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& ΓΕΩΤΕΧΝΙΚΗΣ
ΜΗΧΑΝΙΚΗΣ

Bimrocks Article Part 2: "Case Histories and Practical Guidelines",
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Τα Νέα

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1966 / 1967 – 2007 : 40 χρόνια δραστηριότητας

Η Ελληνική Επιστημονική Εταιρεία Εδαφομηχανικής και Θεμελιώσεων, ο επιστημονικός φορέας των Ελλήνων γεωτεχνικών μηχανικών, συμπλήρωσε ήδη 40 χρόνια ζωής και γόνιμης δράσης.

Το γεγονός αυτό μας δίνει την ευκαιρία να αναλογιστούμε την μέχρι τώρα πορεία και να κάνουμε σχέδια για το μέλλον.

Η 40χρονη πορεία της επιστημονικής μας εταιρείας συμπίπτει με μια περίοδο αλματώδους προόδου όλων των κλάδων της γεωτεχνικής μηχανικής όπως της εδαφομηχανικής, εδαφοδυναμικής και σεισμικής μηχανικής, της βραχομηχανικής και της τεχνολογίας των υπογείων έργων. Παράλληλα είδαν το φως και νέοι κλάδοι όπως η τεχνολογία των γεωσυνθετικών και η γεωπεριβαλλοντική μηχανική. Ανάλογη ήταν επίσης και η ανάπτυξη των μέσων και τεχνολογιών κατασκευής των γεωτεχνικών έργων.

Η πρόοδος αυτή σημειώθηκε βεβαίως σε διεθνές επίπεδο αλλά και η Ελλάδα είχε ουσιαστική συμμετοχή σ᾽ αυτή, όχι μόνο με τη μεταφορά τεχνογνωσίας από το εξωτερικό αλλά και με τη διεξαγωγή βασικής και εφαρμοσμένης έρευνας στα εκπαιδευτικά ιδρύματα της χώρας, καθώς και με την εμπειρία που αποκτήθηκε κατά τη μελέτη και εκτέλεση σημαντικών αναπτυξιακών έργων, ιδίως μετά την ένταξη της Ελλάδας στην Ευρωπαϊκή Ένωση.

Η Εγνατία Οδός, οι οδικοί άξονες ΠΑΘΕ, οι ζεύξεις Ρίου - Αντιρρίου και Ακτίου – Πρέβεζας, η Αττική Οδός, το Μετρό της Αθήνας, οι επεκτάσεις και βελτιώσεις του σιδηροδρομικού

συνέχεια στην σελίδα 3

ΠΕΡΙΕΧΟΜΕΝΑ

2003 - 2th IGEC στην Μαμάια, Ρουμανία - Κ. Ανδριανόπουλος
2005 - 3th IGEC στην Osaka, Ιαπωνία - Ι. Αναστασόπουλος

Bimrocks - Part 2: Case Histories and Practical Guidelines

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INTRODUCTION

Bimrocks (block-in-matrix rocks) are mixture of rocks composed of geotechnically significant blocks within a bonded matrix of finer texture such as weathered rocks, fault rocks, melanges and other complex geological mixtures (Medley,1994a). Despite different geologic formative processes, globally common bimrocks are soil/rock mixtures that have a similar fabric of relatively hard blocks of rock surrounded by weaker matrix rocks. The expression "geotechnically significant blocks" means that there is mechanical contrast between blocks and matrix, and that the geometry and proportion of blocks influence the rock mass properties at the scales of engineering interest.

Two articles are presented in this Bulletin to increase the awareness of bimrocks by geotechnical practitioners and in doing so perhaps lessen the expensive surprises that so often occur with earthwork and tunneling construction in bimrocks. The first article, in the March 2007 Bulletin, presented some fundamental attributes of bimrocks. This second article presents case history experiences and guidelines to characterization of melanges, which are the most intractable of bimrocks. The information presented in the articles is abstracted from comprehensive resources freely provided at http://bimrocks.geoengineer/resources. html .

Characterization, design and construction with bimrocks are challenging in many regions of the world (including Northern Greece and some Greek Isles). Geotechnical engineers and engineering geologists often mischaracterize bimrocks because of their considerable spatial, lithological and mechanical variability. However, correct characterization can reduce expensive and inconvenient surprises during tunneling, earthwork and foundation construction, as briefly described in the following Case Histories.

CASE HISTORY 1: MISCHARACTERIZATION OF A LANDSLIDE

Hillside repairs were proposed to mitigate a landslide that continually disrupted a main road. During the geotechnical investigation the exploration borings were terminated about 2m into "sandstone bedrock." The geotechnical practitioner concluded that the landslide was shallow, being composed of clay and boulder colluvium sliding on the contact with the underlying sandstone bedrock (Figure 1). The engineer recommended that the slide would be most economically repaired by removing the failed soil and re-grading the slope. A repair was designed to remove the shallow landslide and the successful contractor bid was for several hundred thousand dollars. However, during construction, the contractor encountered pervasively sheared shale containing abundant rock blocks to several meters in size, which require required considerable effort to remove since blasting was not permitted. The contractor failed to find solid "bedrock", or even the landslide "failure surface". The excavation was deepened below the design depth of a few meters to several tens of meters. The repair finally cost more than a million dollars.

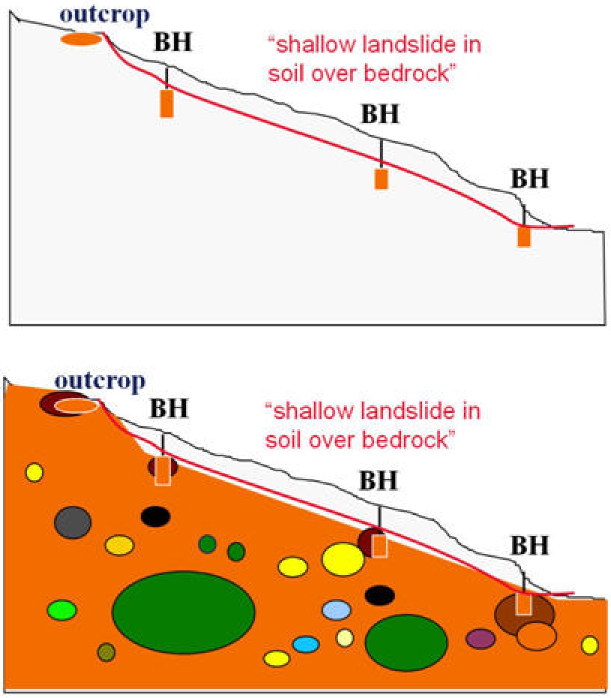

Figure 1: Upper sketch shows interpretation of geology based on assumed continuous sandstone bedrock surface intersected by borings. Lower sketch shows more realistic bedrock conditions in which borings intersected discrete blocks in a bimrock containing blocks of various dimensions and lithology.

The landslide was actually a deep-seated earth flow in pervasively sheared melange, rather than the shallow soil mass sliding on top of "bedrock" interpreted from exploration drilling. "Bedrock" was an artifact of connecting straight lines between the soil/rock contacts intersected by the borings (Figure 1), a very common error made by geopractitioners (Medley, 2005) (Figure 7, Article 1).

Although the geological chaos was a surprise to the geotechnical engineer, available geological maps showed the locale of the landslide to be within melange and large blocks protruded from hillsides around the sites. Blocks and matrix are best seen along coasts and rivers where the blocks form prominent headlands (Figure 2). Inland, although blocks often protrude conspicuously from hillsides

Figure 2: Franciscan melange at Coleman Beach, California. Blocks form erosion-resistant headlands and buttress upslope weaker block-poor melange. Several homes are threatened by cliff-top retreat of block-poor melange.

(Figure 4, Article 1) their presence generally must be inferred by subtle topographic or vegetation contrasts. In northern California the early summer browning of grass occurs first above blocks because the generally sandier soils dry faster than the clayey soils above matrix. The result is a mottling that is characteristic in melange terrains (Figure 3), and which is well exhibited in air photos taken in Spring and early Summer. Road and railway cuts also provide opportunity to inspect bimrocks, such as that shown in Figure 4.

As cautioned by Wakabayashi and Medley (2004), when working with melanges and fault rocks, geologists should not instinctively draw straight lines between outcrops or borehole contacts, because there are considerable design and economic differences between working in coherent "layer-cake" stratigraphy, In such circumstances, a mental picture of the spatial and lithologic variety of blocks/matrix rock mixtures (Figure 1) will reduce errors in geological interpretations.

Figure 3: Franciscan melange in northern California. Occasional blocks protrude from the hillside or form bumps in the topography. Brown patches indicate grass on sandy soils above blocks.

It is vital that the bimrock first be recognized before it can be characterized, and hence an experienced engineering geologist or structural geologist should be retained. As outlined by Wakabayashi and Medley (2004), accurate descriptions of bimrocks are critical, otherwise misinterpretation of the geologic data by non-geologists may result such as the unexpected cost of change orders and construction disputes. For fault rocks, terms such as "melange" are geologically correct, but basic descriptions such as "elongate masses of sandstone and siltstone in a sheared shale matrix" are more appropriate. Logging the material encountered in the borings as "soil above bedrock" increases the probability that the blocks will be interpreted as continuous bedrock. Terms such as "interbedded sandstone and shale" for sandstone blocks in shale matrix gives the false impression of a continuously bedded unit rather than a chaotic unit of blocks separated by matrix. Bimrocks should not be described as "miscellaneous soils" or "soil with boulders". The latter term may mean different things to the geologist who encounters blocks during exploration, and the contractor who has to construct through or around them. Logs and descriptions should not contain the word "diameter" for blocks, since the observed dimensions of blocks are almost always less than the actual maximum sizes of blocks.

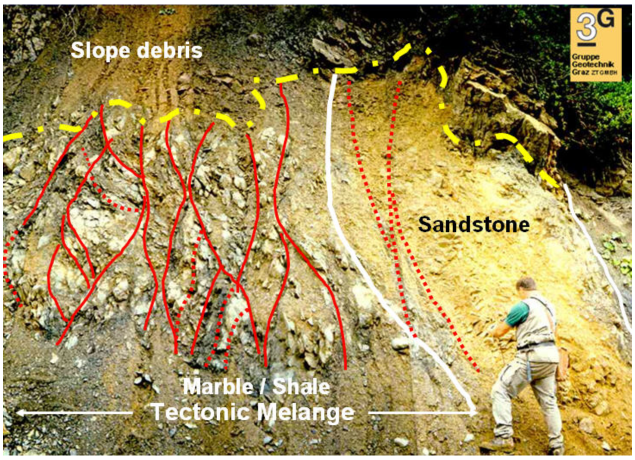

Figure 4: Tectonic melange exposed in slope in Turkey (photo courtesy of Gruppe Geotechnik Graz).

There are many factors that should be considered when analyzing slope stability problems in bimrocks, some of which are illustrated in Figure 5. For example: when blocks are few, the bimrock can likely be analyzed as a conventional soil or rock mass (Figure 5A); landslide failure surfaces are influenced by the orientation and nature of matrix shearing *Figure 5B); large blocks which influence the tortuous failure surface that negotiate around blocks and add strength (Medley, 2004) (Figure 5C); and, block-poor zones within generally block-rich bimrock are weaker and more likely to fail (Figure 5D).

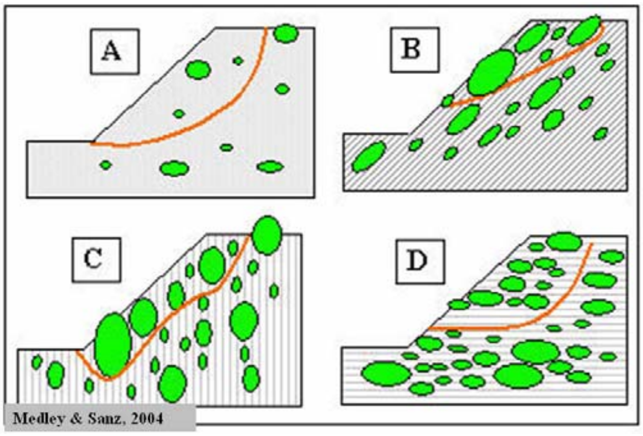

Figure 5: Some situations to consider in analyzing the stability of slopes in melanges.

CASE HISTORY 2: ESTIMATION OF STRENGTH OF A MELANGE UNDERLYING A DAM

This case history outlines the methods used to re-characterize the bedrock underlying Scott Dam, which impounds the Eel River at Lake Pillsbury, 160 km north of San Francisco. Built in the 1920's, the dam is a masonry gravity structure about 40 m high (Figure 6), underlain by melange of the Franciscan Complex ("the Franciscan"). In the 1970's conventional geotechnical analysis indicated that, if the strength of the melange under the dam was similar to the strength of the sheared shale matrix, then the dam should have failed by sliding. Because the dam was intact, the melange bedrock was clearly stronger, possibly due to the presence of the blocks in the sheared shale (Volpe and others, 1991, Goodman and Ahlgren, 2000).

Franciscan melanges and many other bimrocks have scale-independent block size distributions, at least between the laboratory and site scales of engineering interest. Consequently, a characteristic engineering dimension (L_c), must be established, such as footing width, slope height, and laboratory specimen diameter (Medley, 1994a). Flexibility is inherent in the selection of L_c for dam foundations: the dam width, dam height, square root of the area ($\sqrt{A}$) of the

Figure 6: Scott Dam on the Eel River, northern California.

dam footprint, or thickness of a critical failure zone may all be used, as appropriate. As described in Article 1, geotechnically significant blocks that influence bimrock strength range between about $0.05L_c$ (at the block/matrix threshold) and $0.75\ L_c$ (for the largest block, d_{max}). In practice, one should select the most conservative block/matrix threshold that can be justified and measure the blocks between these limits. Blocks smaller than $0.05\ L_c$ are demoted to matrix at the scale of interest but may still be of substantial size. If the scale of interest becomes smaller, blocks previously demoted into matrix become geotechnically significant blocks. The likely mode of failure at Scott Dam was considered to be sliding along an assumed potential 3m thick shear zone within the melange below the base of the dam. Accordingly, L_c was selected as the 3m thickness of the shear zone (Figure 7).

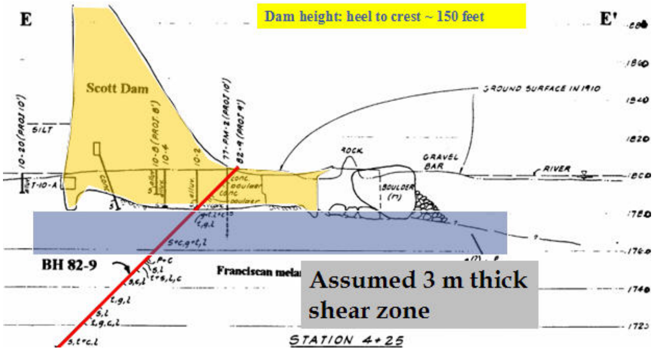

Figure 7: Cross Section through Scott Dam (orange shading) showing typical exploration boring (red), and assumed critical potential failure zone beneath dam, assumed to be 3 m thick, which scaled the problem.

It is difficult to recover good quality core in bimrocks because of the abrupt variations between blocks and matrix, varying block lithologies, extensive shearing and the highly fractured nature of small blocks. Recovery of core tends to be much better in blocks than in matrix because the blocks survive the drilling process, whereas the weak matrix generally does not (Riedmüller et al, 2001). Core recovery can be improved by a committed and careful driller. Goodman and Ahlgren (2000) describe how poor sample recovery resulted when drilling Franciscan melange, at Scott Dam, Northern California, even using triple barrel samplers and the Integral Sampling Method of Rocha (1971), a method in which friable rock is pre-grouted and then cored. Estimates of the linear block proportions (total length of blocks intersected divided by the total length of borings – Figure 8) should be made during core logging and the core should be photographed, and promptly shrink-wrapped with plastic film, since matrix, particularly in sheared melanges, may slake. When logging core, measure all block/core intersections (chords) greater than 2 cm to 3 cm long - even if the block/matrix threshold is larger, the information obtained by measurements will be useful for work performed at laboratory scale.

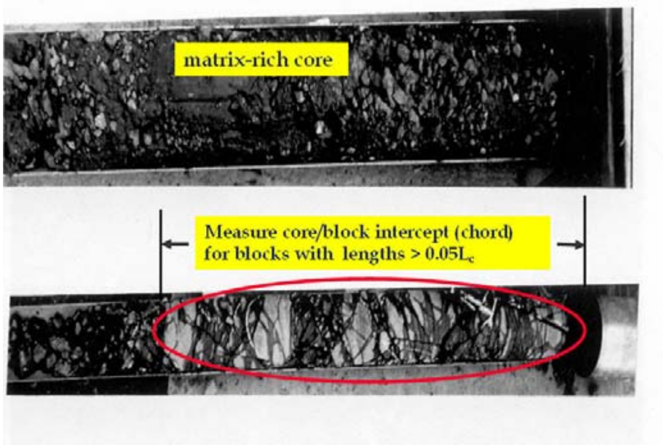

Figure 8: Typical core from an exploration boring at Scott Dam, showing matrix of sheared shale containing blocks that were smaller than $0.05\ L_c$ (0.15m), and assigned to the matrix; and a measurable block (photo: Professor Richard E. Goodman).

For the Scott Dam project, the block/matrix threshold was selected as 0.15m (i.e.: 5 percent of 3m) and this criterion was used to discriminate blocks from matrix while reviewing field data in order to estimate the linear block proportion. Inspection of drill logs and photographs of Scott Dam core (Figure 9) penetrating the assumed potential failure zone indicated that the linear block proportion was about 40 percent.

With enough data, the linear block proportion is equivalent to the volumetric block proportion. However, the minimum total length of exploration core required to yield a reasonably accurate estimate is at least 10 times the size of the expected largest block ($10L_{c,}$ or $10d_{max}$). At Scott Dam, based on field observations and drilling, the size of the largest block d_{max} was estimated to be between 30m and 43m (Medley, 1997), so greater than 300 m to 430m of drilling would have been preferable. In actuality, only about 150m, of core (representing at least $5d_{max}$) was recovered. Hence, the estimated volumetric block proportion had to be adjusted for uncertainty.

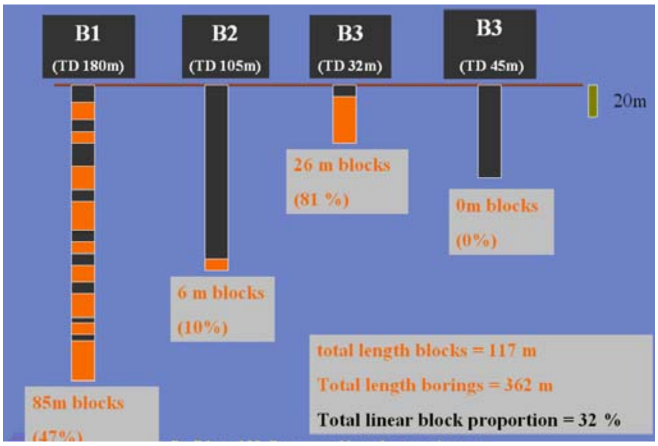

Figure 9: Calculating linear block proportions for individual boreholes B1 to B4 and total block proportion. Block intersections shown in orange. TD is total depth of an individual boring. 20m scale bar shown.

As shown in Figure 10, using the procedure described by Medley (1997) for the estimated linear block proportion of 40%, the uncertainty was 0.2. Hence the adjusted estimate was 40% +/-0.2*40%, or 32% to 48%. A conservative adjusted volumetric block proportion of 32 percent was selected. This estimate was subsequently lowered to 31 percent on the basis of additional exploration drilling (Goodman and Ahlgren, 2000).

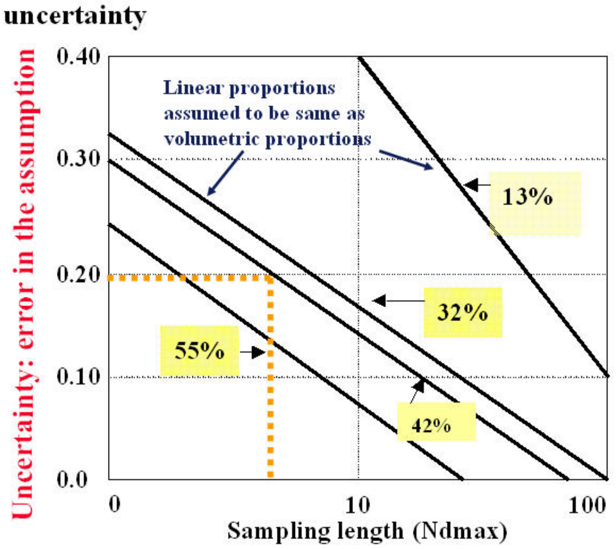

Figure 10 : Uncertainty in estimates of block volumetric proportion as a function of the length of linear measurement, expressed as a multiple of the length of the largest block (dmax), and the measured linear block proportion (13% to 55%) (Medley,1997).

Laboratory specimens of melange were tested using multistage triaxial compression such as those described by Lindquist (1994a), Lindquist and Goodman (1994), Bro (1996, 1997) and Goodman and Ahlgren (2000). Given that the diameter of the laboratory specimens was the characteristic engineering dimension (L_c), blocks in the specimens were those intact inclusions that had maximum dimensions between about 5 percent and 75 percent of the specimen diameter. The volumetric block proportions of each specimen were determined after disaggregating them and wash sieving to retrieve the blocks. The volume of blocks (and thence the volumetric block proportion) can also be estimated by measuring the specific gravity of the blocks and weighing the specimens (Lindquist, 1994a). Medley (1994a) described methods of approximating block proportions from scanlines drawn on the side of specimens or image analysis of specimen exteriors, although these measures are generally not the same as volumetric proportions.

The strength testing of Scott Dam laboratory specimens with different block proportions yielded a plot of effective friction angle as a function of volumetric block proportion (Figure 11). Similar plots can be developed for cohesion and deformation parameters (Lindquist 1994a, 1994b; Goodman and Ahlgren, 2000). The overall strength of the foundation rock mass was determined using the adjusted estimate of rock mass volumetric block proportion and the laboratory plot of effective friction angle as a function of volumetric block proportion. Because of scale independence, melange and other bimrocks at the scale of laboratory specimens are closer to being scale models of the parent rock masses than is generally true in geotechnical engineering. Although the strength estimated is for an overall volumetric block proportion and there may be block-poor and block-rich zones within the rock mass with significant variation from the overall average. For the melange beneath Scott Dam, the friction angle was estimated to be 39 degrees for the overall 31 percent volumetric block proportion (Figure 11).

Additional geotechnical analyses confirmed that the strength of the melange bimrock at the dam foundation was considerably greater than the strength of the matrix alone. On the basis of the geotechnical characterization and analysis of the melange, both the California Division of Safety of Dams and the Federal Energy Regulatory Commission agreed that Scott Dam was safe and did not require any reinforcement (Goodman and Ahlgren, 2000).

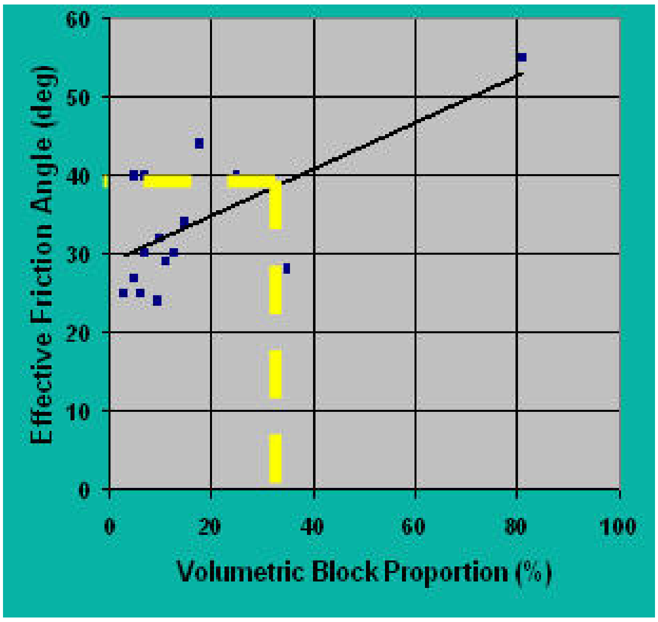

Figure 11 : Plot of effective angle of friction as a function of volumetric block proportion, generated from laboratory testing of Franciscan melange specimens obtained from core drilling at Scott Dam, northern California (After Goodman and Ahlgren, 2000).

CASE HISTORY 3: ESTIMATE OF VOLUMETRIC BLOCK PROPORTION IN AN EXCAVATION

This case history shows that for construction, estimates of block proportion and size should still be made even if volumetric block proportion is too low to improve the geomechanical properties of a rock mass. The Lone Tree Slide was a major landslide in Franciscan melange that blocked a major highway near San Francisco. To stabilize the slope, 950,000 cubic meters of intact and failed melange were excavated to an average depth of 37 m. The original exploration of the landslide indicated a maximum block chord length of about 8 m. However, the sizes and proportion of the hard blocks encountered during excavation were far greater than had been anticipated during design causing delays and unanticipated expense (Van Velsor and Walkinshaw, 1993).

To develop approaches useful for future construction projects, Medley (1994a, 1994b) logged the drilled core and mapped the excavation at Lone Tree Slide. The characteristic engineering dimension (L_c) for the landslide was assumed to be the average thickness of the original slide, some 30m. Several large blocks protruded from the undisturbed hillside adjacent the landslide, the exposed parts of which had maximum observed dimensions of about 30 m (Medley, 1994a). Accordingly, the size of the largest block (d_{max}) was assumed to be about 30 m, and the block/matrix threshold was thus selected as 1.5 m ($0.05L_c$).

About 375 m of drilled core from the landslide exploration was logged. Chords (lengths of intersection between blocks and borings) between 1.0m and up to 7.9m were measured. The linear block proportion for all the melange explored was about 10 percent, which was the weighted average of block-poor melange within the landslide (about zero percent) and block-rich melange beneath the slide (28 percent). The 375 m total length of drilling was equivalent to 12.5d_{max} (where d_{max} was 30 m). For a measured block linear proportion of 10 percent, and d_{max} of 12.5, Figure 10 indicates that the uncertainty is at least 0.40. Hence, the estimated range of volumetric block proportions was 6 percent and 14 percent (10 percent +/- 0.4*10 percent). According to the contractor, the actual volumetric proportion of excavated blocks was between 6 percent and 11 percent, greater that the original design estimate of 5 percent, but closer to the post-project estimate. If the estimation had been performed prior to excavation instead of afterward, a suggested range of between 5% and 15% would have been reasonable to estimate the volumetric block proportion.

CASE HISTORY 4: ESTIMATION OF BLOCK SIZES DURING TUNNELING

The Richmond Transport, a 4.3 m diameter concrete sewer pipe, was constructed in the Sea Cliff and Legion of Honor areas of San Francisco between 1994 and 1996. The pipe was installed within an approximately 3 km long, 6m diameter tunnel excavated by a TBM within Franciscan melange. About 740m of core was recovered from exploration drilling along the alignment of the tunnel. Geological mapping was performed along the coastline west of the tunnel by geotechnical consultants. The rock through which the tunnel was aligned was mapped as three separate zones: two being block-rich, and a central "sheared shale", or block-poor melange zone.

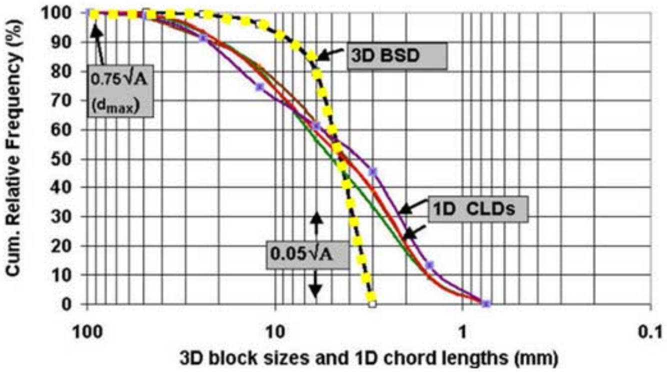

Figure 12 : Comparison of true 3D block size distribution (3D BSD) used for four physical model bimrocks. 1D chord length distributions (CLDs) were generated from measuring all chord lengths in 100 model borings per model. Despite 400 borings, the 1D distributions do not represent the actual 3D distributions. Instead, small blocks are indicated that were not incorporated into the actual models and the proportions of block sizes are underestimated (Medley, 2002).

Although the strength of individual blocks does not influence the overall strength of a bimrock, the lithology, discontinuity fabric, number and size distribution of blocks is of concern to tunneling or earthwork contractors. Since the primary means of obtaining subsurface data is by drilling, it is logical to attempt to estimate block size distributions from chord length distributions. Nevertheless: such estimates should be attempted with great caution because, as shown in Figure 12, chord length distributions may severely overestimate the actual 3D block size distribution of smaller blocks and underestimate the distribution of larger blocks (Medley, 1994a; 1995, 2002). Still, information of great value can still be obtained from drill core, as described in this case history.

The 6 m tunnel diameter was selected as L_c , the characteristic engineering dimension at the scale of the face of the tunnel. The linear block proportion estimated from the core was about 38 percent. The block/matrix threshold was 0.3 m (0.05L_c). Blocks smaller than 0.3m were assigned to the matrix. During tunneling, the contractor encountered consistent mixed-face conditions with so many small and intact blocks that it was difficult to keep the muck delivery system running freely. As shown by Medley (1994a) and Medley and Lindquist (1995), it would be expected that as block size diminishes, the number of blocks increase.

On the basis of the geological map, Medley (1994a) estimated that the largest likely block within the mapped area (A) between the tunnel alignment and coastline, could be as large as 600 m (equivalent to √A). During tunneling, the contractor penetrated 200m through an unexpected hard greywacke block, which had not been predicted by the drilling exploration.

CONCLUSIONS

Fault rocks, weathered rocks, melanges and similar bimrocks are common and problematic for geotechnical engineers working in geologically complex areas of the world, including Greece. It is important that practitioners have at least a conceptual understanding of the existence of bimrocks if not their geology. Despite their heterogeneity, bimrocks can be purposefully characterized for the purpose of geotechnical engineering design and construction, even where there is great uncertainty in the characterization, or when the volumetric proportion of blocks is too little to provide geomechanical benefit. Procedures are available to characterize and analyze bimrocks and implementation of these procedures may reduce expensive surprises by focusing the geopractitioners', owners' and contractors' attentions on the difficulties that may be encountered during design and construction. At the very least, the writer hopes that the two articles presented in this Bulletin have alerted practitioners to use more caution the next time they have the occasion to use the expressions "interbedded" or "soil with boulders" in boring logs or reports and they cast a more critical eye on the cross-sections they develop from their field observations of sites located in bimrocks.

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REFERENCES

*References shown **in Bold** are available at* *http://bimrocks.geoengineer.org/resources.html*

Bro, A., 1996, A weak rock triaxial cell; Technical Note, Int. Jour. Rock Mechanics and Mining Science, v. 33, no. 1, p. 71-74.

Bro, A., 1997, Analysis of multi-stage triaxial test results for a strain-hardening rock, Int. Jour. Rock Mechanics and Mining Science, v. 34, no. 1, p. 143-145.

Irfan, T.Y. and Tang, K.Y., 1993; Effect of the coarse fraction on the shear strength of colluvium in Hong Kong; TN 4/92, Hong Kong Geotechnical Engineering Office, 128 p.

Lindquist, E.S. 1994a; The strength and deformation properties of melange: Ph.D. Dissertation; Dept. of Civil Engineering, Univ. California at Berkeley, California, 262 p.; publ. UMI, Inc., Ann Arbor, Michigan.

Lindquist, E.S. and Goodman, R.E., 1994; The strength and deformation properties of a physical model melange; in Proc. 1st North American Rock Mechanics Conference (NARMS), Austin, Texas; ed. Nelson, P.P. and Laubach, S.E., A.A. Balkema, Rotterdam.

Medley, E.W, 1994a; The engineering characterization of melanges and similar block-in-matrix rocks (bimrocks), Ph.D. dissertation; Dept. of Civil Engineering, University of California at Berkeley, California;, 387 p.; publ. UMI, Inc., Ann Arbor, Michigan.

-------, 1994b; Using stereologic methods to estimate the block volumetric proportion in melanges and similar block-in-matrix rocks (bimrocks): in Proc. 7th Congress of the Int. Assoc Eng. Geol., Lisbon, Portugal; A.A. Balkema, Rotterdam.

-------, 1997; Uncertainty in estimates of block volumetric proportion in melange bimrocks; in Proc. Int. Symp. of Int. Assoc. Eng. Geol., Athens, Greece; June 23-27; A.A. Balkema, Rotterdam.

--------, 2002, Estimating Block Size Distributions of Melanges and Similar Block-in-Matrix Rocks (Bimrocks), Proceedings, 5th North American Rock Mechanics Symposium, University of Toronto, Toronto, Canada, July 2002, pp. 599–606.

-----, 2004; Observations on Tortuous Failure Surfaces, Felsbau Rock and Soil Engineering-Journal for Engineering Geology, Geomechanics and Tunneling, vol. 22, No. 5, September 2004.

-----, 2005; The Arrogance of Straight Lines, GeoStrata Magazine of the Geo-Institute of Am. Soc. Civil Engineers, September/October 2005, pp 28-32.

Medley, E.W. and Lindquist, E.S., 1995; The engineering significance of the scale-independence of some Franciscan melanges in California, USA: in Proc. 35th US Rock Mechanics Symp.; ed. Daemen, J.K. and Schultz, R.A.; A.A Balkema, Rotterdam; p. 907-914.

Medley, E.W. and Sanz, P. Rehermann, 2004; Characterization of Bimrocks (Rock/Soil Mixtures) with Application to Slope Stability Problems, Proceedings of Eurock 2004 and 53rd Geomechanics Colloquium, Salzburg, Austria, October 2004.

Rocha, M. 1971, A method of integral sampling of rock masses, Rock Mechanics, v.3 p. 1-12.

Van Velsor, J.E. and Walkinshaw, J.L., 1993, Accelerated movement of a large coastal landslide, Annual Meeting of the Transportation Research Board, Jan. 1992, Washington, D.C.

Volpe, R.L., Ahlgren, C.S., and Goodman, R.E., 1991; Selection of engineering properties for geologically variable foundations; in Question 66: Proc. of the 17th Int. Congress on Large Dams, Vienna; ICOLD, Paris, p. 1087-1101.

Wakabayashi, J., and Medley, E.W., 2004; "Geological characterization of melanges for geopractitioners", *Feldsbau, J. of Engineering Geology, Geomechanics and Tunnelling*. 22 (5/2004); pp. 10-18.

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Νέες Εκδόσεις

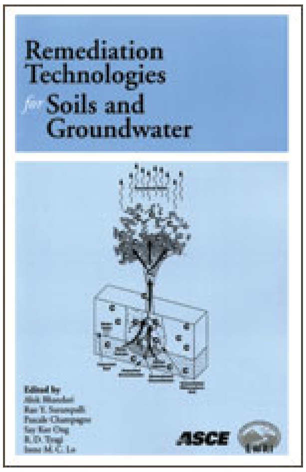
Ralph B. Peck
Educator and Engineer — The Essence of the Man

John Dunnicliff and Nancy Peck Young, Editors

A great read describing how Ralph B. Peck became a hero of the profession, with talent, hard work, perseverance, and good judgement, without trying to impress anyone. The book is divided into six parts:

1. Self Portrait
2. Words of Wisdom
3. Selected Professional Papers and Lectures
4. Vignettes
5. Selected Awards
6. List of Publications

(BiTech Publishers, 2007)



Remediation Technologies for Soils and Groundwater

Alok Bhandari, Rao Y. Surampalli, **Pascale Champagne and Say Kee Ong**, Editors

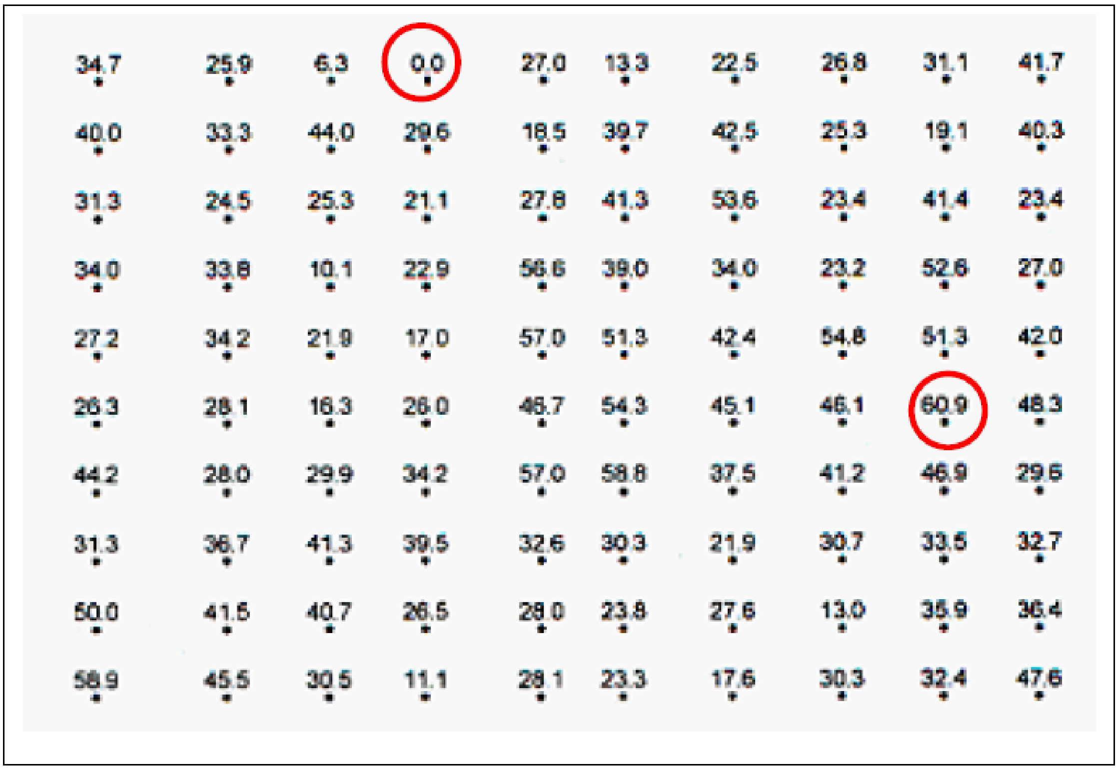
Site remediation is a complex and costly process that aims to restore adversely affected land and groundwater resources to environmentally sustainable conditions. *Remediation Technologies for Soils and Groundwater* provides a comprehensive and thorough overview of conventional engineered processes and technologies used for the remediation of contaminated sites. This committee report's extensive illustrations, tables, and case studies along with it's simple to follow writing style, makes it appropriate for use as a classroom text as well as a reference for practitioners.

(American Society of Civil Engineers, 2007)

Παροράματα

Στο άρθρο του Dr. Edmund Medley, που δημοσιεύσαμε στο προηγούμενο τεύχος, ο δαίμων του «αντιγραφή - επικόλληση» χτύπησε και αφαίρεσε ένθετα από τα Σχήματα 8 και 10. Παραθέτουμε στη συνέχεια τα δύο σχήματα πλήρη:

Figure 8: Franciscan Complex melange, northern California. Note shearing in "matrix" adjacent large headland block with blocks oriented sub-parallel to shearing. Block sizes range between tens of meters and meters. Detail shows "matrix" in at circled area also has block-in-matrix fabric at scale of 3.1 meter long bar. (Photo: E. Medley).



34.7	25.9	6.3	0.0	27.0	13.3	22.5	26.8	31.1	41.7
40.0	33.3	44.0	29.6	18.5	39.7	42.5	25.3	19.1	40.3
31.3	24.5	25.3	21.1	27.8	41.3	53.6	23.4	41.4	23.4
34.0	33.8	10.1	22.9	56.6	39.0	34.0	23.2	52.6	27.0
27.2	34.2	21.9	17.0	57.0	51.3	42.4	54.8	51.3	42.0
26.3	28.1	16.3	26.0	46.7	54.3	45.1	46.1	60.9	48.3
44.2	28.0	29.9	34.2	57.0	58.8	37.5	41.2	46.9	29.6
31.3	36.7	41.3	39.5	32.6	30.3	21.9	30.7	33.5	32.7
50.0	41.6	40.7	26.5	28.0	23.8	27.6	13.0	35.9	36.4
58.9	45.5	30.5	11.1	28.1	23.3	17.6	30.3	32.4	47.6

Figure 10: Plan view of an array of 100 linear block proportions ranging between 0% and 61% measured for a physical model bimrock with actual volumetric block proportion of 32%.   The range in spatial variability is indicated by the circled values (After Medley, 1997).

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