates tunnel T3-T4, the longest road tunnel in Brazil

This talk will present and overview of the upgrade scheme along with methods and technology implemented to overcome the geotechnical challenges and reduce environmental impact. Additionally, logistical solutions developed for equipment and emergency access will also be discussed.

When : Thursday, 3rd September at 18:00 BST [UTC+1]

Streaming Link : https://youtu.be/Drp6uwQRKVI

CHINESE NATIONAL COMMITTEE ON LARGE DAMS

Dear Colleagues and Friends,

With the support of ICOLD and concerted efforts of all parties, CHINCOLD has successfully organized 12 round tables and technical tours. About 130 participants from over 30 countries have attended these meetings with support from CHINCOLD since 2009, which have promoted technical exchange and cooperation, and have been included as a part of the capacity building efforts of ICOLD. We appreciate all your efforts for that.

CHINCOLD will continue to organize the 13th Round Table Meeting on sustainable Development of Dams and Hydropower in 2020. However, under this Covid-19 situation, for the sake of everyone’s safety, we have to make the decision to hold the Round Table Meeting in 2020 **on line**.

We are sorry that we could not be able to welcome you to an on-site meeting in Guangzhou city this year. But we will try our best to make this on-line event wonderful and meaningful. During the meeting, ICOLD and the World Bank officials will report on the capacity-building and hydropower sustainable development. We would like hereby to invite experts from developing countries, especially African and Asian countries, to do presentations on the topic of current situation and future demand of hydropower development. Meanwhile, experts from hydropower development companies, design and research institutes, construction companies, etc. are welcomed to participate in the discussion.

In the meantime, we would like to remind you that the Round Table Meeting has been delayed to **late November 2020**. More information about On-line Round Table Meeting will be available and announced soon. The latest updates will be accessible via CHINCOLD Cloud Platform (**http://www.chincold-smart.com/en/index**).

If you are interested in making 15-min presentation at the meeting, please contact us at chincold-en@vip.126.com before November 1. We will reply the email in 24 hours if we receive it.

We sincerely appreciate your support for CHINCOLD, and hope you and your family stay safe and remain healthy at this difficult time.

Chinese National Committee on Large Dams

ΠΡΟΣΕΧΕΙΣ ΓΕΩΤΕΧΝΙΚΕΣ ΕΚΔΗΛΩΣΕΙΣ

Για τις παλαιότερες καταχωρήσεις περισσότερες πληροφορίες μπορούν να αναζητηθούν στα προηγούμενα τεύχη του «περιοδικού» και στις παρατιθέμενες ιστοσελίδες.

WTC 2020 ITA-AITES World Tunnel Conference, September 2020, Kuala Lumpur, Malaysia, www.wtc2020.my
ITA and IEM hereby jointly announce that WTC2020 in Kuala Lumpur, Malaysia scheduled from 11th to 17th September 2020 will be moved to a fully digital platform due to the impacts of COVID19, including border restrictions and health risks associated with international travel and the assembly of large meetings.

Online Conference RTG^{2}EE - Recent Trends in Geotechnical and Geo-Environmental Engineering and Education, Online Conference, 10 – 11 September 2020, Bali, Indonesia, https://rtgee.org

Postponed Fourth International DAM WORLD Conference, 21-25th September 2020, Lisbon, Portugal, https://dw2020.lnec.pt

Cancelled EUROCK 2020 Hard Rock Excavation and Support, 12-14 October 2020, Trondheim, Norway, www.eurock2020.com

E-UNSAT 2020 4th European Conference on Unsaturated Soils - Unsaturated Horizons, 19 to 21 October 2020, Lisbon, Portugal, fully online, https://eunsat2020.tecnico.ulisboa.pt

Cancelled GEO-EXPO 2020 Scientific and Expert Conference, 22-23 October 2020, Prijedor, Bosnia and Herzegovina www.geotehnika.ba

HYDRO 2020 Strategies for future progress, 26-28 October 2020, Strasbourg, France, www.hydropower-dams.com/hydro-2020 (on-line)

GeoAmericas2020 4th Pan American Conference on Geosynthetics, 26-31 October 2020, Rio de Janeiro, Brazil, www.geoamericas2020.com (on-line)

5th Symposium of the Macedonian Association for Geotechnics, 29-31 October 2020, Ohrid, North Macedonia, mag@gf.ukim.edu.mk

3rd Conference of the Arabian Journal of Geosciences (CAJG), 2-5 November 2020, Sousse, Tunisia, https://cajg.org (on-line)

5TH World Landslide Forum Implementation and Monitoring the USDR-ICL Sendai Partnerships 2015-2015, 2-6 November 2020, Kyoto, Japan, http://wlf5.iplhq.org

Postponed Fourth GeoMEast©2020 International Underground Structures Conference (IUSC), 8-12 November 2020, Cairo, Egypt, http://underground.geomeast.org

CouFrac2020 goes fully virtual!! CouFrac 2020 - International Conference on Coupled Processes in Fractured Geological Media: Observation, Modeling, and Application, November 11-13, 2020, Seoul, Korea, http://coufrac2020.org

Conference postponed 10th International Conference on Scour and Erosion (ICSE-10), November 15-18, 2020, Arlington, Virginia, USA, www.engr.psu.edu/xiao/ICSE-10 Call for abstract.pdf

Postponed ATS 2020 AUSTRALASIA TUNNELLING CONFERENCE, Nov 29 – Dec 2, 2020, Melbourne, Australia, https://www.ats2020.com.au

ASIA 2020 Eighth International Conference and Exhibition on Water Resources and Renewable Energy Development in Asia, 8-10 December 2020, Kuala Lumpur, Malaysia, www.hydropower-dams.com/asia-2020

6th ICFGE 2020 Forensic Geotechnical Engineering & Geo-Disaster Documentation, December 10-12, 2020 IIT Delhi, India, http://tc302-issmge.com

27th European Young Geotechnical Engineers Conference and Geogames, 17 – 19 December 2020, Moscow, Russia, https://t.me/EYGEC2020

Postponed ARMS11 11th Asian Rock Mechanics Symposium, Challenges and Opportunities in Rock Mechanics, 2021, Beijing, China, www.arms11.com

Postponed ISGPEG 2020 International Conference on Innovative Solutions for Geotechnical Problems in Honour of Prof. Erol Guler, 2021, Istanbul, Turkey, www.isgpeg2020.org/en

BSGC 2020 IS GOING VIRTUAL! 14th Baltic Sea Geotechnical Conference 2020 Future Challenges for Geotechnical Engineering, 18-20 January 2021, Helsinki, Finland, www.ril.fi/en/events/bsgc-2020.html

NGM 2020 IS GOING VIRTUAL! Nordic Geotechnical Meeting Urban Geotechnics, 18-20 January 2021, Helsinki, Finland, www.ril.fi/en/events/ngm-2020.html

PanAm Unsat 2021 3rd Pan-American Conference on Unsaturated Soils, 25-28 January 2021, Rio de Janeiro, Brazil, https://panamunsat2021.com

XIII International Symposium on Landslides - Landslides and Sustainable Development, 21-26 February 2021, Cartagena, Colombia, www.scg.org.co/xiii-isl

88th ICOLD Annual Meeting & Symposium on Sustainable Development of Dams and River Basins, 24-27 February 2021, New Delhi, India, https://www.icold2020.org

2021 GEOASIA7 - 7th Asian Regional Conference on International Geosynthetics Society, March 1-4, 2021, Taipei, Taiwan, www.geoasia7.org

3rd International Symposium on Coupled Phenomena in Environmental Geotechnics, 17 – 19 March 2021, Kyoto, Japan, https://cpeg2020.org

ICEGT-2020 2nd International Conference on Energy Geotechnics, 28-31 March 2021, La Jolla, California, USA, https://icegt-2020.eng.ucsd.edu/home

International Conference on Challenges and Achievements in Geotechnical Engineering
31.03.2021 – 02.04.2021, Tirana, Albania

Organiser: Albanian Geotechnical Society
Contact person: Erdi Myftaraga
Phone: +355699336911
Email: emy@greengeotechnics.com

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EUROENGEO 3RD EUROPEAN REGIONAL CONFERENCE OF IAEG, 8 - 12 April 2021, Athens, Greece, www.euroengeo2020.org

AFRICA 2021 Water Storage and Hydropower Development for Africa, 13-15 April 2021, Lake Victoria, Uganda, www.hydropower-dams.com/africa-2021

2nd Vietnam Symposium on Advances in Offshore Engineering – Sustsainable Energy & Marine Planning, 22-24 April 2021, Ho Chi Minh City, Vietnam, https://vsoe2021.sciencesconf.org

16th International Conference of the International Association for Computer Methods and Advances in Geomechanics – IACMAG - CHALLENGES and INNOVATIONS in GEOMECHANICS, 03-05-2021, Torino, Italy, www.symposium.it/en/events/2020/16th-international-conference-of-iacmag?navbar=1

EUROGEO WARSAW 2020 7th European Geosynthetics Congress, 16-19 May 2021, Warsaw, Poland, www.eurogeo7.org

WTC 2021 World Tunnel Congress 2021 - Underground solutions for a world in change, 16-19 May 2021, Copenhagen, Denmark, www.wtc2021.dk

TISOLS Tenth International Symposium on Land Subsidence, Living with Subsidence, 17-21 May 2021, Delft - Gouda, the Netherlands, www.tisols2020.org/tisols2020

7th International Conference on Industrial and Hazardous Waste Management 18 - 21 May, 2021, Chania, Crete, Greece, http://hwm-conferences.tuc.gr

2020 CHICAGO International Conference on Transportation Geotechnics, May 23 - 26, 2021, Chicago, Illinois, USA, http://conferences.illinois.edu/ICTG2020

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Fifth International Conference on New Developments in Soil Mechanics and Geotechnical Engineering
27 – 29 May 2021, Nicosia, Northern Cyprus
https://zm2020.neu.edu.tr/

On behalf of the Organising Committee of the "Fifth International Conference on New Developments in Soil Mechanics and Geotechnical Engineering" we would like to inform you that in view of the spread of coronavirus (COVID-19), and the global threat a decision is taken to postpone the conference from September 3 to 5, 2020 to May 27 to 29, 2021. We hope the new date of the conference will be suitable for all our keynote speakers, session chairs, presenters, and participating colleagues. The conference will be held in Nicosia – North Cyprus. The conference is organised jointly by the Turkish Society of Soil Mechanics and Geotechnical Engineering and Near East University with the aim of bringing scientists, engineers, practitioners, and researchers together, to exchange knowledge and discuss the new developments in the field of soil mechanics and geotechnical engineering. The four previous conferences were participated by eminent ISSMGE member.

Themes and Topics

1. Laboratory testing and modelling
2. Geotechnical properties and improvement of soils
3. Analysis and evaluation of foundations
4. Earthquake geotechnical engineering and natural hazards
5. Environment preservation, water, and energy
6. Special and specific Issues
7. New methods in geotechnical engineering

Contact

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Joint meeting of ISSMGE TC201 and TC210, ICOLD TC E and TC LE "Dams and Levees: Particle Movements – Case Studies, Experiments, Theory", June, 2020, Budapest, Hungary, www.isc6-budapest.com

6th International Conference on Geotechnical and Geophysical Site Characterization "Toward synergy at site characterisation", June 2021, Budapest, Hungary, www.isc6-budapest.com

2021 ICOLD MARSEILLE - ICOLD 27th Congress - 89th Annual Meeting Sharing Water: Multipurpose of Reservoirs and Innovations, 4 - 11 June 2021, Marseille, France, https://cigb-icold2021.fr/en/

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International Airfield and Highway Pavements Conference
June 6-9, 2021, Austin, Texas, USA
www.pavementsconference.org

Welcome to the International Airfield and Highway Pavements Conference of the Transportation & Development Institute (T&DI) of ASCE. This international conference will provide an unrivaled chance to interact and exchange information with worldwide leaders in the fields of highway and airport pavements, as well as airport safety technologies.

This conference will bring together designers, project/construction managers, academics, and contractors from around the world to discuss the state-of-the-art implementation, construction, design, in airfield and highway pavements.

Conference Topics

- Techniques for Airfield and Highway Pavement Construction
- Maintenance and Rehabilitation
- Modeling, Analysis, and Evaluation of Airfield and Highway Pavements
- Characterization of Asphalt
- Concrete and Aggregate Bound and Unbound Pavement Layer Materials
- Methods on Highway and Airfield Pavement Design
- Analysis and Evaluation
- Material Quality Control and Quality Assurance
- Sustainability and Life Cycle Assessment
- Asset Management and Sustainability
- Rehabilitation and Preservation Techniques and Case Studies
- Monitoring, Evaluation, and Nondestructive Testing
- Interlayer Materials and Other Geo-engineering Transportation Engineering Materials
- Instrumentation and Accelerated Loading Testing
- Studies of Interesting Special Airfield and Highway Paving Projects
- Role of Pavement Infrastructure
- Expected Challenges and Opportunities in the Age of Autonomous-Connected Vehicles

Contact

Transportation & Development Institute of ASCE

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Customer Service | Conference Registration

- (800) 548-2723 (Toll-free)
- +1 (703) 295-6300 (International)
- 866-902-5593 (Fax)
- registrations@asce.org

ASCE Mailing Address

American Society of Civil Engineers
1801 Alexander Bell Drive
Reston, VA 20191-4382

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MSL 2021 The 1st Mediterranean Symposium on Landslides SLOPE STABILITY PROBLEMS IN STIFF CLAYS AND FLYSCH FORMATIONS, 7-9 June 2021, Naples, Italy, https://medsymplandslides.wixsite.com/msl2021

9th International Conference on Computational Methods for Coupled Problems in Science and Engineering (COUPLED PROBLEMS 2021), 13-16 June 2021, Sardinia, Italy, coupledproblems_sec@cimne.upc.edu

Cities on Volcanoes 11 - Volcanoes and Society: environment, health and hazards, 14-18 June 2021, Heraklion, Crete, https://pcoconvin.eventsair.com/volcanoes11

EGRWSE 2020 - 3rd International Conference on Environmental Geotechnology, Recycled Waste Materials and Sustainable Engineering, 17-19 June 2021, Izmir, Turkey, www.egrwse2020.com

2nd ICPE 2021 The Second International Conference on Press-in Engineering, 19-21 June 2021, Kochi, Japan, https://icpe-ipa.org/

1st International Conference on Sustainability in Geotechnical Engineering, ICSGE, 27-30 June 2021, Lisboa, Portugal, http://icsge.lnec.pt/#

IS-Cambridge 2020 10th International Symposium on Geotechnical Aspects of Underground Construction in Soft Ground, 28 June to 01 July 2021, Cambridge, United Kingdom, www.is-cambridge2020.eng.cam.ac.uk

ICONHIC2021: THE STEP FORWARD - 3rd International Conference on Natural Hazards & Infrastructure, 22 – 24 June 2021, Athens, GREECE, https://iconhic.com/2021

DFI Deep Mixing, 5-8 July 2020, TBD, Gdansk, Poland, www.dfi.org/DM2020

II International Seminar "Tailings and Waste Rock Disposal", July 12 – 14, 2021, Lima, Peru, www.geoingenieria.org.pe

7th ICRAGEE International Conference on Recent Advances in Geotechnical Earthquake Engineering and Soil Dynamics, 12-17 July 2021, Bengaluru, India, http://7icragee.org

GEOCHINA 2021 - 6th GeoChina International Conference Civil & Transportation Infrastructures: From Engineering to Smart & Green Life Cycle Solution, July 19 to 21, 2021, NanChang, China, http://geochina2021.geoconf.org

37th General Assembly of the European Seismological Commission, September 2021, Corfu, Greece, www.escgreece2020.eu

ACE 2020 14th International Congress on Advances in Civil Engineering, September 2021, Istanbul, Turkey, www.ace2020.org/en

RMEGV 2021 - 5th International Workshop on Rock Mechanics and Engineering Geology in Volcanic Fields, 9÷11 September 2021, Fukuoka, Japan, https://ec-convention.com/rmegv2021

SYDNEY 7iYGEC 2021 7th International Young Geotechnical Engineers Conference A Geotechnical Discovery Down Under, 10-12 September 2021, Sydney, Australia, http://icsmge2021.org/7iygec

SYDNEY ICSMGE 2021 20th International Conference on Soil Mechanics and Geotechnical Engineering, 12-17 September 2021, Sydney, Australia, www.icsgme2021.org

International Conference on Textile Composites and Inflatable Structures (MEMBRANES 2021), 13-15 September 2021, Munich, Germany , https://congress.cimne.com/membranes2021/frontal/default.asp

EUROCK TORINO 2021 - ISRM European Rock Mechanics Symposium Rock Mechanics and Rock Engineering from theory to practice, 20-25 September 2021, Torino, Italy, http://eurock2021.com

ISFOG 2020 4th International Symposium on Frontiers in Offshore Geotechnics, 8 – 11 November 2021, Austin, United States, www.isfog2020.org

2021 GEOASIA7 - 7th Asian Regional Conference on International Geosynthetics Society, November 22-26, 2021, Taipei, Taiwan, www.geoasia7.org

ICGE - Colombo - 2020

3rd International Conference in Geotechnical Engineering

~~10 – 11 August 2020~~ **Postponed to 6 - 7 December 2021**

@ Cinnamon Grand, Colombo, Sri Lanka

http://icgecolombo.org/2020/index.php

The Sri Lankan Geotechnical Society (SLGS) is pleased to announce its 3rd International Conference on Geotechnical Engineering (ICGE – Colombo -2020) to be held on 6-7 December 2021 in Colombo. ICGE – Colombo brings together the world community of engineers and scientists in every branch of geotechnical engineering. The conference will serve as a forum for reviewing the current state of the art and discuss future directions and exciting developments.

Themes

- Site Investigation
- Earthquake Engineering
- Landslides & Slope Stability
- Transportation Geotechnics
- Offshore & Harbor Geotechnics
- Environmental Geotechnics
- Ground Subsidence
- Problematic Soils
- Ground Improvement
- Analytical & Numerical Modelling
- Foundations
- Tunnelling & Deep Excavations
- Geosynthetics
- Engineering Geology & Rock Engineering
- Instrumentation & Monitoring
- Energy Geotechnics
- Case Histories

Contact Us

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Conference Secretaries

Dr J S M Fowze : jsmfowze@gmail.com
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Dr Udeni Nawagamuwa: udeni@uom.lk
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GeoAfrica 2021 - 4th African Regional Conference on Geosynthetics Geosynthetics in Sustainable Infrastructures and Mega Projects, Spring 2022, Cairo, Egypt, https://geoafrica2021.org

LARMS 2021 – IX Latin American Rock Mechanics Symposium Challenges in rock mechanics: towards a sustainable development of infrastructure, 15 – 18 May 2022, Asuncion, Paraguay, https://larms2021.com

Eurock 2022

Rock and Fracture Mechanics in Rock Engineering and Mining

13÷17 June 2022, Helsinki, Finland

Contact Person: Lauri Uotinen
E-mail: lauri.uotinen@aalto.fi

3rd European Conference on Earthquake Engineering and Seismology (3ECEES), 19-24 June 2022, Bucharest, Romania, https://3ecees.ro

CPT'22

5th International Symposium on Cone Penetration Testing
26-29 June 2022, Bologna, Italy

Organiser : Italian Geotechnical Society (AGI) and University of Bologna (endorsed by TC102)

Contact person: Susanna Antonielli (AGI), Prof. Guido Gottardi (University of Bologna)

Email: guido.gottardi2@unibo.it

Email : agi@associazionegeotecnica.it

9th International Congress on Environmental Geotechnics
Highlighting the role of Environmental Geotechnics in Addressing Global Grand Challenges
26-29 June 2022, Chania, Crete island, Greece
www.iceg2022.org

The 9th International Congress on Environmental Geotechnics is part of the well established series of ICEG. This conference will be held on an outstanding resort in the town of Chania of the island of Crete in Greece. The theme of the conference is "Highlighting the role of Environmental Geotechnics in Addressing Global Grand Challenges" and will highlight the leadership role of Geoenvironmental Engineers play on tackling our society's grand challenges.

Contact Information

- Contact person: Dr. Rallis Kourkoulis
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5th International Symposium on Cone Penetration Testing (CPT'22)
26-29 June 2022, Bologna, Italy

Organiser : Italian Geotechnical Society (AGI) and University of Bologna (endorsed by TC102)

Contact person: Susanna Antonielli (AGI), Prof. Guido Gottardi (University of Bologna)

Email: guido.gottardi2@unibo.it
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UNSAT2022
8th International Conference on Unsaturated Soils
June or September 2022, Milos island, Greece

XII ICG - 12th International Conference on Geosynthetics, September 18 – 22, 2022, Rome, Italy, www.12icg-roma.org

15th ISRM

International Congress in Rock Mechanics
9÷14 October 2023, Salzburg, Austria

Contact Person: Prof. Wulf Schubert
E-mail: salzburg@oegg.at

ΕΝΔΙΑΦΕΡΟΝΤΑ ΓΕΩΤΕΧΝΙΚΑ ΝΕΑ

A spectacular initiative

A 245-tonne circular concrete chamber has been installed at the Hönggerberg campus. It serves as the housing of a large geotechnical centrifuge that is used to model earthquakes and their effects on soils and buildings.

It takes just under an hour to lift and set down the 245-tonne circular platform. The time-lapse video shows the process in 42 seconds. (Video: ID MMS ETH Zurich)

From afar, it looked like a UFO hovering over the Hönggerberg campus. That's how massive the circular concrete chamber looked with its four "teeth". It hung about 25 metres above the ground, suspended by an equally massive special crane. The crane was required to lift the circular platform and lower it onto the designated location – after all, at ten metres in diameter and three metres in height, it weighs a staggering 245 tonnes. To assemble the crane alone, about 30 lorry deliveries have been necessary since Monday to bring all the parts onto the campus. The platform itself was cast from reinforced concrete at the HIF building site during recent months.

Centrifuge simulates earthquakes

As it turned out, it took just under an hour to lower the circular chamber into the ground on Friday morning. It is now underground in the inner courtyard, which spans between the test hall and the new extension wing of the HIF building. The HIF building, which was erected in 1976 and is currently undergoing renovations and an extension, houses the professorships of the Department of Civil, Environmental and Geomatic Engineering (D-BAUG).

"I'm thrilled," said Ioannis Anastasopoulos, Professor of Geotechnical Engineering, as he witnessed the installation of the chamber, which has been installed at his request. The chamber itself is merely the first step on the way to a new research infrastructure for geotechnical engineering: the next step will involve installing a geotechnical beam centrifuge into the chamber. This centrifuge will allow the ETH researchers to simulate earthquakes, ground movements, such as landslides, and hydrodynamic processes, such as tsunami waves and scouring.

One of the largest centrifuges in the world

These realistic models enable conclusions to be drawn about the stability of critical infrastructure and the potential risk of ground movement due to earthquakes, landslides, tsunamis or scouring. The new centrifuge will contribute to the simulation of various problems that are of great relevance to the needs of the construction industry, such as the foundations of bridges and high-rise buildings, dams, landslides, and tunnels.

The new research infrastructure represents a significant advancement in realistically simulating such complicated processes, allowing for design optimization and risk reduction. In Europe, there are few others of a comparable size – in the UK, France, and the Netherlands. With a diameter of 9 metres and a capacity of 500 gtons, the geotechnical centrifuge will even be one of the largest in the world. The figure of "500 gtons" refers to the fact that the centrifuge can carry 2 tons at an increased gravitational field of 250 g (g = earth's gravity). And, 2 tons multiplied by 250 gravities results in 500 gtons. This is how the centrifuge capacity is measured.

The circular concrete chamber is anchored in the ground

The positioning of the circular concrete chamber on the steel springs allows to cushion the vibrations of the geotechnical centrifuge

Concrete chamber absorbs vibrations

The circular reinforced concrete chamber serves as the foundation of the centrifuge and rests on the specially designed steel springs. This special design absorbs the vibrations generated by the centrifuge and prevents them from penetrating the soil and spreading beneath the campus, thus ensuring that high-accuracy measurements taken in laboratories inside other campus buildings won't be disturbed. "This the first vibration isolated geotechnical centrifuge in the world," says Ioannis Anastasopoulos.

Delighted Ioannis Anastassopoulos, Professor of Geotechnics, and his colleague, Ralf Herzog (on the left)

The centrifuge is not brand new, but rather an example of how existing equipment can be reused for research. Decommissioned in Germany, it is now being fully refurbished in terms of hydraulics, electronics and control systems. In October, it will be coming to the Hönggerberg campus. A state-of-the-art centrifuge-mounted shaker will be added to allow reproduction of real earthquakes.

The new centrifuge will be part of a new *Centre of Excellence in Centrifuge Modelling* at the Institute for Geotechnical Engineering, which will further strengthen ETH Zurich's leading position in this research area and substantially broaden the Institute's innovation potential. It is a key component of this centre of excellence, which will include other soil testing facilities. Considering the combined capabilities, the new ETH Centre of Excellence will be unique at a worldwide level. With respect to seismic shaking for example, there are only three centrifuge facilities in Europe capable of such testing.

(Florian Meyer / *ETHzürich*, 17.08.2020, https://ethz.ch/services/en/news-and-events/internal-news/archive/2020/08/a-spectacular-initiative.html)

Catastrophic failures raise alarm about dams containing muddy mine wastes

Mud released by a burst tailings dam at an iron mine near Brumadinho, Brazil, killed 270 people in 2019.

The dam, a 40-meter wall of rocks and dirt, gave way without warning, unleashing a torrent of mud. Within a day, some 21 million cubic meters of gray goo and water—the tailings waste left behind by 16 years of copper and gold mining at the Mount Polley mine in western Canada—escaped from a holding pond behind the dam, buried a creek, and poured into Quesnel Lake, home to one-third of British Columbia's legendary Fraser River sockeye salmon.

The 2014 Mount Polley disaster shocked mining engineers around the world. Many considered Canada a leader in developing rules aimed at preventing the failure of such tailings dams, and respected the mine's owner, Imperial Metals. "That wasn't supposed to be able to happen," Jim Kuipers, an engineer and former tailings dam manager who now consults for environmental groups, recalls a colleague telling him.

Since then, the sense of crisis has deepened. In 2015, a tailings dam in Brazil collapsed, unleashing a mammoth mud spill that killed 19 people, contaminated 668 kilometers of river, and reached the Atlantic Ocean. In 2018, a dam failed at a major mine in Australia; luckily, a second barrier prevented disaster. Last year, a dam disintegrated at a decommissioned Brazilian iron mine, releasing a torrent that killed 270 people.

Engineers fear more catastrophes await, as the world confronts a swelling volume of muddy mine tailings, contained by more and larger dams. Some rise to nearly the height of the Eiffel Tower and hold back enough waste to fill Australia's Sydney Harbor. "The consequences of a failure are getting much bigger," says Priscilla Nelson, a geotechnical engineer at the Colorado School of Mines.

In response, scientists, governments, environmentalists, and miners are searching for safer ways to handle the tainted mud. Some are trying to simply inventory the world's tailings dams—estimates of the number range from 3500 to 21,000—and identify those most at risk of failure. A few have called for a ban on one common but failure-prone design. Others are working on regulatory and management fixes. "The mining industry," says Joseph Scalia, a geotechnical engineer at Colorado State University, "is realizing they can't just spend as little as possible and the problem is going to go away."

Tailings are the trash of the mining world. To extract most metals, from iron to gold, miners often mix pulverized rock with water, creating a milkshake of silt and gravel. As higher quality mineral deposits run out, miners are turning to lower grade sources that generate more waste. Worldwide, the metal content of copper ore has fallen by nearly half since the mid–20th century. Extracting a single kilogram of copper can now produce 200 kilograms of sludge. The muck is often contaminated with toxic metals or minerals that produce sulfuric acid when exposed to air.

Tailings dams, unlike those built to store water or generate power, don't earn revenue, creating an incentive for mine owners to minimize costs. Many are built piecemeal throughout the life of a mine. And the barriers are often made from a mixture of rock and the tailings themselves, rather than a more uniform and predictable material such as concrete. Those factors contribute to a failure rate that, over the past century, was more than 100 times higher than that of reservoir and power dams, according to one estimate.

Each disaster has its own constellation of causes, but some arise from seemingly trivial errors. At Mount Polley, investigators led by Norbert Morgenstern, a geotechnical engineer at the University of Alberta concluded that part of the dam was built on a weak patch of silt and clay. Exploratory boreholes drilled prior to construction were too shallow to find the problem. Builders further weakened the dam by making its walls steeper than planned, after the company ran short of rock. One night, the weight of the sludge became more than the dam could bear.

It could have been much worse. No one died. Workers ultimately repaired the dam and shoveled up much of the mud that had buried the creek. (The company says the spill didn't cause long-term harm to the Quesnel Lake ecosystem, but some ecologists say it's still too early to tell.)

Morgenstern, who also led the investigations into the 2015 Brazilian incident and the 2018 Australia failure, has found that faulty engineering, including inadequate scrutiny of the underlying geology, was at the heart of all but two of 15 major incidents between 1980 and 2015.

One major problem, he says, is the "normalization of deviance." The phrase, coined after the 1986 explosion of the space shuttle Challenger, describes how engineers can be lulled into accepting a series of seemingly small risks that snowball into a catastrophe.

There is an unwritten covenant that regulators and mine owners can count on engineers to design a safe tailings system, Morgenstern told a gathering of Brazilian geotechnical engineers in 2018. "That covenant," he said, "has been broken."

The search is on for fixes. Some mining watchdogs are calling for replacing one common type of dam, called an upstream dam, and banning future use of the design. Upstream dams are built in stairlike stages, heading upstream over the accumulating tailings (see graphic, above). Part of the weight of each added step is borne by the tailings below. This approach is often the cheapest, because the tailings serve as construction material.

More than 40% of major tailings dams are the upstream design, according to a global inventory of more than 1700 dams recently launched by pension funds of Sweden and the Church of England, which have pressed the mining industry to strengthen environmental and safety measures. A study of 8000 tailings dams in China found that 95% were upstream dams. And such dams are involved in three-quarters of tailings dam failures, according to one estimate.

The problem is that tailings aren't a predictable building material, and they are often waterlogged. The water can act like a lubricant, reducing the friction that binds an earthen dam together. Engineering flaws such as poor drainage can exacerbate the problem. In extreme cases—such as the 2019 disaster at the Brazilian iron mine—dam sections simply liquefy.

In Chile, where earthquakes make upstream dams even riskier, the government has forbidden the design since 1970. Brazil banned them in the wake of the 2019 accident, and has ordered the mothballing of all upstream dams by 2027. Worldwide, such a policy could mean the demise of thousands of mines and tailings dams (which could be replaced by dams with different designs). Although such a change might be expensive for companies, right now communities near dams are bearing the costs of cheaper construction, says Payal Sampat of Earthworks, a nonprofit group that promotes mining reforms. "That is unacceptable."

Some experts caution against a one-size-fits-all approach. Upstream dams can perform safely, particularly in places with dry climates and few earthquakes, says David Williams, a geotechnical engineer at the University of Queensland, St. Lucia. "You can construct [an upstream dam] to be perfectly safe. You can also build it in a not so good way."

One knowledge gap is an understanding of the forces that can suddenly turn an earthen dam into a liquid river of mud. At the Georgia Institute of Technology, geotechnical engineer Jorge Macedo is stress testing tailings in his lab to document the conditions that trigger liquefaction, particularly in silt, a little-studied material that is common in tailings used to build upstream dams.

Firefighters search for survivors in the mud unleashed by a 2019 tailings dam failure in Brazil.

Other researchers are looking at better ways to spot dams on the verge of failure. Moe Momayez, an engineer and geophysicist at the University of Arizona, is testing sensors on an Arizona dam that track temperature and moisture levels. Some dams are already equipped with radar or lasers that watch for worrying bulges. Momayez's goal is to integrate streams of data in a computer system that can spot problems that might escape periodic inspections. "We have a pretty good idea how these tailing dams fail," Momayez says. "The question is, can we predict that, can we get ahead of the curve?"

Some engineers would like to simply eliminate the need for massive dams. "The best tailings dam is no dam at all," Nelson says. She is studying whether mine waste can be melted into glasslike fibers that could be used for textiles or reinforcing concrete. In June, mining giant BHP said it would spend $10 million to study such reuse of copper tailings.

A more mature approach is to wring the water from tailings, creating waste the consistency of damp earth, which can be sculpted into mountains. The leftovers can still be toxic, but there's less danger of a devastating flood, says Jan Morrill of Earthworks. "Filtered tailings should be considered the industry standard," Morrill says.

Although the approach has been around for decades, it's rarely used, representing just 4% of tailings systems in the pension funds' inventory. Filtered tailings systems can cost five to 10 times more than a conventional dam, says Harvey McLeod, a geological engineer who designs tailings dams for Klohn Crippen Berger, a private firm. It's also an enormous challenge to process tailings at big mines churning out 100,000 tons of waste per day, particularly in wet climates. "It's easier said than done," McLeod says.

Many groups are also pushing for regulatory and management reforms. After the 2019 Brazilian disaster, investment funds worth more than $10 trillion helped bring together officials from industry, government, and the investor group Principles for Responsible Investment to create a set of global guidelines for tailings dam construction. Earlier this month, the coalition issued its plan, calling for stiffer engineering standards for new dams. It also urges top mining executives, rather than lower level staff, to be responsible for tailings safety, and for independent experts to review companies' waste plans. But it doesn't push for a ban on upstream dams.

Morgenstern notes that similar reforms he and others suggested in the late 1990s, after an earlier string of dam disasters, were never fully embraced. He expects it won't become clear until the end of the year whether the new proposals will fare better. Still, he's heartened that, after the recent tragedies, muddy mine waste is again in the spotlight. "The tree," he says, "has been shaken."

(Warren Cornwall / AAAS – Science, Aug. 20, 2020, https://www.sciencemag.org/news/2020/08/catastrophic-failures-raise-alarm-about-dams-containing-muddy-mine-wastes)

Devastating debris flows in Charikar, Afghanistan

Whilst the world's attention has been focused on the impacts of Hurricane Laura in the USA, a far more deadly disaster has occurred in Afghanistan. On Tuesday 25 August 2020 deadly debris flows struck the community of Charikar in Afghanistan. Unfortunately, as is common for such events, these events have been reported to be either floods or flash floods, but the images suggest that they were debris flows. There is considerable uncertainty about the number of fatalities, but at least 100 died in Charikar and the total death toll in the wider area is reported to be at least 162 people.

As yet I have not been able to track down a good overview image of the site of this disaster. This image, posted to Twitter by Salaamedia, shows the scale of the event:-

The aftermath of the 25 August 2020 debris flows at Charikar in Afghanistan

The image below, also posted to Twitter by Salaamedia, shows the nature of the deposits left by the debris flows:-

The deposit left by the 25 August 2020 debris flows at Charikar in Afghanistan

A quick look at the Google Earth imagery demonstrates clearly why Charikar is so seriously affected by debris flows:-

The town is clearly built on a set of large fans emerging from steep, rugged and tectonically active mountains. This environment is tailor-made for debris flows, especially, as is likely, rainfall intensity is increasing in response to global heating.

(Dave Petley / LANDSLIDE BLOG, 28 August 2020, https://blogs.agu.org/landslideblog/2020/08/28/charikar-debris-flows-1/)

Pipelines 2020 Collection

In conjunction with the UESI Pipelines 2020 Virtual Conference (August 9-12, 2020), ASCE is highlighting these select papers on pipeline systems engineering.

Design-Build Project Administration: Case Studies from Water Utilities in the U.S. Southwest/Pacific Region

Impact of Tunnel Boring Machine Advance Rate for Pipeline Construction Projects

Condition Assessment and Repair Prioritization of a Large Diameter Pipeline System

Risk Identification for Pipeline Installation by Horizontal Directional Drilling (HDD)

Strain Demands on Buried Pipelines from Earthquake-Induced Ground Movements

The Use and Role of Lightweight Backfilling Materials in the Installation and Performance of Buried Pipelines/Culverts
Journal of Pipelines Systems Engineering and Practice

A Review of Failure Prediction Models for Oil and Gas Pipelines
Journal of Pipelines Systems Engineering and Practice

ΕΝΔΙΑΦΕΡΟΝΤΑ - ΣΕΙΣΜΟΙ

The Canterbury Earthquake: Images of the distorted railway line

Back in September I posted a series of images that I took of the of the surface fault rupture for the 4th September 2010 Mw = 7.1 Canterbury earthquake in New Zealand. Included was this one, taken of a railway line that crossed the fault rupture at the eastern end of the fault near to Rolleston:

Thanks to Malcolm Teasdale of Kiwirail for sending these two images of the state of the track at this site immediately after the earthquake (posted with permission):

The second image is particularly interesting. Note how the rails show high levels of deformation whilst the surrounding ground shows comparatively little. Notice also how the big kink on the left side has pushed the ballast aside and into the track side ditch. This has happened on the right side too, but to a lesser extent. The right side bend nearest the camera has pushed the ballast towards the camera.

My initial hypothesis here (I am no expert on railway track deformation) in order to stimulate discussion is that the buckling may be the result of compressional deformation across a broad zone. The compression on the very strong railway line was accommodated when a weak point was found, leading to a comparatively rapid deformation to form the main buckle on the left. This then concentrated stress on both sides of the buckle, allowing the other (right side) bends to form. Can anyone who knows more on this topic comment further?

(Dave Petley / THE LANDSLIDE BLOG, 2 November 2010, https://blogs.agu.org/landslideblog/2010/11/02/the-canterbury-earthquake-images-of-the-distorted-railway-line)

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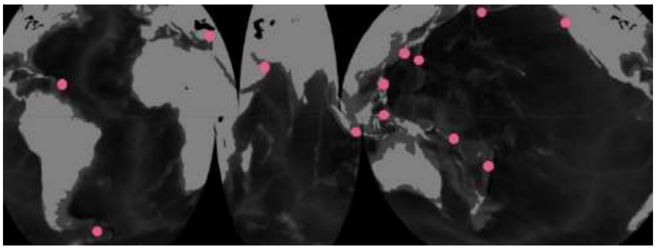
Research offers new clues about where and how subduction starts on Earth



An international team of researchers published a new study providing new clues about how and where subduction begins on Earth, the process behind the deadliest volcanic eruptions.

The Earth's largest earthquakes and most explosive volcanoes occur at subduction zones where a tectonic plate sinks back into the Earth's interior, explained co-author Caroline Eakin from the Australian National University (ANU).

"Subduction zones are a vital ingredient for plate tectonics, and thus for maintaining a habitable planet." Eakin added, "But how they originate is one of the biggest unsolved puzzles in modern Earth Science."

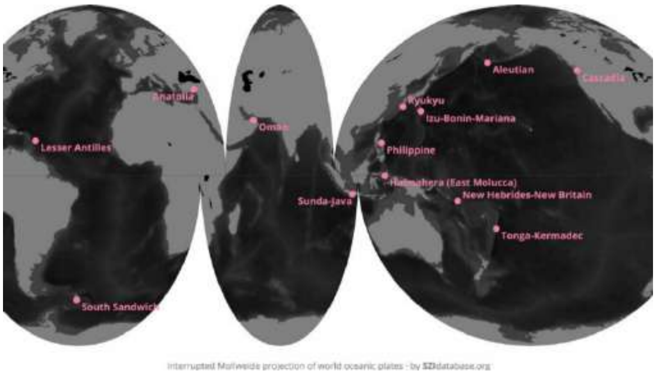
"Now we've been able to compile 100 million years of existing evidence for Subduction Zone Initiation (SZI). One of the biggest things this showed was that subduction breeds subduction. Truly spontaneous subduction in "pristine" places is practically unheard of."

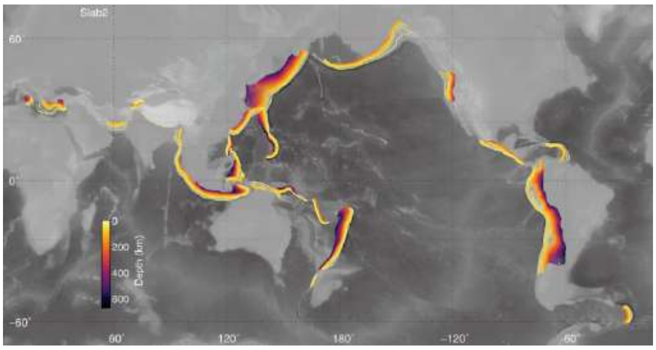
The study-- led by the Centre for Earth Evolution and Dynamics at the University of Olso-- was taken by a team of 14 researchers around the world.

The findings led to a new database on Subduction Zone Initiation, which is open for community input.

"By looking at multiple events, we found SZI clustering around two time periods-- six to 16 million years ago and 40 to 55 million years ago," said Eakin.

"Going forward, ANU researchers will also be deploying ocean-bottom seismometers around Macquarie Island, a location chosen due to its potential for future Subduction Zone Initiation."





Global map of subduction zones. Image credit: USGS

Reference

"A transdisciplinary and community-driven database to unravel subduction zone initiation" - Crameri, F. et al. - Nature Communications - DOI: 10.1038/s41467-020-17522-9

A transdisciplinary and community-driven database to unravel subduction zone initiation

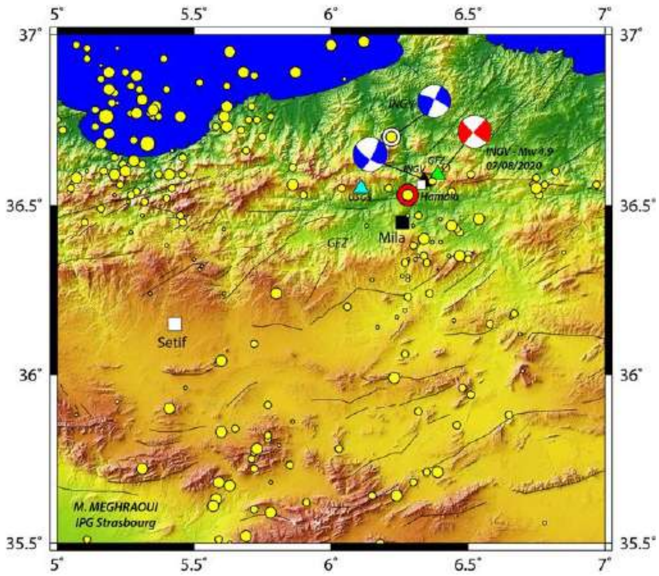
Abstract

Subduction zones are pivotal for the recycling of Earth's outer layer into its interior. However, the conditions under which new subduction zones initiate are enigmatic. Here, we constructed a transdisciplinary database featuring detailed analysis of more than a dozen documented subduction zone initiation events from the last hundred million years. Our initial findings reveal that horizontally forced subduction zone initiation is dominant over the last 100 Ma, and that most initiation events are proximal to pre-existing subduction zones. The SZI Database is expandable to facilitate access to the most current understanding of subduction zone initiation as research progresses, providing a community platform that establishes a common language to sharpen discussion across the Earth Science community.

(Julie Celestial / THE WATCHERS, August 2, 2020, https://watchers.news/2020/08/02/research-offers-new-clues-about-where-and-how-subduction-starts-on-earth)

☙ ❧

Mila shallow EQ - Algeria, Impressive surface ruptures



[Mehdi ZARE](#) Replying to [@mustmeg22](#)

Cher Mustapha, Il est étrange qu'un tel tremblement de terre d'une magnitude 5,5 puisse provoquer une rupture de surface aussi évidente. Peut-être en raison de foyers très peu profonds?

[Meghraoui](#)

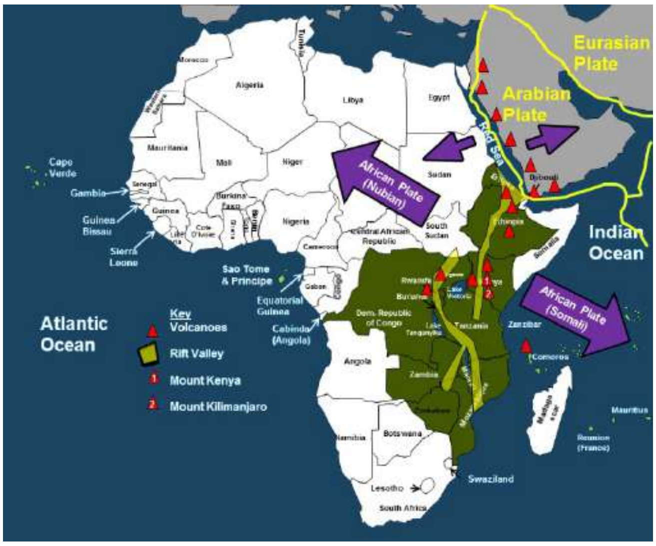
Salut Mehdi, Oui, c'est une curiosité, mais il y a plusieurs exemples de séismes très superficiels (< 6 km) qui montrent des ruptures en surface cosimiques. Attention, peut-être ce ne sont pas des failles, elles peuvent être gravitaires.

[Dr. Ramazan Demirtaş](#) Replying to [@mustmeg22](#)

It looks like a secondary cracks, namely soil failure due to shaking.

(Meghraoui, Aug 8, 2020, https://twitter.com/mustmeg22/status/1291856674542755842)

All part of the future breakup of Africa due to the expanding Earth.



https://twitter.com/SecretzChannel/status/1292033223430733825/photo/2

ΕΝΔΙΑΦΕΡΟΝΤΑ - ΓΕΩΛΟΓΙΑ

Crystal caves

Back in 1914, *National Geographic* published this image, taken with flashlights from a cave in the mining town of Santa Rosalia in the northern Mexican state of Chihuahua. These men are surrounded by calcite crystals as they explore the mine, says **Sara Manco**, our senior photo archivist. "I love the rich texture of the crystals," Manco says, "and how it seems as though one can climb on the crystals without breaking any."

National Geographic

ΕΝΔΙΑΦΕΡΟΝΤΑ - ΠΕΡΙΒΑΛΛΟΝ

Blanket of rock debris offers glaciers more protection from climate change than previously known

A new study which provides a global estimate of rock cover on the Earth's glaciers has revealed that the expanse of rock debris on glaciers, a factor that has been ignored in models of glacier melt and sea level rise, could be significant.

The Northumbria University study, which has been published in Nature Geoscience this week, is the first to manually verify the rock debris cover on every one of the Earth's glaciers.

As glaciers shrink, their surrounding mountain slopes become exposed and eroded rock debris slides down and accumulates on glacier surfaces. This debris forms a protective layer that can be many metres thick, reducing the rate at which the ice below melts. Although the effects of this protective cover are known, it has never been carefully mapped until now, and so has not been included in global glacier models.

As well as revealing where rock debris is located on Earth's glaciers, the researchers also found and corrected key errors within the Randolph Glacier Inventory – a global inventory of glacier outlines on which hundreds of studies are based.

Using Landsat imagery, the research team from Northumbria University's Department of Geography and Environmental Sciences and the Swiss Federal Research Institute WSL spent three years painstakingly examining and manually verifying more than 923,000 square kilometres of glacier worldwide.

The exercise allowed them to analyse the debris cover on a global-, regional-, as well as individual glacier-scale and created the world's first baseline dataset of glaciers in their current state.

They found more than 29,000 square kilometres of the world's mountain glacier area is covered in rock debris – an area equivalent to almost 500 Manhattan Islands.

Lead researcher Sam Herreid undertook the study for his PhD at Northumbria University and is now believed to be the only person who has examined every glacier on Earth, manually correcting the Randolph Glacier Inventory and bringing a level of consistency that has never before been present in a global glacier dataset.

He explained: "The structure of the debris cover of each glacier is unique and sensitive to climate, but until now, global glacier models have omitted debris cover from their forecasts of how glaciers respond to a changing climate.

"We now know that debris cover is present on almost half of Earth's glaciers, with 7.3% of the world's total mountain glacier area being debris covered.

"When we consider that much of this debris cover is located at the terminus, or toe, of a glacier where melt would usually be at its highest, this percentage becomes particularly important with respect to predicting future water resources and sea level rise."

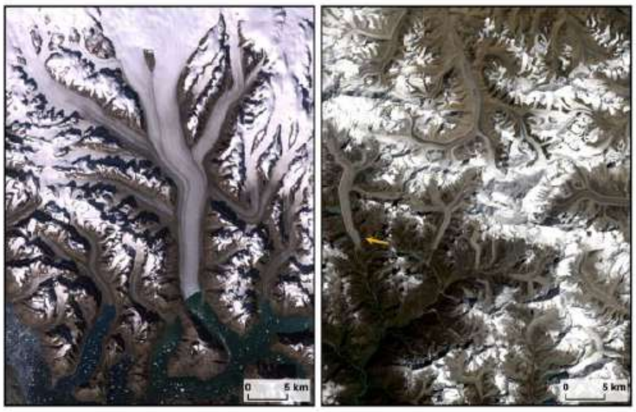
The study also uncovered errors within the Randolph Glacier Inventory, finding an error rate of 3.3%. One of their findings revealed that 10,000 square kilometres of mapped glacier area was not actually glacier, but rather bedrock or vegetated ground that was either incorrectly mapped previously or glacier area that has since melted away.

This, combined with the melt reduction from debris insulating the ice below, means that all past global glacier models based on the Inventory are likely to have overestimated the true volume of glacier melt, run off and subsequent contribution to global sea level rise.

They described the 10.6% of glacier area that requires an updated approach to estimating melt as "an alarmingly high number" and said that their work provides a key dataset for revising, and likely lowering, the glacier contribution to sea level rise.

The team also devised a way to analyse how the world's debris-covered glaciers will evolve over the coming centuries.

By comparing the many states of glaciers present on Earth today, from those considered to be 'young' and icy in Greenland, to 'old' and rock covered in the Himalaya, they were able to piece together a conceptual timeline which they believe outlines how a glacier might evolve in the future.



'Young' debris cover in SE Greenland (left) and 'old' cover in the Everest region of the Himalaya, with the arrow pointing to one of the debris covered glacier tongues.

Their timeline reveals that many glaciers are at the older end of the spectrum and can therefore be considered to be on the decline.

Co-author Francesca Pellicciotti of the Swiss Federal Research Institute WSL and an Associate Professor at Northumbria University, explained: "The upper levels of the glaciers are constantly accumulating snow and will always be debris free, so we looked only at the lower levels of glaciers which is where rock debris can accumulate.

"Ice melts and flows away as water, but the rocks do not, and accumulate at the surface. Changes in the rate of mountain erosion as well as glacier changes in a warming climate will affect the size and shape of the rock layer at the surface of a glacier at any one time.

"Although we can't say exactly what year a glacier will evolve to a certain state, say, a state where it is almost entirely covered in rocks, we were able to place each glacier on a conceptual timeline and learn roughly how far along this line each glacier is to becoming almost entirely covered in rocks.

She added: "We found that the bulk of glaciers that have a debris cover today are beyond a peak debris cover formation state and are trending closer to the "old" Himalayan glaciers that might not be around for much longer.

"From a climate change perspective this is one more indication of the toll a warming climate is having on Earth's glaciers. However, we now have a benchmark measurement of debris cover for all of Earth's glaciers and new tools to monitor and predict the rate of changes couple to a warming climate."

Northumbria University is renowned for being one of the leading centres in Europe for research into coldand palaeo environments. In recent years the University has been granted major research funding to investigate and model changes to Antarctica's major glaciers. It is the only UK university to be involved in two investigations in the £20 million UK-US International Thwaites Glacier Collaboration.

The study The state of rock debris covering Earth's glaciers is now available in Nature Geoscience.

(Northumbria University, Newcastle / News, 4th August 2020 https://www.northumbria.ac.uk/about-us/news-events/news/rock-debris-on-glaciers/)

The state of rock debris covering Earth's glaciers

Sam Herreid & Francesca Pellicciotti

Abstract

Rock debris can accumulate on glacier surfaces and dramatically reduce glacier melt. The structure of a debris cover is unique to each glacier and sensitive to climate. Despite this, debris cover has been omitted from global glacier models and forecasts of their response to a changing climate. Fundamental to resolving these omissions is a global map of debris cover and an estimate of its future spatial evolution. Here we use Landsat imagery and a detailed correction to the Randolph Glacier Inventory to show that 7.3% of mountain glacier area is debris covered and over half of Earth's debris is concentrated in three regions: Alaska (38.6% of total debris-covered area), Southwest Asia (12.6%) and Greenland (12.0%). We use a set of new metrics, which include stage, the current position of a glacier on its trajectory towards reaching its spatial carrying capacity of debris cover, to quantify the state of glaciers. Debris cover is present on 44% of Earth's glaciers and prominent (>1.0 km^2) on 15%. Of Earth's glaciers, 20% have a substantial percentage of debris cover for which the net stage is 36% and the bulk of individual glaciers have evolved beyond an optimal moraine configuration favourable for debris-cover expansion. Use of this dataset in global-scale models will enable improved estimates of melt over 10.6% of the global glacier domain.

Nature Geoscience (2020), https://doi.org/10.1038/s41561-020-0615-0, https://www.nature.com/articles/s41561-020-0615-0

Incredible sceneries in Kamchatka

Στο τελευταίο της ταξίδι, η φωτογράφος Isabella Tabacchi επισκέφθηκε την περιοχή της Καμτσάτκα στο ανατολικό τμήμα της Ρωσίας και μέσα από τον φωτογραφικό της φακό, μας παρουσιάζει κάποια δυνατά πλάνα της απόκοσμης και άγρια όμορφης αυτής περιοχής.

Όλη η συλλογή, περιλαμβάνει τοπία που μαρτυρούν την παρθένα φύση της Καμτσάτκα, τα οποία έρχονται σε αντίθεση με τα χρώματα των δέντρων, των λουλουδιών και των δασών αλλά και των ηφαιστείων που ολοκληρώνουν το γύρω σκηνικό.

Η συγκεκριμένη σειρά φωτογραφιών πέρασε και από ένα "meta-editing", κατά την οποία η φωτογράφος επέλεξε να τονίσει λίγο περισσότερο τα ισχυρά στοιχεία των "αιχμαλωτισμένων" τοπίων, προκαλώντας με αυτό τον τρόπο δέος και έκπληξη στον θεατή.

https://mancode.gr/travel/incredible-sceneries-in-kamchatka/

ΕΝΔΙΑΦΕΡΟΝΤΑ - ΛΟΙΠΑ

Marvel of engineering

Check out this 240-kilometer highway, dubbed a "ladder-like sky road", which is made up of 270 viaducts and 25 tunnels in Southwest China's Sichuan Province.

(Global Times, 24.08.2020, https://www.facebook.com/globaltimesnews/videos/353065262384901

Αδρεναλίνη: Η νέα γέφυρα που αιωρείται πάνω από καταρράκτη της Νορβηγίας είναι μόνο για τολμηρούς

Η θέα κόβει την ανάσα, όπως και το γεγονός ότι τα άκρα που συνδέουν τη γέφυρα έχουν υψομετρική διαφορά περίπου 16 μ.

Η αδρεναλίνη στα ύψη -κυριολεκτικά: Η νέα γέφυρα πεζών που μοιάζει να αιωρείται πάνω από το βαθύ φαράγγι και τον εντυπωσιακό καταρράκτη Vøringsfossen στη δυτική Νορβηγία με τα νερά που πέφτουν από ύψος 145 μέτρων, αναμένεται να γίνει το νέο αξιοθέατο του ήδη διάσημου τουριστικού προορισμού (τουλάχιστον για όσους έχουν την τόλμη να τη διασχίσουν).

Η μήκους 47 μέτρων πεζογέφυρα είναι επικλινής και τα δύο άκρα της έχουν υψομετρική διαφορά 16 μέτρων.

Επιπλέον, η θέα στο χωρίς υπερβολή παραμυθένιο τοπίο, έχει ακόμη έναν βαθμό δυσκολίας, καθώς για να φτάσουν στη γέφυρα, οι επισκέπτες πρέπει να ανέβουν τα 99 σκαλοπάτια που συνδέουν τις δύο πλευρές της εντυπωσιακής κοιλάδας Måbødalen.

Το πρότζεκτ της κατασκευής ξεκίνησε πριν από μία δεκαετία, ενώ η γέφυρα αποτελεί μέρος ενός ευρύτερου σχεδίου (κόστους 4.400.000 δολαρίων) που περιλαμβάνει νέες πλατφόρμες για ακόμη καλύτερη θέα, μονοπάτια και ένα καφέ και αναμένεται να παραδοθεί στο σύνολο του το 2022.

Προκειμένου να διασφαλίσει ότι η όποια επέμβαση δεν θα βλάψει το περιβάλλον, ο αρχιτέκτονας Carl-Viggo Hølmebakk έκανε ψηφιακή σάρωση του εδάφους προτού ξεκινήσει η ανοικοδόμηση, ενώ παράλληλα με τις συμβατικές μεθόδους κατασκευής, η ομάδα του χρησιμοποίησε ελικόπτερα και ορειβάτες.

Η γέφυρα άρχισε να κατασκευάζεται το 2015, ωστόσο λόγω κλίματος και θέσης (ψηλά στα βουνά) οι εργασίες μπορούσαν να πραγματοποιηθούν μόνο κατά τη διάρκεια της σύντομης θερινής περιόδου.

Ο Hølmebakk παραδέχεται ότι ορισμένοι ίσως αισθάνονται ότι η γέφυρα παρεμβαίνει στη φυσική ομορφιά του τοπίου, αλλά υπογραμμίζει ότι έχει σχεδιαστεί με ευαισθησία και επισημαίνει ότι εξασφαλίζει έναν ασφαλέστερο τρόπο διάβασης για τους περιπετειώδεις ταξιδιώτες που θέλουν να απολαύσουν την ομορφιά του καταρράκτη.

(Newsroom, HuffPost Greece, 22/08/2020, https://www.huffingtonpost.gr/entry/adrenaline-e-nea-yefera-poe-aioreitai-pano-apo-katarrakte-tes-norveyias-einai-mono-yia-tolmeroes_gr_5f40b582c5b6305f3257bfc0)

ΗΛΕΚΤΡΟΝΙΚΑ ΠΕΡΙΟΔΙΚΑ

https://www.issmge.org/publications/issmge-bulletin/vol-14-issue-4-august-2020

Κυκλοφόρησε το Τεύχος 4 του Τόμου 14 (Αυγούστου 2020) του ISSMGE Bulletin με τα παρακάτω περιεχόμενα:

- **Research highlights**
- **Message from member society**
- **Latest news from the British Geotech-nical Society (BGA)**
- **Conference report**
  - 1st International Webinar Series: Recent Advances in Geotechnical Engineering Re-search and Practice, India
  - Annual Croce Lecture, Italy
- **ISSMGE Foundation reports**
- **Event Diary**
- **Corporate Associates**
- **Foundation Donors**

Geo-Trends Review

A Crowdsourcing Magazine for the Geotechnical Engineering Community - Issue #12 - August 2020

https://www.mygeoworld.com/geotrends/issues/12-august-2020

Special Issue on Hurricane Geotechnics by GEER published

https://www.geocasehistoriesjournal.org/announcements/vol-5-issue-4-has-been-released/

We are pleased to announce the Special Issue #4 of Volume #5 of the International Journal of Geoengineering Case Histories, an official Journal of the International Society for Soil Mechanics and Geotechnical Engineering (ISSMGE).

This Special Issue of the ISSMGE International Journal of Geoengineering Case Histories draws from the hurricane reconnaissance efforts by the Geotechnical Extreme Event Reconnaissance (GEER; geerassociation.org) Association between 2008 and 2017. Post-hurricane geotechnical reconnaissance has drawn attention to impacts on foundations, earthen structures, coastal infrastructure, scour, and sediment erosion and relocation. The need for a better understanding of such impacts is urgent due to the increasing phenomena of sea level rise, storm frequency and intensity, and growing population in coastal areas.

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