ΕΛΛΗΝΙΚΗ
ΕΠΙΣΤΗΜΟΝΙΚΗ
ΕΤΑΙΡΕΙΑ
ΕΔΑΦΟΜΗΧΑΝΙΚΗΣ
& ΓΕΩΤΕΧΝΙΚΗΣ
ΜΗΧΑΝΙΚΗΣ

Τα Νέα της Ε Ε Ε Ε Γ Μ

65

Αρ. 65 – ΙΟΥΝΙΟΣ 2014 - Α

Έγκριση εφαρμογής και χρήσης των Ευρωκωδίκων

Δημοσιεύτηκε στο ΦΕΚ Β 1457/5.6.2014 η Κ.Υ.Α. ΔΙΠΑΔ/οικ. 372/30.5.2014 «Έγκριση εφαρμογής και χρήσης των Ευρωκωδίκων σε συνδυασμό με τα αντίστοιχα Εθνικά Προσαρτήματα».

Με την Κ.Υ.Α. αυτή εγκρίνεται η εφαρμογή και η χρήση, σε όλα τα Δημόσια και Ιδιωτικά έργα, των μεταφρασμένων στην Ελληνική γλώσσα κειμένων των Ευρωκωδίκων. Οι ισχύοντες, πλέον, ευρωκώδικες παρατίθενται σε Παραρτήματα και ονομάζονται Ελληνικά Ευρωπαϊκά Πρότυπα (παράρτημα 1) και συνοδεύονται από τα Εθνικά Προσαρτήματά τους που ονομάζονται Ελληνικά Πρότυπα (παράρτημα 2).

Η εφαρμογή των εν λόγω προτύπων δεν είναι υποχρεωτική, αλλά υπόκειται στην διακριτική επιλογή του εκάστοτε Κυρίου του Έργου, ο οποίος δύναται να τα εφαρμόσει ως κανονιστικά κείμενα για τον σχεδιασμό και την μελέτη νέων φερουσών κατασκευών, καθώς και για την αποτίμηση και τον ανασχεδιασμό υφισταμένων φερουσών κατασκευών. Συνακολούθως, αίρεται η υποχρεωτικότητα εφαρμογής των προϋπαρχόντων κανονιστικών κειμένων δόμησης (εθνικές προδιαγραφές και κανονισμοί), τα οποία παρατίθενται στο Παράρτημα 3 της Κ.Υ.Α.

Στο νέο αυτό πλαίσιο, ο κύριος του έργου οφείλει να επιλέγει το πλαίσιο των κανονιστικών κειμένων του σχεδιασμού και της μελέτης της φέρουσας κατασκευής του έργου, εφαρμόζοντας είτε τις μέχρι σήμερα υποχρεωτικές εθνικές προδιαγραφές, είτε τους Ευρωκώδικες σε συνδυασμό με τα Εθνικά

(συνέχεια στην σελ.3)

Π Ε Ρ Ι Ε Χ Ο Μ Ε Ν Α

(συνέχεια από την πρώτη σελίδα)

τους Προσαρτήματα (δεν επιτρέπεται η επιλεκτική χρησιμοποίηση διατάξεων προερχομένων από το μη επιλεγέν πλαίσιο).

Λαμβάνοντας υπόψη, πάντως, ότι η χρήση των Ευρωκωδικων, στον σχεδιασμό και στην εκπόνηση των μελετών για την κατασκευή των Τεχνικών Έργων Πολιτικού Μηχανικού, αποτελεί τεκμήριο συμμόρφωσης προς τις απαιτήσεις της Κατευθυντήριας Ευρωπαϊκής Οδηγίας 89/106/EEC, εκτιμάται ότι η δυνατότητα επιλεκτικής εφαρμογής των που δίδει η εν λόγω Κ.Υ.Α. συνιστά μία μεταβατική κατάσταση, απαιτούμενη για την απόκτηση πλήρους γνώσης και εξοικείωσης των μελετητών και των μηχανικών του δημοσίου τομέα.

Όπως, άλλωστε, αναφέρεται και στην Κ.Υ.Α., τελική επιδίωξη είναι η εναρμόνιση της Ελληνικής Νομοθεσίας με τα Ευρωπαϊκά Πρότυπα των Ευρωκωδίκων για την επίτευξη του στόχου της Ενιαίας Ευρωπαϊκής Αγοράς και των γενικότερων κοινών στόχων της Ευρωπαϊκής Τυποποίησης.

EUROCODES
BUILDING THE FUTURE

2014-05-09

Δελτίο Τύπου

ΕΥΡΩΚΩΔΙΚΕΣ

«ΑΝΑΣΚΟΠΗΣΗ ΠΡΟΤΥΠΩΝ ΕΥΡΩΚΩΔΙΚΩΝ»

Τα κείμενα των Ευρωκωδίκων που αναφέρονται στο παρόν Δελτίο Τύπου έχουν τεθεί σε ανοιχτό σχολιασμό για την επισήμανση παρατηρήσεων από την μέχρι σήμερα χρήση τους

Για την ηλεκτρονική υποβολή σχολίων σύμφωνα με τον Πίνακα σχολιασμού, τίθεται καταληκτική ημερομηνία η 31^{η} Ιουλίου 2014.

Οι Ευρωκώδικες εκπονήθηκαν από την Τεχνική Επιτροπή Ευρωκωδίκων της Ευρωπαϊκής Επιτροπής Τυποποίησης CEN/TC 250 "Structural Eurocodes" με τη συμμετοχή των εθνικών εμπειρογνωμόνων και εκπροσώπων των Οργανισμών Τυποποίησης των Κρατών Μελών και παρέχουν ένα κοινό για όλη την Ευρωπαϊκή Ένωση σύνολο μεθόδων για τον υπολογισμό της μηχανικής αντοχής των Δομικών Έργων και των στοιχείων τους.

Ο ΕΛΟΤ παρακολουθεί τις εργασίες της CEN/TC 250 με την κατοπτρική επιτροπή ΕΛΟΤ ΤΕ 67 «Ευρωκώδικες» και τις ακόλουθες Ομάδες Εργασίας που έχουν συγκροτηθεί για τον σκοπό αυτό:

1. ΕΛΟΤ /ΤΕ 67 /ΟΕ1 Ευρωκώδικας 1 «Δράσεις σε δομήματα»
2. ΕΛΟΤ /ΤΕ 67 /ΟΕ2 Ευρωκώδικας 2 «Κατασκευές από Σκυρόδεμα»
3. ΕΛΟΤ /ΤΕ 67 /ΟΕ3 Ευρωκώδικας 3 «Μεταλλικές κατασκευές»
4. ΕΛΟΤ /ΤΕ 67 /ΟΕ4 Ευρωκώδικας 4 «Σύμμικτες κατασκευές»
5. ΕΛΟΤ /ΤΕ 67 /ΟΕ5 Ευρωκώδικας 5 «Ξύλινες κατασκευές»
6. ΕΛΟΤ /ΤΕ 67 /ΟΕ6 Ευρωκώδικας 6 «Τοιχοποιία»
7. ΕΛΟΤ /ΤΕ 67 /ΟΕ7 Ευρωκώδικας 7 «Γεωτεχνικός Σχεδιασμός»
8. ΕΛΟΤ /ΤΕ 67 /ΟΕ8 Ευρωκώδικας 8 «Αντισεισμικές κατασκευές»
9. ΕΛΟΤ /ΤΕ 67 /ΟΕ9 Ευρωκώδικας 9 «Σχεδιασμός κατασκευών αλουμινίου»
10. ΕΛΟΤ /ΤΕ 67 /ΟΕ10 Ευρωκώδικας 10 «Βάσεις υπολογισμού κατασκευών»
11. ΕΛΟΤ /ΤΕ 67 /ΟΕ11 Ευρωκώδικας 11 «Κατασκευές από ινοπλισμένα πολυμερή»

Ο ΕΛΟΤ ολοκλήρωσε την έκδοση των ΕΥΡΩΚΩΔΙΚΩΝ και τα Εθνικά Προσαρτήματα που τους συνοδεύουν σε συνεργασία με το ΥΠΥΜΕΔΙ τον Νοέμβριο του 2010.

Η ενημέρωση και συντήρηση των Ευρωκωδίκων είναι βασική δραστηριότητα για τη διατήρηση της αξιοπιστίας τους, της εγκυρότητας και της συνοχής τους, καθώς μέσω αυτής διασφαλίζεται ότι οι Ευρωκώδικες επικαιροποιούνται σύμφωνα με τις απαιτήσεις της επιστήμης και δεν περιλαμβάνουν παροράματα.

Στα πλαίσια αυτά η Τεχνική Επιτροπή CEN/TC 250 ξεκίνησε τη διαδικασία ανασκόπησης των κειμένων των Ευρωκωδίκων που περιλαμβάνονται στον ακόλουθο πίνακα:

(όπου Α1 ή Α2 αφορά στην $1^{η}$ ή $2^{η}$ έκδοση Τροποποιήσεων και αντίστοιχα όπου AC στην έκδοση Διορθώσεων)

Ο ΕΛΟΤ καλεί κάθε ενδιαφερόμενο να υποβάλει στον *ΕΣΥΠ/ΕΛΟΤ/Διεύθυνση Τυποποίησης* τυχόν παρατηρήσεις, προτάσεις αλλαγών κ.λπ. όπως προέκυψαν από την χρήση και εφαρμογή των ως άνω κειμένων των Ευρωκωδίκων.

Τα σχόλια αυτά θα διαβιβασθούν για να εξετασθούν από την αρμόδια Τεχνική Επιτροπή ΕΛΟΤ ΤΕ 67 και τις αντίστοιχες Ομάδες Εργασίας, προκειμένου να υποβληθούν στην Ευρωπαϊκή Τεχνική Επιτροπή CEN/TC 250 ως οι διαμορφωμένες ελληνικές θέσεις.

Για τη διευκόλυνση υποβολής και διαχείρισης των υποβαλλόμενων σχολίων οι ενδιαφερόμενοι καλούνται να συμπληρώνουν το έντυπο σχολιασμού (στην αγγλική ή στην ελληνική γλώσσα), σημειώνοντας ευκρινώς τον κωδικό του σχολιαζόμενου εγγράφου, καθώς και τα κεφάλαια-παραγράφους-εδάφια υπό σχολιασμό.

Κατεβάστε τον Πίνακα σχολιασμού από εδώ

Πληροφορίες
Γαρδέλη Ευγενία , Βελλή Κίρκη
Τηλ.: 210 2120124 210 2120121

Ηλεκτρονική αποστολή σχολίων

eurocodes@elot.gr

ΕΥΡΩΚΩΔΙΚΑΣ	***Εθνικό Πρότυπο***
ΕΥΡΩΚΩΔΙΚΑΣ ΒΑΣΕΙΣ ΣΧΕΔΙΑΣΜΟΥ	
• **EN 1990:2002** [A1:2005 + AC:2008 + AC 2010] *Eurocode - Basis of structural design*	• ΕΛΟΤ ΕΝ 1990 Ευρωκώδικας - Βάσεις σχεδιασμού δομημάτων • ΕΛΟΤ ΕΝ 1990/Α1 Ευρωκώδικας - Βάσεις σχεδιασμού δομημάτων
ΕΥΡΩΚΩΔΙΚΑΣ 1	
• **EN 1991-1-1:2002** [AC:2009] *Eurocode 1 - Actions on structures - General actions - Densities, self-weight, imposed loads for buildings*	• ΕΛΟΤ ΕΝ 1991.01.01 Ευρωκώδικας 1: Δράσεις σε δομήματα - Μέρος 1-1: Γενικές δράσεις - Πυκνότητες, ίδια βάρη και επιβαλλόμενα φορτία σε κτίρια
• **EN 1991-1-2:2002** [AC:2009 + AC:2012 + AC:2013] *Eurocode 1 - Actions on structures - General actions - Actions on structures exposed to fire*	• ΕΛΟΤ ΕΝ 1991.01.02 Ευρωκώδικας 1: Δράσεις σε δομήματα - Μέρος 1-2: Γενικές δράσεις - Δράσεις σε δομήματα λόγω πυρκαγιάς
• **EN 1991-1-3:2003** [AC:2009] *Eurocode 1 - Actions on structures - General actions - Snowloads*	• ΕΛΟΤ ΕΝ 1991.01.03 Ευρωκώδικας 1 - Δράσεις σε δομήματα - Μέρος 1-3: Γενικές δράσεις - Φορτία χιονιού
• **EN 1991-1-4:2005** [AC:2009 + AC:2010 + A1:2010] *Eurocode 1 - Actions on structures - General actions - Wind actions*	• ΕΛΟΤ ΕΝ 1991.01.04 Ευρωκώδικας 1: Δράσεις σε δομήματα - Μέρος 1-4: Γενικές δράσεις - Δράσεις ανέμου • ΕΛΟΤ ΕΝ 1991.01.04/Α1 Ευρωκώδικας 1: Δράσεις σε δομήματα - Μέρος 1-4: Γενικές δράσεις - Δράσεις ανέμου
• **EN 1991-1-5:2003** [AC:2009] *Eurocode 1 - Actions on structures - General actions - Thermal actions*	• ΕΛΟΤ ΕΝ 1991.01.05 Ευρωκώδικας 1: Δράσεις σε δομήματα - Μέρος 1-5: Γενικές δράσεις - Θερμικές δράσεις
ΕΥΡΩΚΩΔΙΚΑΣ 2	
• **EN 1992-1-1:2004** [AC:2008 + AC:2010] *Eurocode 2 - Design of concrete structures - General rules and rules for building*	• ΕΛΟΤ ΕΝ 1992.01.01 Ευρωκώδικας 2: Σχεδιασμός κατασκευών από σκυρόδεμα - Μέρος 1-1: Γενικοί κανόνες και κανόνες για κτίρια
• **EN 1992-1-2:2004** [AC:2008] *Eurocode 2 - Design of concrete structures - General rules - Structural fire design*	• ΕΛΟΤ ΕΝ 1992.01.02 Ευρωκώδικας 2: Σχεδιασμός κατασκευών από σκυρόδεμα - Μέρος 1-2 : Γενικοί κανόνες - Σχεδιασμός φορέων σε πυρκαγιά
• **EN 1992-2:2005** [AC:2008] *Eurocode 2. Design of concrete structures - Concrete bridges - Design and detailing rules*	• ΕΛΟΤ ΕΝ 1992.02 Ευρωκώδικας 2: Σχεδιασμός κατασκευών από σκυρόδεμα - Μέρος 2: Γέφυρες από σκυρόδεμα - Σχεδιασμός και κατασκευαστικοί κανόνες
• **EN 1992-3:2006** *Eurocode 2 - Design of concrete structures - Liquid retaining and containing structures*	• ΕΛΟΤ ΕΝ 1992.03 Ευρωκώδικας 2: Σχεδιασμός κατασκευών από σκυρόδεμα - Μέρος 3: Σιλό και δεξαμενές
ΕΥΡΩΚΩΔΙΚΑΣ 3	
• **EN 1993-1-1:2005** [AC:2005 + AC:2006 + AC:2009] *Eurocode 3 - Design of steel structures - General rules and rules for buildings*	• ΕΛΟΤ ΕΝ 1993.01.01 Ευρωκώδικας 3: Σχεδιασμός κατασκευών από χάλυβα - Μέρος 1-1: Γενικοί κανόνες και κανόνες για κτίρια

ΕΥΡΩΚΩΔΙΚΑΣ	***Εθνικό Πρότυπο***
• **EN 1993-1-8:2005** [AC:2005 + AC:2009] *Eurocode 3 - Design of steel structures - Design of joints*	• ΕΛΟΤ ΕΝ 1993.01.08 Ευρωκώδικας 3: Σχεδιασμός κατασκευών από χάλυβα - Μέρος 1-8: Σχεδιασμός κόμβων
• **EN 1993-1-12:2007 [**AC:2009] *Eurocode 3 - Design of steel structures - Additional rules for the extension of EN 1993 up to steel grades S 700*	• ΕΛΟΤ ΕΝ 1993.01.12 Ευρωκώδικας 3: Σχεδιασμός κατασκευών από χάλυβα - Μέρος 1-12: Πρόσθετοι κανόνες για την επέκταση του ΕΝ 1993 σε χάλυβες S 700
• *ΕΥΡΩΚΩΔΙΚΑΣ 4*	
• **EN 1994-1-1:2004** [AC:2009] *Eurocode 4 - Design of composite steel and concrete structures - General rules and rules for buildings*	• ΕΛΟΤ ΕΝ 1994.01.01 Ευρωκώδικας 4: Σχεδιασμός σύμμικτων κατασκευών από χάλυβα και σκυρόδεμα - Μέρος 1-1: Γενικοί κανόνες και κανόνες για κτίρια
• **EN 1994-1-2:2005** [AC:2008 + A1:2014] *Eurocode 4 - Design of composite steel and concrete structures - General rules - Structural fire design*	• ΕΛΟΤ ΕΝ 1994.01.02 Ευρωκώδικας 4: Σχεδιασμός σύμμικτων κατασκευών από χάλυβα και σκυρόδεμα - Μέρος 1-2: Γενικοί κανόνες - Σχεδιασμός φορέων σε πυρκαγιά
• **EN 1994-2:2005** [AC:2008] *Eurocode 4 - Design of composite steel and concrete structures - General rules and rules for bridges*	• ΕΛΟΤ ΕΝ 1994.02 Ευρωκώδικας 4: Σχεδιασμός σύμμικτων κατασκευών από χάλυβα και σκυρόδεμα - Μέρος 2: Γενικοί κανόνες και κανόνες για γέφυρες
ΕΥΡΩΚΩΔΙΚΑΣ 5	
• **EN 1995-1-1:2004** [AC:2006 + A1:2008] *Eurocode 5 - Design of timber structures – General - Common rules and rules for buildings*	• ΕΛΟΤ ΕΝ 1995.01.01 Ευρωκώδικας 5: Σχεδιασμός ξύλινων κατασκευών - Μέρος 1-1: Γενικά - Κοινοί κανόνες και κανόνες για κτίρια
ΕΥΡΩΚΩΔΙΚΑΣ 6	
• **EN 1996-1-1:2005+A1:2012** *Eurocode 6 - Design of masonry structures - Part 1-1: General rules for reinforced and unreinforced masonry structures*	• ΕΛΟΤ ΕΝ 1996-1-1+A1 Ευρωκώδικας 6: Σχεδιασμός κατασκευών από τοιχοποιία - Μέρος 1-1: Γενικοί κανόνες για κατασκευές από οπλισμένη και άοπλη τοιχοποιία
• **EN 1996-1-2:2005** [AC:2010] *Eurocode 6 - Design of masonry structures - Part 1-2: General rules - Structural fire design*	• ΕΛΟΤ ΕΝ 1996.01.02 Ευρωκώδικας 6: Σχεδιασμός κατασκευών από τοιχοποιία - Μέρος 1-2: Γενικοί κανόνες - Σχεδιασμός φορέων σε πυρκαγιά
• **EN 1996-2:2006** [AC:2009] *Eurocode 6 - Design of masonry structures - Part 2: Design considerations, selection of materials and execution of masonry*	• ΕΛΟΤ ΕΝ 1996.02 Ευρωκώδικας 6: Σχεδιασμός κατασκευών από τοιχοποιία - Μέρος 2: Θέματα σχεδιασμού, επιλογή υλικών και κατασκευή τοιχοποιίας
• **EN 1996-3:2006** [AC:2009] *Eurocode 6 - Design of masonry structures - Part 3: Simplified calculation methods for unreinforced masonry structures*	• ΕΛΟΤ ΕΝ 1996.03 Ευρωκώδικας 6: Σχεδιασμός κατασκευών από τοιχοποιία - Μέρος 3: Απλοποιημένες μέθοδοι υπολογισμού για κατασκευές από άοπλη τοιχοποιία
ΕΥΡΩΚΩΔΙΚΑΣ 7	
• **EN 1997-1:2004** [AC:2009 + A1:2013] *Eurocode 7 - Geotechnical design - General rules*	• ΕΛΟΤ ΕΝ 1997.01 Ευρωκώδικας 7: Γεωτεχνικός σχεδιασμός - Μέρος 1: Γενικοί κανόνες • ΕΛΟΤ ΕΝ 1997-1/A1

ΕΥΡΩΚΩΔΙΚΑΣ	***Εθνικό Πρότυπο***
	Ευρωκώδικας 7: Γεωτεχνικός σχεδιασμός - Μέρος 1: Γενικοί κανόνες
• **EN 1997-2:2007** [AC:2010] *Eurocode 7 - Geotechnical design - Ground investigation and testing*	• ΕΛΟΤ EN 1997.02 Ευρωκώδικας 7: Γεωτεχνικός σχεδιασμός - Μέρος 2: Εδαφικές έρευνες και δοκιμές
ΕΥΡΩΚΩΔΙΚΑΣ 8	
• **EN 1998-1:2004** [A1:2013 + AC:2009] *Eurocode 8 - Design of structures for earthquake resistance - General rules, seismic actions and rules for buildings*	• ΕΛΟΤ EN 1998.01 Ευρωκώδικας 8: Αντισεισμικός σχεδιασμός των κατασκευών - Μέρος 1: Γενικοί κανόνες, σεισμικές δράσεις και κανόνες για κτίρια • ΕΛΟΤ EN 1998-1/A1 Ευρωκώδικας 8: Αντισεισμικός σχεδιασμός των κατασκευών - Μέρος 1: Γενικοί κανόνες, σεισμικές δράσεις και κανόνες για κτίρια
• **EN 1998-3:2005** [AC:2010 + AC:2013] *Eurocode 8 - Design of structures for earthquake resistance - Assessment and retrofitting of buildings*	• ΕΛΟΤ EN 1998.03 Ευρωκώδικας 8: Αντισεισμικός σχεδιασμός των κατασκευών - Μέρος 3: Αποτίμηση της φέρουσας ικανότητας κτιρίων και επεμβάσεις
ΕΥΡΩΚΩΔΙΚΑΣ 9	
• **EN 1999-1-1:2007** [A1:2009 + A2:2013] *Eurocode 9 - Design of aluminium structures - General structural rules*	• ΕΛΟΤ EN 1999.01.01 Ευρωκώδικας 9: Σχεδιασμός κατασκευών από αλουμίνιο - Μέρος 1-1: Γενικοί κανόνες • ΕΛΟΤ EN 1999.01.01/A1 Ευρωκώδικας 9: Σχεδιασμός κατασκευών από αλουμίνιο - Μέρος 1-1: Γενικοί κανόνες • ΕΛΟΤ EN 1999-1-1/A2 Ευρωκώδικας 9: Σχεδιασμός κατασκευών από αλουμίνιο - Μέρος 1-1: Γενικοί κανόνες
• **EN 1999-1-2:2007** [AC:2009] *Eurocode 9 - Design of aluminium structures - Structural fire design*	• ΕΛΟΤ EN 1999.01.02 Ευρωκώδικας 9 - Σχεδιασμός κατασκευών από αλουμίνιο - Μέρος 1-2: Σχεδιασμός φορέων σε πυρκαγιά
• **EN 1999-1-3:2007 [**A1:2011] *Eurocode 9 - Design of aluminium structures - Structures susceptible to fatigue*	• ΕΛΟΤ EN 1999.01.03 Ευρωκώδικας 9: Σχεδιασμός κατασκευών από αλουμίνιο - Μέρος 1-3: Κατασκευές ευαίσθητες σε κόπωση • ΕΛΟΤ EN 1999-1-3/A1 Ευρωκώδικας 9: Σχεδιασμός κατασκευών από αλουμίνιο - Μέρος 1-3: Κατασκευές ευαίσθητες σε κόπωση
• **EN 1999-1-4:2007** [AC:2009 + A1:2011] *Eurocode 9 - Design of aluminium structures - Coldformed structural sheeting*	• ΕΛΟΤ EN 1999.01.04 Ευρωκώδικας 9 - Σχεδιασμός κατασκευών από αλουμίνιο - Μέρος 1-4: Δομικά φύλλα ψυχρής έλασης • ΕΛΟΤ EN 1999-1-4/A1 Ευρωκώδικας 9 - Σχεδιασμός κατασκευών από αλουμίνιο - Μέρος 1-4: Δομικά φύλλα ψυχρής έλασης
• **EN 1999-1-5:2007** [AC:2009] *Eurocode 9 - Design of aluminium structures - Shell structures*	• ΕΛΟΤ EN 1999.01.05 Ευρωκώδικας 9 - Σχεδιασμός κατασκευών από αλουμίνιο - Μέρος 1-5: Κελυφωτές κατασκευές

ΑΡΘΡΑ

How Eurocode 7 has affected geotechnical design: a review

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Eurocode 7, the new European standard for geotechnical design, together with the other Eurocodes for structural design, was implemented in 2010, and relevant parts of British Standards that covered the same ground were withdrawn. Since it is a single code covering all aspects of the design of all types of geotechnical structure, including geotechnical investigations and the determination and selection of geotechnical parameters, and since it is based on the limit state design method with partial factors, its implementation has resulted in many changes to geotechnical design practice. These changes to geotechnical design caused by the introduction of Eurocode 7 are reviewed, including the new terminology, the new associated European investigation, testing and execution standards, the way geotechnical parameters are selected, the way geotechnical calculations are carried out and the way safety elements are introduced. Some of the issues that have arisen and difficulties that have been encountered with the introduction of Eurocode 7 are identified, and the plans for the future development of Eurocode 7 are discussed.

1. Introduction

EN 1997, which is Eurocode 7: Geotechnical design, and comprises Part 1: General rules (CEN, 2004) and Part 2: Ground investigation and testing (CEN, 2007), is the new European standard for geotechnical design. It was implemented in the UK and many other European countries on 31 March 2010. As one of the suite of 10 harmonised Eurocodes published by the European Committee for Standardization (CEN) for the design of building and civil engineering works, Eurocode 7 is based on the limit state design method, with the design principles and requirements for the safety, serviceability and durability of structures set out in the head Eurocode, EN 1990 (CEN, 2002). Eurocode 7 also refers to the many new European normative standards (ENs) for geotechnical investigations and testing, and for the execution of geotechnical structures. Hence Eurocode 7 differs from the former British Standards (BSs) published by the British Standards Institution (BSI) for geotechnical design in its nature, in its use of the limit state design method and through its reference to ENs for geotechnical investigation, testing and execution, which have requirements and specifications that differ from those in the former BSs. Thus the introduction of Eurocode 7 has had, and is having, a significant effect on geotechnical design, and this paper reviews those effects and their consequences.

Since each country is responsible for setting the safety level for its structures, the Eurocodes are published in each country as national standards, with identical wording to the EN versions. Each country is required to produce national annexes (NAs) that provide values for the partial factors and other safety parameters left open to national choice, referred to as nationally determined parameters (NDPs), to be used for the design of building or civil engineering works to be built in that country. Thus Parts 1 and 2 of Eurocode 7 have been published in the UK by BSI as BS EN 1997-1:2004 (BSI, 2004b) and BS EN 1997-2:2007 (BSI, 2007a), with the national annexes as NA BS EN 1997-1:2004 (BSI, 2007b) and NA BS EN 1997-2:2007 (BSI, 2009a).

Following the publication of EN 1997-1 in 2004, a number of books and guidance documents, most with worked examples, have been published to explain its principles and application (e.g. Bond and Harris, 2008; BSI, 2011a; DCLG, 2007; Driscoll et al., 2008; Frank et al., 2004). In addition, journal papers that focus on particular aspects of geotechnical designs to Eurocode 7 have been published, and are referred to in the appropriate sections of this paper. Training courses and information about Eurocode 7 have also been provided by universities, professional organisations and companies.

2. Nature and status of Eurocode 7

Eurocode 7 differs in nature from the earlier geotechnical British Standards, such as BS 8004: Code of practice for foundations (BSI, 1986) and BS 6031: Code of practice for earthworks (BSI, 2009b). Although having the title 'British Standard', BS 8004 and BS 6031 are termed codes of practice in their titles, and it is stated in their introductions that these standards provide guidance and recommendations. These recommendations are expressed in sentences in which the principal auxiliary verb used is 'should'.

The Eurocodes, in contrast, while they have 'code' in their title, are always referred to as European standards, and are divided into Principles and Application Rules. The Principles are defined in §1.4(2) of EN 1990, where the symbol § represents a paragraph, as 'general statements and definitions for which there is no alternative, as well as requirements and analytical models for which no alternative is permitted unless specifically stated'. The Principles are expressed in sentences using the verb 'shall' rather than 'should'. Thus when carrying out a geotechnical design to Eurocode 7, the requirements, not recommendations, in the Principles must be satisfied. All other paragraphs that are not Principles are Application Rules, which are defined in EN 1990 §1.4(4) as 'examples of generally recognized rules, which comply with the Principles and satisfy their requirements'. The Application Rules are generally expressed using the verbs 'may' or 'should'. Regarding the use of alternatives to the Application Rules given in Eurocode 7, EN 1997-1 §1.4(5) states that

It is permissible to use alternatives to the Application Rules given in this standard, provided it is shown that the alternative rules accord with the relevant Principles and are at least equivalent with regard to the structural safety, serviceability and durability, which would be expected when using the Eurocodes.

A note to this states that

If an alternative design rule is submitted for an Application Rule, the resulting design cannot be claimed to be wholly in accordance with EN 1997-1, although the design will remain in accordance with the Principles of EN 1997-1.

The same Application Rule and an equivalent note are given in EN 1997-2 §1.4(5) with regard to geotechnical investigations and testing. The significance of this is commented upon below in Section 6.

An important feature of Eurocode 7 is that it provides a broad framework for the design of all different types of geotechnical structure, giving many lists of items to be considered, taken into account or checked in a geotechnical design. Through these checklists, which are often mandatory, EN 1997-1 identifies what has to be achieved, but generally does not specify how. Thus EN 1997-1 involves a risk analysis approach to geotechnical design that requires geotechnical engineers to identify all the different hazards involved, and to think carefully about the measures that need to be taken to minimise or mitigate the likelihood of their occurrence. It is suggested that completion and retention of these checklists could be considered as an element of design in order to record and demonstrate that these factors have been taken into account in the design.

Unlike the Eurocodes for structural materials, EN 1997-1 does not include any detailed calculation models (design equations) as Application Rules in the code text because, when it was being drafted, it was found that different calculation models were used in the different CEN countries, and some calculation models were still being developed. Hence, rather than include particular models in the code text, it was decided instead to select the most commonly used and best agreed models, for example the calculation models for bearing resistance and earth pressure, and to place those in Informative Annexes. The sources of these calculation models have been traced by Orr (2008). The UK NA to EN 1997-1 states that the Informative Annexes, and hence the calculation models in them, 'may be used' when carrying out geotechnical designs to BS EN 1997-1. Alternative calculation models to those given in the Informative Annexes, for example based on existing practice, may be used if the designer can demonstrate that they provide designs that are at least as reliable as those obtained using the calculation models in the Annexes. An example of a situation where an alternative model may be used is indicated by the following statement from the UK NA to EN 1997-1 concerning the bearing resistance equation in Annex D:

Annex D omits depth and ground inclination factors which are commonly found in bearing resistance formulations. The omission of the depth factor errs on the side of safety, but the omission of the ground inclination factor does not. An alternative method to BS EN 1997-1:2004, Annex D, including the depth and ground inclination factors as appropriate, may be used.

Since BS EN 1997-1 has been published in the UK as the British Standard for geotechnical design, it has superseded most of the former geotechnical British standards. As Eurocode 7 provides a broad overall framework for geotechnical design, and does not provide many calculation models, some of the guidance for construction and calculation models included in these former standards that are not in BS EN 1997-1 may be used when designing to Eurocode 7, because the UK NA to BS EN 1997-1 states that (with links for the references added in brackets):

The following is a list of references that contain non-contradictory complementary information for use with BS EN 1997-1:2004: BS 1377 (BSI, 1990), BS 5930 (BSI, 1999), BS 6031 (BSI, 2009b), BS 8002 (BSI, 1994), BS 8004 (BSI, 1986), BS 8008 (BSI, 1996), BS 8081 (BSI, 1989), PD 6694-1 (BSI, 2011b), CIRIA C580 (Gaba et al., 2003), UK Design Manual for Roads and Bridges (Highways Agency, 2011). It should be noted that if any parts of these references is in conflict with BS EN 1997-1:2004, then, until such time as revised residual documents are published, the Eurocode takes precedence.

However, because most of the superseded BSs are no longer being maintained and updated by BSI, designers should be wary of referring to them. An example of where designers should be wary of referring to these standards is given in Section 7 in connection with the use of Ciria C580 for the design of retaining walls. Most other European countries have considered it necessary to prepare supporting documents that provide non-conflicting complementary information (NCCI), including detailed calculation models for designs to Eurocode 7.

3. Eurocode terminology

Since Eurocode 7 is one of the suite of structural Eurocodes that are harmonised not only across the different design materials, such as concrete, steel and soil, but also across the different countries in Europe, one effect of the implementation of Eurocode 7 has been the introduction of the Eurocode terminology into geotechnical design, which can appear strange initially to those from an English-speaking background. Examples of this terminology are as follows.

- *Action*, which is defined in EN 1990 §1.5.3.1 as: '(a) Set of forces (loads) applied to the structure (direct actions); (b) Setof imposed deformations or accelerations caused, for example, by temperature changes, moisture variation, uneven settlement or earthquakes (indirect actions)'. EN 1997-1 §1.5.2.1 defines a geotechnical action as an 'action transmitted to the structure by the ground, fill, standing water or ground-water'; hence the forces due to earth and water pressures are examples of actions. In defining actions in geotechnical design, the earlier ENV version of Eurocode 7 (CEN, 1994) stated that 'For any calculation the values of actions are known quantities. Actions are not unknowns in the calculation model.'

- *Resistance*, which is defined in EN 1990 §1.5.2.15 as the 'capacity of a member or component . . . to withstand actions without mechanical failure'. EN 1997-1 §1.5.2.7 includes 'resistance of the ground' as an example of a resistance in geotechnical design. Hence, in designs to Eurocode 7, the resistance of the ground is the maximum resisting force provided by the ground when its strength is fully mobilised. In the design of a footing or a pile, for example, this resistance was previously referred to as the bearing capacity.

- *Weight density*, which is the term used in the Eurocodes for the weight per unit volume of a material – that is, kN/m3 – which traditionally was referred to as the unit weight.

Since earth pressures, which involve soil strength, are actions according to the definition given above, and because soil is a frictional material, resistances are often functions of effective stresses – that is, of actions – Eurocode 7 does not always explicitly state whether a particular force is an action or a resistance, for example the passive pressure on a retaining structure. This has given rise to different interpretations of Eurocode 7 (Bond and Harris, 2008; Smith and Gilbert, 2011a) and has affected the ways in which partial factors are applied, as discussed in Section 6.

4. Assumptions in Eurocode 7

To achieve designs with the required safety, serviceability and durability, the provisions in Eurocode 7, like those in the other Eurocodes, are based on the following assumptions, given in Application Rule §1.3(2) in EN 1997-1.

– *Data required for design are collected, recorded and interpreted by appropriately qualified personnel;*

– *Structures are designed by appropriately qualified and experienced personnel;*

– *Adequate continuity and communication exist between the personnel involved in data-collection, design and construction;*

– *Adequate supervision and quality control are provided in factories, in plants, and on site;*

– *Execution is carried out according to the relevant standards and specifications by personnel having the appropriate skill and experience;*

– *Construction materials and products are used as specified in this standard or in the relevant material or product specifications;*

– *The structure will be adequately maintained to ensure its safety and serviceability for the designed service life;*

– *The structure will be used for the purpose defined for the design.*

Three of the above assumptions refer to the personnel involved in the different aspects of the geotechnical design process as being ‘appropriately qualified’ or having ‘appropriate skill and experience’. These are important assumptions, which, when fulfilled, should ensure the reliability and safety of geotechnical designs. The competences required by those involved in geotechnical investigations and testing are identified in the CEN and ISO (International Standards Organisation) Technical Specification CEN ISO/TS 22475-2:2006 Qualification criteria for enterprises and personnel, which has been published as BS 22475-2 (BSI, 2011c). A Technical Specification (TS) is a normative document that has not yet received sufficient agreement for publication as a European standard, but is published in anticipation of future harmonisation. It may be adopted as a national standard, but conflicting national standards may continue to exist.

Since no register of appropriately qualified and experienced geotechnical personnel existed in the UK when Eurocode 7 was published, the Institution of Civil Engineers (ICE), the Institute of Materials, Minerals and Mining (IoM3) and the Geological Society London (GSL) sponsored, under the leadership of the British Geotechnical Association (BGA) and on behalf of the Ground Forum, the development of the UK Register of Ground Engineering Professionals (RoGEP). The Ground Forum is the ‘umbrella’ body for the UK ground engineering sector, and brings together the learned societies and trade associations that collectively represent most of the construction-related ground engineering disciplines, and gives the industry a single voice. Further information about the Ground Forum can be found online at www.ground-forum.org.uk. The aim of RoGEP, which was established in June 2011, is to provide external stakeholders, including clients and other professionals, with a means to identify individuals who are suitably qualified and competent in ground engineering. Ground engineering is defined by the Ground Forum as

an understanding of geological structures, materials and processes, combined with the systematic application of investigative, scientific and engineering techniques to produce practical solutions to ground related issues for the benefit of society.

RoGEP registrants may be consultants, contractors, from public bodies or academia. These individuals may be involved in various disciplines or on various projects that fall under the broad heading of ground engineering. They must have an appreciation of other disciplines and interests that extend beyond, but interface with, ground engineering, and must be able to demonstrate how ground engineering interacts with other technical professions. Chartered membership of the ICE, IoM[3] or GSL is required for acceptance to RoGEP. The benefits of the Register are that it provides the public and clients assurance that the registrant has achieved a recognised competence standard through a rigorous assessment process, and is committed to continuing professional development (CPD). Further information about RoGEP and how to register is available on-line at www.ukrogep.org.uk.

The list of aspects covered by the above assumptions is very comprehensive, ranging from the collection of data and communication, through the design and construction aspects, to maintenance of the completed structure. Compliance with these assumptions should have the effect of improving the safety and reliability of geotechnical designs. The assumption that adequate continuity and communication exist between the personnel involved in the different aspects and stages of a geotechnical project is a particularly important assumption with regard to achieving the required safety of geotechnical designs. To ensure that the assumptions are complied with, Application Rule §1.3(3) states that ‘compliance with them should be documented, e.g. in the Geotechnical Design Report’. The need to produce a Geotechnical Design Report, with all the geotechnical and other data, design calculations, drawings and recommendations and items to be checked during construction or requiring maintenance, is an important effect of the introduction of Eurocode 7. To ensure that the structure is adequately maintained, Principle §2.8(6)P states that ‘An extract from the Geotechnical Design Report, containing the supervision, monitoring and maintenance requirements for the completed structure, shall be provided to the owner/ client.’

5. Geotechnical investigations and testing to Eurocode 7

Unlike structural design using manufactured materials, the geotechnical design process set out in Eurocode 7 involves first determining the soil parameter values from geotechnical investigations and field and/or laboratory tests, and then selecting characteristic values of soil parameters for use in design before carrying out any design calculations. EN 1997-1 requires in section 3.4.1(1)P that the results of the geotechnical investigation and tests be compiled in a Ground Investigation Report, which forms part of the Geotechnical Design Report. Part 2 of Eurocode 7, EN 1997-2, provides the requirements for ground investigations and the derivation of parameter values from soil tests, and refers to a number of European standards, prepared by CEN and/or by ISO, for carrying out geotechnical investigations and some common field and laboratory tests. These standards, together with some that are still being developed, are listed in Table 1, and more information about them is provided by Orr (2012a). Once a CEN standard has been approved by the CEN members and published as an EN, it must then be published as a national standard. For example, in the UK it is published by BSI as a BS, and supersedes any existing British Standards covering the same topic; the relevant existing BSI test standards will therefore be progressively withdrawn as more ENs are published. Thus the introduction of Eurocode 7 has had the effect of introducing as current BSs many new European standards for geotechnical investigations and testing, where a current BS is a document that is deemed to represent what is accepted good practice at present, as followed by competent and conscientious practitioners.

As many of these standards for geotechnical investigations and testing have more stringent requirements than the existing standards for the checking of test equipment and performing the tests, they should result in improved geotechnical investigations and the obtaining of more reliable parameter values. An example of this is the standard for the standard penetration test, BS EN ISO 22476-3 (BSI, 2005), which partially replaces BS 5930:1999+A2:2010 (BSI, 1999) and Part 9: *In-situ tests* of BS 1377 (BSI, 1990). As noted by Hepton and Gosling (2008), this standard has new requirements for hammer energy calibration and documented equipment checks that will have to be actioned, but otherwise does not provide any major issue for UK practice.

The new standards for describing and classifying soil are BS EN ISO 14688-1:2002 *Identification and description* (BSI, 2002) and BS EN ISO 14688-2:2004 *Classification principles* (BSI, 2006). These standards are referred to in the revised version of BS 5930 (1999) with Amendment 1 (primarily to Section 6: Description of soil and rock), which removes text of BS 5930 superseded by BS EN ISO 14688-1:2002, BS EN ISO 14688-2:2004 and BS EN ISO 14689-1:2003 (BSI, 2004a), and makes reference to the relevant standard for each affected subclause. The new standards do not provide much detailed guidance on the description and classification of soils, and therefore BS 5930 has been revised to provide non-conflicting complementary information

Table 1. CEN/ISO standards for geotechnical investigation and testing

CEN/ISO Ref.	Subject	Status
Identification and classification of soil		
14688-1	Soil identification and description	Current BS
14688-2	Soil classification	Current BS
Identification and classification of rock		
14689-1	Rock identification and description	Current BS
Laboratory testing of soil		
17892-1	Water content	Not implemented in UK
17892-2	Density of fine-grained soil	Not implemented in UK
17892-3	Particle density – pycnometer method	Not implemented in UK
17892-4	Particle size distribution	Not implemented in UK
17892-5	Incremental loading oedometer test	Not implemented in UK
17892-6	Fall cone test	Current DD
17892-7	Unconfined compression test on fine-grained soils	Not implemented in UK
17892-8	Unconsolidated undrained triaxial test	Not implemented in UK
17892-9	Consolidated triaxial compression tests on water-saturated soils	Not implemented in UK
17892-10	Direct shear tests	Not implemented in UK
17892-11	Permeability determination by constant and falling head	Not implemented in UK
17892-12	Atterberg limits	Not implemented in UK
Geohydraulic testing		
22282-1	General rules	Under development
22282-2	Water permeability tests in a borehole without packer	Under development
22282-3	Water pressure tests in rock	Under development
22282-4	Pumping tests	Under development
22282-5	Infiltrometer tests	Under development
22282-6	Water permeability tests in a borehole using closed systems	Under development
Sampling methods and groundwater measurements		
22475-1	Technical principles for execution	Current BS
22475-2	Qualification criteria for enterprises and personnel	Current BS
22475-3	Conformity assessment of enterprises and personnel by third party	Current BS
Field testing		
22476-1	Electrical cone and piezocone penetration tests	Under development
22476-2	Dynamic probing	Current BS
22476-3	Standard penetration test	Current BS
22476-4	Ménard pressuremeter test	Under development
22476-5	Flexible dilatometer test	Under development
22476-6	Self-boring pressuremeter test	Under development
22476-7	Borehole jack test	Under development
22476-8	Full displacement pressuremeter test	Under development
22476-9	Field vane test	Under development
22476-10	Weight sounding test	Published by CEN as TS but not listed by BSI
22476-11	Flat dilatometer test	Current DD
22476-12	Mechanical cone penetration test (CPTM)	Current BS
22476-13	Plate loading test	Under development
Testing of geotechnical structures		
22477-1	Pile load test by static axially loaded compression	Under development
22477-2	Pile load test by static axially loaded tension test	Under development
22477-3	Pile load test by static transversely loaded tension test	Under development
22477-4	Pile load test by dynamic axially loaded compression test	Under development
24777-5	Testing of anchorages	Under development
22477-6	Testing of nailing	Under development
22477-7	Testing of reinforced fill	Under development

(NCCI) for describing and classifying UK soils. The revised version of BS 5930 states that Informative Annex B of BS EN ISO 14688-2, which provides an example of a soil classification based on grading alone, is not preferred in UK practice, as it takes no account of plasticity or water content. This is particularly relevant for certain soils, such as some glacial tills, which can behave as fine soils but, based on grading alone, would be classified as coarse soils according to Appendix B of BS EN ISO 14688-2. An example of a potential problem with describing and classifying soils to EN ISO 14688 rather than a national standard occurs in Finland. The former Finnish standard for soil description used the letters Sa for clay, which is savi in Finnish, whereas EN 14688 uses Sa for sand and Cl for clay. Thus there is potential for confusion, for example when reading borehole logs, unless it is clear which standard is being used.

EN 1997-2 states that the strength and compressibility of soil can only be determined from tests carried out on quality class 1 samples obtained using category A sampling methods. The standard for soil sampling, EN ISO 22475-1, specifies the quality classes of samples required to obtain particular soil parameters from laboratory tests and the sampling method category required to obtain a particular quality class. While quality class 1 samples may be readily obtained in homogeneous and fine-grained soils using thin-walled samplers, Taylor et al. (2011) have pointed out that thin-walled samplers can prove to be totally ineffective for obtaining quality class 1 samples in certain soils, such as glacial tills, that include coarse particles. Hence if quality class 1 samples cannot be obtained, either because suitable equipment is not available or because the soil is too coarse, they recommend that use be made of alternative equipment and, in accordance with EN 1997-1 §1.5.2.2, account be taken of comparable experience and the quality of the samples when selecting the parameter values for design calculations.

The CEN standards for determining, presenting and evaluating parameters from laboratory tests – that is, the 12 parts of 17892 listed in Table 1 – have been published by CEN and ISO as Technical Specifications (CEN ISO/TSs), and are referred to in EN 1997-2. The UK NA to EN 1997-2 (BSI, 2009a) states that laboratory tests should continue to be carried out using parts of BS 1377 (BSI, 1990), since the parts of CEN ISO/TS 17892 have not been implemented in the UK, except for Part 6 on the strength index testing of soil using the fall cone test. This is the only one of the laboratory test TSs to be used in the UK, because it has been published by BSI (2010a) as the Draft for Development DD CEN ISO/TS 17892-6 (a Draft for Development in this context is a document published to adopt a CEN ISO/TS before it can be published as a BS). In addition to the European standards for geotechnical investigations and testing, CEN has published the 12 ENs for carrying out geotechnical work (i.e. execution standards) shown in Table 2, some of which are referred to in EN 1997-1 and all of which have also been published as British Standards – for example BS EN 1536 (BSI, 2010b), the standard for the execution of bored piles.

Table 2. CEN/ISO standards for the execution of special geotechnical works

CEN/ISO Ref.	Subject	Status
1536	Bored piles	Current BS
1537	Ground anchors	Current BS. Under revision
1538	Diaphragm walls	Current BS
12063	Sheet pile walls	Current BS
12699	Displacement piles	Current BS
12715	Grouting	Current BS
12716	Jet grouting	Current BS
14199	Micropiles	Current BS
14475	Reinforced fill	Partially supersedes BS 8006:1995
14679	Deep mixing	Current BS
14731	Ground treatment by deep vibration	Current BS
14490	Soil nailing	Current BS
15237	Vertical drainage	Current BS

With the introduction of many new European standards for geotechnical investigations and testing, the question arises as to whether it can be claimed that a geotechnical design is in accordance with Eurocode 7 if the geotechnical investigations and testing are not wholly in accordance with EN 1997-2 and the new European standards for testing. In Section 3: 'Geotechnical data' of EN 1997-1, §3.1(4), which is an Application Rule, states that 'requirements for laboratory and field testing should be taken from EN 1997-2'. However, as noted above in Section 2, it is permissible to use alternative rules for laboratory and field testing to those given in EN 1997-2 and in the standards referred to in EN 1997-2, provided the alternative rules accord with the relevant Principles and are at least equivalent with regard to the structural safety. Therefore, in this situation, while a design could not be claimed to be wholly in accordance with EN 1997-1, it could be claimed to be in accordance with the Principles of Eurocode 7.

6. Features of geotechnical designs to Eurocode 7

6.1 Challenges in geotechnical design

The three challenges that faced the drafters of Eurocode 7 (Orr, 2006), and now affect those carrying out geotechnical designs to Eurocode 7, are that geotechnical designs have to

- be consistent with the basis of design set out in EN 1990
- take account of the special features of soil
- be acceptable to the geotechnical community.

The basis of design set out in EN 1990 for the harmonised suite of Eurocodes, including Eurocode 7, is the limit state concept used in conjunction with partial factors. While the limit state design concept with partial factors has been used for many years for the design of structures, it has not been used much for geotechnical designs, either in the UK or in the rest of Europe. In adapting this limit state concept for geotechnical design, the following special features of soil have had to be taken into account.

- Soil is a frictional material, and hence, as noted above, soil resistance is a function of the normal effective stress due to the soil weight as well as the soil strength. Thus the weight of soil, as well as being a direct disturbing force and giving rise to earth pressure forces, can at the same time also be a component of the resistance. Consequently, care is needed when factoring the forces due to soil weight. Some issues that have arisen when factoring soil weight and earth pressures are discussed in Sections 6.6 and 7.

- The forces due to water pressures need to be taken into account and factored consistently with the forces due to soil weight. How to factor water pressures is an aspect that has caused some difficulties, as outlined in Section 7.

- Soil is not homogeneous, and its properties vary over the zone of soil involved in a particular limit state, for example along a failure surface. Therefore the definition in EN 1990 of the characteristic value being the 5% fractile of a set of test results is not appropriate for geotechnical design. Instead, EN 1997-1 states that the characteristic value of a geotechnical parameter shall be selected as 'a cautious estimate of the value affecting the occurrence of the limit state', so that the geotechnical designer is responsible for selecting the values of parameters for use in design calculations. Hence it should be noted that, when designing to Eurocode 7, there is no such thing as a single characteristic value of a geotechnical property, since the value selected will depend on the limit state being considered. This definition for the characteristic value is a change from previous practice, where generally the values of soil parameters for use in geotechnical design were not defined in the code of practice but were provided by those who carried out the geotechnical investigation without any reference to the design situation or relevant failure mechanism. Orr (2012b) carried out a questionnaire survey of the national representatives from some countries on the CEN subcommittee TC250/SC7 responsible for the development of Eurocode to investigate experiences with the use of Eurocode 7 in Europe. Surprisingly it was found that, largely for indemnity reasons, characteristic soil parameter values in some countries are still provided by those carrying out the geotechnical investigation rather than being selected by those responsible for the geotechnical design. Another change from existing practice, which could cause misunderstanding, is that the unfactored soil parameters values provided by geotechnical investigations for use in geotechnical designs were previously called design values, whereas in Eurocode 7 design values are the factored soil parameters values used in design calculations, and are obtained by applying partial factors to characteristic values.

6.2 Limit state design method

The limit state design method in Eurocode 7 normally requires that separate calculations be carried out to check that the occurrence of an ultimate limit state (ULS) and a serviceability limit state (SLS) are sufficiently unlikely. A consequence of this is that designs to Eurocode 7 require that more attention than heretofore be given to the prediction of foundation settlements and ground movements. Hence there is a need for reliable geotechnical investigations and testing methods to determine soil stiffness and compressibility parameters, and for improved methods to calculate deformations. Also, there is a need for good communication with structural engineers regarding the effects of ground deformations and soil–structure interaction on structures, and regarding the deformations that are acceptable. However, with regard to the prediction of settlements of spread foundations, geotechnical engineers should note the following caution provided in EN 1997-1 §6.6.1(6): 'Calculations of settlements should not be regarded as accurate. They merely provide an approximate indication.'

Eurocode 7 requires that, where relevant, the following five different types of ULS should be considered and separate sets of partial factors are provided for each type:

– Loss of equilibrium of the structure or the ground, considered as a rigid body, in which the strengths of structural materials and the ground are insignificant in providing resistance (EQU);

– Internal failure or excessive deformation of the structure or structural elements, including e.g. footings, piles or basement walls, in which the strength of structural materials is significant in providing resistance (STR);

– Failure or excessive deformation of the ground, in which the strength of soil or rock is significant in providing resistance (GEO);

– Loss of equilibrium of the structure or the ground due to uplift by water pressure (buoyancy) or other vertical actions (UPL);

– Hydraulic heave, internal erosion and piping in the ground caused by hydraulic gradients (HYD).

In the case of a GEO ULS, Eurocode 7 requires that the following inequality – that is, static equilibrium – be verified

1: $$E_d < R_d$$

where E_d is the design action effect and R_d is the design resistance. As noted above, since soil is a frictional material, E_d and R_d are each functions of both the actions and the soil strength, as well as being functions of the geometry.

6.3 Design approaches

To take account of the special features of soil, and also to accommodate the different design traditions and views in Europe on how partial factors should be applied in geotechnical design, the following three design approaches (DAs) have been introduced

- DA1 with partial factors applied in separate combinations either to just the actions (DA1.C1) or to the material properties and the variable actions (DA1.C2)

- DA2 with partial factors applied to the resistances and to the actions or action effects

- DA3 with partial factors applied to both the actions and the material properties.

Table 3 shows which design approach or approaches have been adopted by the various CEN member countries for different types of geotechnical design; the countries are identified by abbreviations. The information in Table 3, which is based mainly on Bond and Harris (2008) and updated by the author, indicates that DA1 has been adopted by the UK and five or six others of the 33 CEN member countries for all types of geotechnical design. As Table 3 shows, the majority of the countries have adopted DA2 for the design of spread foundations, pile foundations and retaining structures, and DA3 for the design of slopes. Many countries have adopted DA2* for the design of spread foundations, with the * indicating that partial factors are applied to the action effects rather than to the actions. Some countries allow the use of two design approaches for some designs; this is mainly to allow the use of DA3 with material factoring in numerical analyses as an alternative to DA2 with resistance factoring. Two countries, the Czech Republic and Ireland, permit the use of any one of the three design approaches, although it is being proposed in the Czech Republic only to permit the use of one design approach for any design situation, generally DA1, but with DA2 for piles and anchors, and DA3 for slopes. The design approaches given for Switzerland (CH) in Table 3 indicate how partial factors are generally applied in that country since Eurocode 7 has not yet been implemented there in its

Table 3. Selection of design approaches by CEN member countries

Type of design	DA1	DA2		DA3	DA1, DA2 or DA3	Not known
		DA2	DA2*			
Spread foundations	B, IS, I, LT, P, RO, UK	F, EST	A, CR, CY, D, E, FIN, GR, H, I, PL, SK, SLO	CH, DK, F, N, NL, S	CZ, IRL	BU, L, LV, MK, MT, TU
Pile foundations	B, I, LT, P, RO, UK	A, CH, CR, CY, D, DK, E, EST, F, FIN, GR, H, I, IS, N, PL, S, SK, SLO		NL, S	CZ, IRL	BU, L, LV, MK, MT, TU
Retaining structures	B, IS I, LT, P, UK	A, CH, CR, CY, D, E, EST, F, FIN, GR, H, I, PL, SK, SLO		A, DK, F, N, NL, RO, S	CZ, IRL	BU, L, LV, MK, MT, TU
Slopes	B, IS, EST, LT, P, UK	E, F		A, CH, CR, CY, D, DK, E, F, FIN, GR, H, I, N, NL, PL, RO, S, SK, SLO	CZ, IRL	BU, L, LV, MK, MT, TU
Overall	6–7	2–19		2–19	2	6

Note: A = Austria; B = Belgium; BU = Bulgaria; CH = Switzerland; CR = Croatia; CZ = Czech Republic; CY = Cyprus; D = Germany; DK = Denmark; E = Spain; EST = Estonia; F = France; FIN = Finland; GR = Greece; H = Hungary; I = Italy; IRL = Ireland; IS = Iceland; L = Luxembourg; LI = Lithuania; LV = Latvia; MK = The Former Yugoslav Republic of Macedonia; MT = Malta; N = Norway; NL = the Netherlands; P = Poland; PL = Portugal; RO = Romania; S = Sweden; SK = Slovakia; SLO = Slovenia; TU = Turkey; UK = UK.

original form with design approaches. The design approaches and different NDP values adopted by the different countries reflect to a large extent the different geotechnical design practices in these countries. However, both the Commission and CEN wish to see more harmonisation in the application of the Eurocodes, and therefore, in the further development of Eurocode 7 and the other Eurocodes, they are seeking a reduction in the number of design approaches, particularly in the number of partial factors used, and more agreement regarding the values of the NDPs.

DA1 has the advantage that, as the partial factors are applied to the actions and the soil strength, they are applied closer to the source of the uncertainties than in DA2, where the partial factors are applied to the resistances. Another advantage of DA1 is that it is easier to use in finite-element analyses. Furthermore, using DA2 and applying partial factors to resistances can cause confusion and unexpected results. For example, the following equation for the undrained bearing resistance of a spread foundation is given in EN 1997-1

2: $$R / A' = (\pi + 2)\, c_u\, s_c\, i_c\, b_c + q$$

where A′ is the effective foundation area; c_u is the undrained shear strength; s_c, i_c and b_c are dimensionless factors for the shape of the foundation base, the inclination of the load and the inclination of the base respectively; and q is the surcharge or overburden pressure due to the soil weight at the level of the foundation base. Thus the force due to the surcharge, A′q, is included as a component part of the resistance, although it could also be considered as a favourable action. This does not cause any problem in DA1, since partial factors are applied to soil strengths and actions, and the partial factors on favourable actions and resistances are always unity. However, as partial factors are applied to actions and resistances in DA2, A′q could be factored in a number of different ways, including being factored twice if it is treated both as an action and as a part of the resistance, although normally parameters are not doubly factored in designs to Eurocode 7. The reason why problems do not normally occur when using DA2 and factoring the resistances is that, as noted in Section 2, most of those countries that have adopted DA2, such as Germany, also have accompanying non-conflicting complementary information, such as national standards and guidance documents (e.g. DIN, 2012) that provide detailed calculation models which prescribe how the partial factors are to be applied. The design of retaining structures to Eurocode 7 is another situation where, as noted by Markham (2012), there can be uncertainty as to whether forces, in this case earth pressure forces, are to be treated as actions or resistances. This is discussed in Section 7.

The design of piles to Eurocode 7 is a topic that has given rise to much discussion and debate, and has resulted in some changes to design practice. EN 1997-1 places great emphasis on pile load tests to validate pile designs, and has introduced ξ factors applied to pile load test results to determine the characteristic pile resistance. These provide higher – that is, more optimistic and hence more economic – characteristic pile resistances when more pile load tests are carried out. Owing to the uncertainties in calculating pile resistance from soil parameter values, partial factors are applied to pile resistances rather than to soil strengths in DA1 as well as in DA2. Also, as described by Bond and Simpson (2009, 2010) and by Vardanega et al. (2012), model factors have been introduced in the UK NA to EN 1997-1, so that the overall safety level of pile designs to Eurocode 7 is similar to former practice, and the occurrence of an SLS as well as a ULS is sufficiently unlikely. This is in accordance with the note to EN 1997-1 §7.6.4.1(2), which states: 'For piles bearing in medium-to-dense soils and for tension piles, the safety requirements for the ultimate limit state design are normally sufficient to prevent a serviceability limit state in the supported structure.'

6.4 Finite-element analyses and Eurocode 7

The use of finite-element analyses for geotechnical designs to Eurocode 7 is another area that has given rise to some discussion and developments. Potts and Zdravkovic (2012) have outlined two possible approaches to carrying out numerical analysis for DA1. Their approach 1 is to start the numerical analysis with unfactored strength values, and gradually reduce the strength at relevant stages until failure occurs. The advantage of this approach is that a single analysis is used to investigate both SLS and ULS. The disadvantages are that inconsistent strength reduction approaches are used in different software, and that some software can perform such reductions only if simple constitutive models are used. Their approach 2 is to start the numerical analysis with factorised strength values and continue until failure occurs. The advantages of this approach are that it is the easier alternative, no software modification is needed, and it can be used with most constitutive models. The disadvantages are that the initial stresses may not be consistent with those in situ, and an additional analysis is needed to investigate serviceability. Smith and Gilbert (2011a, 2011b) have presented a general numerical method that includes the use of action and resistance factors to analyse the stability of different structures. Building on this work, Smith (2012) has presented a simple but theoretical framework that should underpin ultimate limit state design and permit the definition of a rigorous and consistent methodology for the application of partial factors.

7. Experiences and problems with the implementation of Eurocode 7

A workshop on experiences with the Implementation of Eurocode 7 was held during the European Conference on Soil Mechanics and Geotechnical Engineering in Athens in 2011, and Orr (2012b) has summarised the presentations at this workshop. Dr C. Smith (University of Sheffield) reported that Eurocode 7 is being used continuously in the UK by larger consulting firms, but probably less so by very small firms. He also said that, although there had been a lot of critical debate during the development of Eurocode 7, BSI has received very few criticisms since it was published, and most users now commented favourably on it. Dr T. Orr (Trinity College Dublin) reported on its implementation in Ireland. He carried out a questionnaire survey of the main geotechnical engineers in Ireland and found that, although they initially thought Eurocode 7 was not easy to use, once familiar with it, they now have no difficulty using it, although they do find it more complicated than the traditional design method. Based on the survey of the national representatives from some countries on the CEN subcommittee TC250/SC7, referred to in Section 6, Orr (2012b) reported similar findings about the effects of implementing Eurocode 7 in those European countries.

At the workshop in Athens, Smith gave an example of where there could be confusion in implementing Eurocode 7 (Orr, 2012b). This example was the design of the Bahrain–Qatar causeway bridge, one of the world's longest bridges; because it is a structure outside Europe being designed to the Eurocodes by an international team, the question arose regarding which NAs and what partial factor values to use.

How to design retaining structures to Eurocode 7 has given rise to some discussion, for example in the paper by Markham (2012) on the design of temporary excavation support to Eurocode 7. The first difficulty that Markham mentions is that, where suitable geotechnical investigation data are not available he says, it is not possible to carry out a temporary design to Eurocode 7. This is not strictly so, however, because a design can be carried out in accordance with the Principles of Eurocode 7, but the designer would need to use comparable experience to select appropriately cautious characteristic parameter values and, as noted in Sections 2 and 5, could not claim the design to be wholly in accordance with EN 1997-1.

A second difficulty mentioned by Markham (2012), which arises because Eurocode 7 does not provide a detailed method for the design of retaining structures, is that the method in Ciria report C580 (Gaba et al., 2003) for the design of temporary retaining walls is not compatible with EN 1997-1, and he found that it produces designs with overall safety factors that are considerably less than recommended in Ciria C580. Roscoe (2012) has expressed surprise at this finding, and states that it may be due to the way the partial factors were applied. Also, as noted in Section 2, engineers should be wary of referring to documents that are not consistent with EN 1997-1. Simpson (2005) examined the design of retaining walls to Eurocode 7 by engineers from a number of different countries, and found that the results of the calculations were within the range of results from national standards, which should allay the concern expressed by Beal (2012) in his discussion on Markham (2012) about designs to Eurocode 7 and existing practice giving different results. More guidance is clearly required on the design of retaining structures to Eurocode 7, for example by a revision of Ciria C580.

Another problem mentioned by Markham (2012) is how to treat and factor the earth pressures around a retaining wall, which are both unfavourable and favourable, providing a disturbing force and a resistance, and change from active to passive close to the toe. EN 1997-1 does not provide specific guidance on how earth pressures should be treated or factored; that depends on the design approach adopted. According to §2.4.2(4), earth pressures – that is, both active and passive – should be considered for inclusion as actions, and the note to §2.4.2(9)P states that:

Unfavourable (or destabilising) and favourable (or stabilising) permanent actions may in some situations be considered as coming from a single source. If they are considered so, a single partial factor may be applied to the sum of these actions or to the sum of their effects.

This is the single-source principle. As Roscoe (2012) notes in his discussion contribution on Markham, neither EN 1997-1 nor the UK NA to EN 1997-1 describes these situations, and hence guidance is needed. The single-source principle should be used in DA1, with both the active and passive pressures treated as actions and the same partial factor for unfavourable actions applied to both, since the overall effect of the actions is unfavourable. This partial factor should not be applied to the net total pressure, because, as noted by Roscoe, this is indeed fraught with difficulties. Applying a single partial factor to all the earth pressures avoids any confusion due to pressures changing from active to passive near the toe. However, it has the consequence in DA1.C1, when neither the soil strength nor the resistance is factored, that factoring only the earth pressure forces on opposite sides of the wall by the same amount provides no margin of safety. Hence, in DA1, the design of the wall length is determined by DA1.C2, because in this case the partial factor applied to the soil strength increases the active pressure and reduces the passive pressure, thus providing the required margin of safety. The partial factor on unfavourable actions in DA1.C2 is unity so that, as noted in Section 6.3, double factoring does not occur. In contrast, in DA2, the active pressure is treated as an unfavourable action and the passive pressure is treated as a resistance, with appropriate partial factors applied to these.

Beal (2012) in his discussion on Markham (2012) notes that, considering the problems that arose when partial factors were introduced into structural design, it may take time to reconcile partial factors with the complexity of geotechnical design. An aspect of geotechnical design where the application of Eurocode 7 and partial factors has proved challenging, and has caused much discussion (e.g. Orr, 2005; Simpson et al., 2009), is how to select the design values of water pressures for both uplift (UPL) and seepage (HYD) ultimate limit states. According to §2.4.6.1(8): 'Design values of water pressures may be derived either by applying partial factors to characteristic water pressures or by applying a safety margin to the characteristic water level.' A problem with factoring water pressures is that this can result in water pressures that are unreasonable or not physically possible, for example when factoring water pressures behind a retaining wall. However, in the structural design of retaining walls, water pressures are normally factored to obtain the design bending moments in the wall. In effective stress analyses it is necessary to factor earth and water pressures consistently, and if a partial action factor of unity is applied to the unfavourable earth pressure, as in DA1.C2, then the design water pressure should be obtained by applying an appropriate safety margin to the characteristic water level. Another problem occurs in the case of seepage around a wall. EN 1997-1 offers the following two alternative equations (2.9a and 2.9b) for analysing this situation, one comparing the design disturbing pore water pressure, $u_{dst;d}$, with the design stabilising total stress, $\sigma_{stb;d}$, and the other comparing the design seepage force, $S_{dst;d}$, with the stabilising submerged soil weight, $G'_{stb;d}$

3: 2:9a : $u_{dst;d} < \sigma_{stb;d}$

4: 2:9b : $S_{dst;d} < G'_{stb;d}$

It is not clear from EN 1997-1 how the partial factors should be applied to the terms in these equations, and quite different results can be obtained depending on how the partial factors are applied. Further guidance is required on how to handle water pressures, and this is being prepared by one of the Evolution Groups mentioned in Section 8.

8. Future development of Eurocode 7

The chairman of CEN TC250/SC7, Dr Andrew Bond, carried out a questionnaire survey in 2011 of the CEN members and the geotechnical industry to find out what changes and improvements to EN 1997 they would most like to see. He presented the results of this survey at a Symposium on Eurocode 7 held in Cambridge in May 2011, which was reported by Spear and Selemetas (2011). The responses obtained from the UK engineers given in Table 4 show that the changes they considered to be the most important for Eurocode 7 were to

- add new parts to Eurocode 7 covering detailed design (e.g. footings, walls, pile and slopes)
- improve the general guidance on selecting characteristic soil parameter values
- improve the guidance on selecting water pressures
- add new parts to Eurocode 7 covering reinforced soil
- simplify and/or reduce the number of DAs.

Arising from this survey, and to prepare for the future development of Eurocode 7, SC7 decided to establish the 15 Evolution Groups (EGs) to

- examine the different aspects of Eurocode 7 and identify issues causing concern or problems
- make proposals that will serve as a sound basis on which to prepare the next version of Eurocode 7
- prepare model designs to Eurocode 7.

Table 4. Top five topics as voted by UK engineers

Rank	Topic	Percentage of respondents who chose topic
1	Add new parts to Eurocode 7 covering detailed design (e.g. footings, walls, pile and slopes)	100
2	Improve general guidance on selecting characteristic soil parameter	94
3	Improve guidance on selecting water pressures	70
4	Add new parts to Eurocode 7 covering reinforced soil	59
5	Simplify/reduce number of DAs	43

The topics being addressed by the Evolution Groups, the names of the convenors and their countries of origin are given in Table 5. The proposed timetable for the development of the Eurocodes is due to start with a formal review of the existing standards in 2013, followed by the preparation of revised standards in 2015, and formal votes on the revised versions in 2017, leading to publication and introduction of the revised standards probably in 2020. Most of the EGs have commenced their work, and are addressing many of the issues that have been raised since Eurocode 7 was introduced. Eurocode 7 encourages the use of finite-element analyses, although EN 1997-1 provides no guidance on their use. Hence the work of EG4: Numerical methods is important, as it is addressing the need for guidance in the revised version of Eurocode 7 on the use of numerical methods in geotechnical design (Lees, 2012). As more geotechnical designs are based on finite-element analyses, providing such guidance is likely to have a significant effect on geotechnical design. For more information about the Evolution Groups and their activities, readers should visit the website www.eurocode7.com/sc7/evolutiongroups.html.

9. Conclusion

The main effects of the introduction of Eurocode 7 on geotechnical design and its impact on the geotechnical profession have been to

- harmonise geotechnical design with structural design through the introduction of a common design method, a common design language, and consistent safety requirements and partial factors
- provide a single code for all different types of geotechnical structure, rather than a number of separate and different codes as formerly
- provide a general framework for geotechnical design, with many lists of items to be taken into account or considered, and no calculation models in the core text
- provide a code that is flexible, not prescriptive, except with regard to the requirements for safety, and through the introduction of three Design Approaches has enabled the use of either partial material factors or partial resistance factors, and hence has accommodated different national design practices and preferences in Europe
- ensure the safety of geotechnical designs by covering all aspects of geotechnical design, from initial geotechnical investigations and soil testing through the design and construction stages to the maintenance of the completed structure
- require the geotechnical designer to select the appropriate values of soil parameters for use in particular geotechnical design situations, rather than accept design values provided by those involved in ground investigations
- require good communication between the different per-

Table 5. SC7 Evolution groups

Evolution group	Topic	Convenor (country of origin)
0	Management and oversight	Andrew Bond (UK)
1	Anchors	Eric Farrell (Ireland)
2	Maintenance and simplification	Bernd Schuppener (Germany)
3	Model solutions	Trevor Orr (Ireland)
4	Numerical methods	Andrew Lees (Cyprus)
5	Reinforced soil	Martin Vanicek (Czech Republic)
6	Seismic design	Giuseppe Scarpelli (Italy)
7	Pile design	Christian Moormann (Germany)
8	Harmonisation	Andrew Bond (UK)
9	Water pressures	Norbert Vogt (Germany)
10	Calculation models	Christos Vrettos (Greece)
11	Characterisation	Lovisa Moritz (Sweden)
12	Tunnelling	To be decided
13	Rock mechanics	John Harrison (UK/Canada)
14	Ground improvement	To be decided

Table 5. SC7 Evolution groups

sonnel involved in geotechnical designs, for example by requiring the preparation of a geotechnical design report

- refer to many new European standards for geotechnical investigation and testing, which generally have more stringent requirements than the former standards, and should improve the quality of geotechnical data and hence the safety of geotechnical designs.

Although concerns and adverse comments were expressed about Eurocode 7 before it was finalised, the results of a questionnaire survey by the author and reports presented at the workshop in Athens on experiences with its implementation in a number of European countries indicated that, since it has been introduced, geotechnical engineers in these countries have generally not had much difficulty accommodating the necessary changes to geotechnical design practices, and have commented favourably on it. However, engineers have found some challenges in implementing Eurocode 7: for example, how to carry out geotechnical investigations that comply with Eurocode 7; how to select characteristic values; how to factor water pressures; and how to design reinforced earth structures. These and other issues related to Eurocode 7 are being addressed through the establishment of Evolution Groups to investigate them and prepare proposals for future development, leading to a planned revision of Eurocode 7, together with a revision of the other Eurocodes.

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A Brief History of Geotextiles: A 40-Year Update

Chris Kelsey

The discipline of geosynthetics began many years before it had a name. The terms "geotextile" and "geosynthetics" were not coined until Dr. J. P. Giroud used those terms in a seminal paper and presentation at an engineering conference in Paris in 1977. The significance of that conference led to it being known, after the fact, as the First International Conference on Geosynthetics (1 ICG).

This year, as *Land and Water Magazine* celebrates its 40th anniversary, the 1983-founded International Geosynthetics Society (IGS) will hold its 10th International Conference on Geosynthetics, 21-25 September 2014 in Berlin, Germany.

But even before the term geotextile was proposed, the materials were being used in the field. The Dutch incorporated geotextiles into the extraordinary Delta Works flood protection scheme in the early 1960s. This design, which helped usher the international geosynthetics manufacturer Tencate into the geosynthetics market, was a response to a deadly North Sea flood in the Netherlands in 1953.

The utilization of geotextiles in the Delta Works engineering response has been part of the system's exceptional long-term durability. The American Society of Civil Engineers (ASCE) even honored the Delta Works as one of the Seven Wonders of the Modern World.

Further to the early use of geotextiles, Prof. Georg Heerten published an article in 1984 in the very first issue of the renowned journal Geotextiles & Geomembranes. His topic: "Geotextiles in coastal engineering—25 years experience."

Prof. Heerten formerly held a key leadership position with the manufacturer NAUE in Germany (which advanced geosynthetic clay liner materials through manufacturing innovations with needlepunched nonwoven geotextiles). Today, Professor Heerten is Chairman of the German Geotechnical Society (DGGT), which is co-locating its 2014 biennial "Baugrundtagung" (geotechnical conference) with the 10th ICG in Berlin.

Suffice it to say, geotextiles have enjoyed a long history, not only as "geotextiles" but under various names (e.g., "construction fabrics") extending back well before they were given a formal name.

Even Dr. Giroud was utilizing geosynthetics in designs years before he had more engineering-specific names for them. Eight years before the watershed moments at the Paris conference, where the geosynthetics field would finally transition towards a more unifying, forward-looking identity in terminology, Dr. Giroud was working with geotextiles and geomembranes as a practicing engineer. His early 1970s work included a number of field firsts, such as the first use of a double-liner system, the first use of a geotextile cushion with a geomembrane, and the first use of a geotextile for filtration and internal integrity of a dam embankment.

That dam—the 17 m high Valcros Dam in France—set the stage for a number of important dam and embankment designs that utilized geotextile filtration for long-term performance.

Valcros Dam was constructed in 1970. It continues to perform well today.

EXPANDING FUNCTIONS

It is impossible to succinctly describe the last 40 years in geotextiles, but their multi-functional utility cannot be overlooked. Indeed, geosynthetics have extended into common use in every major sector of civil engineering; but in nearly all cases that inclusion of a geosynthetic, that exploration and establishment of design, has been assisted by geotextiles.

Geotextiles often enable or enhance the use of other geosynthetics. Here, a geotextile protection layer is installed between a geomembrane and a drainage/venting geocomposite in a landfill capping system. Photo by Chris Kelsey.

Geosynthetics are function-specific materials. Geomembranes, for example, provide containment. Geogrids provide reinforcement. Geotextiles provide nearly everything: filtration, drainage, separation, protection, reinforcement, etc.

Contaminated or weak soils are separated from clean soils by geotextiles. Wastewater soils, dredged spoils, and other are dewatered and isolated for easy disposal through geotextile tubes. Soil containers constructed of geotextiles are filled with local soils, sewn together, and installed along waterways for erosion control and scour protection. Landfills utilize geotextile cushioning between geomembranes and geocomposite drainage layers. (Installers are particularly versed in addressing this importance to geotextiles. Visit Colorado Lining International's website, for example, to find information on the many ways geotextiles beneficially impact waste management and other containment installations.) Geotextiles are used to wrap or line drainage trench zones, for everything from buried pipes of all sizes to avenue-wide installation. Roadways utilize geotextile separation to extend roadway service lives and decrease maintenance needs.

The list of applications that use geotextiles is extensive. The list is so long the geotextile is often not noted in project descriptions, but you can readily see geotextiles in project photos.

As example, re-open the January/February 2014 issue of *Land and Water Magazine*. On page 16, you'll find Matthew Kocian's article "GeoHistory in the Making." In it, Kocian describes a 40+ year geotextile performance study from a low-volume road in Delaware. (Kocian works for Polymer Group, Inc., which produces one of the longest-utilized brands in the field's geotextiles: Typar.) On page 20, Kristy Morris, Eileen Alduenda, and Nancy L.C. Steele write on an impressive neighborhood retrofit design in "Monitoring Your BMPs." Look at the photo on page 23: geotextile in the infiltration trench.

In short, geotextiles play a strong role in helping other materials—geosynthetics, aggregates, concrete, etc.—perform better. This helps those materials expand their application reach.

A CHALLENGE OF PERCEPTION

One of the true challenges of the geo- textile market is that the materials are often perceived as too common. They are common, and in general they perform what might be viewed as utility functions in construction, but the engineering behind geotextiles is far from common.

Newer geotextile-geogrid composite materials, such as the Combigrid® seen here, provide a single layer solution for reinforcement, separation, and drainage/filtration. Photo by NAUE.

Manufacturing them requires a real understanding of polymers and installation conditions that must be managed, such as chemical and biological challenges in soils; UV exposure; temperature fluctuations; etc.

Over the past 40 years, significant advances have occurred in manufacturing, such as in the additive packages on the polymeric side. These advances have greatly expanded the possible strengths and lifetime durability of geotextiles. Yet, the products mostly look the same. They mostly feel the same. And manufacturing advances have also contributed to improving the economics of geotextile production, even for the most highly engineered geotextiles.

So in some respects, the science behind manufacturing, being as strong as it is, has contributed to making geotextiles seem less dynamic than they are.

But these materials, no matter how deeply or how long they are buried, should not be "out of sight, out of mind" materials. Geotextiles have long performed exceptionally in engineering and construction.

Geotextiles are being utilized in, and at times enabling, some of the most interesting and forward-engineering occurring. So the best way to view their impact on the field may be less through a purely historical perspective; the most revealing look may be found in how they are influencing engineering today and going forward.

TRENDS

A Wider View of Geocomposites

For many years, the term "geocomposite" was used almost exclusively in reference to drainage composites. These are the wick drains used to accelerate the consolidation of soils; the sheet drains used to provide drainage against walls or wall block (such as within retaining walls); strip drains used in landscaping or near foundations; etc. These products are generally constructed of a polymeric core that is wrapped in a filter fabric, which is, essentially, a geotextile.

Similarly, geonets, such as those installed in capping systems, frequently are bonded a geotextile filtration element.

Today, many are using the term geocomposite to apply to other combinations of polymeric materials, such the fusion of geotextiles and geogrids.

Some manufacturers embed the geotextile layer between the geogrid bars. Some bond the geotextile to a side of the geogrid. Regardless of how it is done, the result is a single-roll product that for all intents and purposes in an installation is a "single layer" material.

For constructions such as "floating roads" (a strategy used when building upon weak ground, such as when adding wind farm access roads over peat-thick land in the UK) or anywhere in which a reinforcement grid alone will not prevent soft soils from migrating, this composite reinforcement strategy is attractive. It takes materials that historically were both used in an installation and often separate by some fill and converts them into a single layer, thus decreasing the need for fill.

NAUE's Combigrid® and HUESKER's products are notable additions to this composite material trend.

On the Waterfront, Out to Sea

Geotextiles are really extending influence in shoreline and immediate off shore installations. Geotextile sand containers are being used to create soft armor defense against wave-induced erosion. Though "soft," these bags are far from weak. They are extremely durable in both exposed and buried installations.

A long record of exemplary installations can be found in Australia, the United Kingdom, Germany, and the United States.

As noted earlier, Georg Heerten wrote about 25 years of projects with this product sector back in 1984.

But the feel of geotextile containers is newer today. Artificial surf reefs, extensive shoreline protection installations (walls, breakwaters, etc.), and scour protection strategies are growing. Geotextile containers are even being used in off shore wind farm constructions.

There, the geotextile containers are providing scour and erosion protection around the off shore turbine footings. They are even helping improve the construction of off shore monopiles by creating a stable base which the pile may be driven through.

Higher strength geotextiles are having a substantial and beneficial impact in challenging settings. Mirafi ® H2Ri, for example, has guarded against frost boil degradation of key energy access roads in Alaska. Photo by Tencate Geosynthetics.

Also of note in waterside constructions, geotextile tubes are playing a fantastic role in providing sustainable beach defense against hurricane erosion. Grand Isle, Louisiana, in fact, utilized more than 9,000-m-long installation of geotextile tubes (Tencate Geotube®).

In wastewater, geotextile tubes are being used to separate solids and sludge. For wastewater treatment plants (WWTPs), aerations. Dried sludge from biosolids can generate 6,000 Btus. If separated out, WWTP biosolids involve many other energy-producing elements: grit, 4,000 Btus; screenings, 9,000 Btus; and grease, 16,000 Btus (which is more than gasoline). Considering that WWTP and related watermoving and treatment operations consume ~4% of US energy, and factoring in that up to 60% of a water utility's costs may be related to energy needs (depending on municipal size, state regulations, extensiveness of treatment, etc.), geotextiles may be part of a much more energy-efficient future.

The Federal Highway Administration's (FHWA) Geosynthetic Reinforced Soil – Integrated Bridge System (GRS-IBS) utilizes geotextiles to greatly shorten construction windows and equipment needs while significantly lowering construction costs for small bridges. Photo by FHWA.

While the construction of the products may be called a geotextile container or bag or tube, the end results are often the same: durability, strength, excellent filtration characteristics, erosion control, the ability to utilize local fill, increased sustainability, lower costs, etc.

Better Liners

Geosynthetic clay liners (GCLs)—another composite product that benefits immensely from geotextiles—are seeing revitalization through both bentonite modification that enhances the internal sealing performance of the geosynthetic and greater geotextile cover/carry layer performance. Much of the credit here is due to manufacturers working more closely with clients to determine more precise challenges to GCLs (e.g., specific slope angles, soil conditions, freeze-thaw cycles, roots); and the result is a rapidly expanding portfolio of GCL product options, all of which are achieving some pretty impressive performance results.

Needlepunch (nonwoven geotextile) technology in manufacturing and performance characteristic-enhancing coatings are big drivers in helping the GCL market unveil new innovations. And it is moving GCLs out of a basic capping system solution into an extremely broad range of longterm containment installations.

Companies playing an important role here include CETCO, GSE, Terrafix, Geofabrics Australasia and NAUE.

Geotextiles are being produced in significantly higher strengths, and the engineering principles that govern the basic functions to geotextiles enable faster construction, including in applications that traditionally were not geotextile applications.

The US Federal Highway Administration (FHWA), for example, has crystallized many years of research in the field utilization of geosynthetic-reinforced soil (GRS) in bridge construction. Targeted to smaller, single span bridges, such as those frequently needed by county engineers, the GRS-IBS (Integrated Bridge System) approach has been found to reduce construction costs by 25 – 30% (versus standard pile capped abutment on deep foundations). Up to 60% savings are actually achievable. One of the primary reasons for savings is the significantly shorter construction window—"days, not months," the FHWA notes. Also, this type of construction decreases the need for highly specialized construction equipment. And since deep foundations are not needed for piles, the land disturbance is greatly decreased. The construction footprint of the GRS-IBS approach is, thus, a great way to lower the carbon footprint of construction and overall impact construction has on the environment.

(A basic search for "GRS-IBS" online yields an enormous amount of practical information from FHWA, county engineers, video demonstrations, etc.)

In other strength-related trends that are building upon geotextiles' past and shaping their future use, a number of companies are marketing high-strength materials that reassert the engineering behind these materials.

Tensar markets a high-strength geotextile called Basetex™, which is being used in tensioned membrane designs, such as for load-transfer platforms with piled embankments.

Tencate's Mirafi ® H2RSi series exemplifies not only the traditional expansion in functions that geotextiles have been part of but the future in which geotextiles can in many respects perform these functions solely: confinement, reinforcement, drainage, filtration, and separation. Utilizing a special yarn to provide enhanced wicking through the plane of the geotextile and exhibiting a tensile modulus that surpasses many other "traditional" stabilization products, the material is being used in rail construction, roads, embankments on soft soils, MSE structures, voids bridging, and much more.

Polymer Group, Inc.'s geotextile-based geocellular confi nement product Defen-Cell® has been used not only by the military for protection against ballastics but in the civilian market (often as Typar® Geocell) for flood defense, load support, slope protection, secondary containment berms, and erosion and sediment control.

Typar Geosynthetics' geotextile-based geocell has been used for a diverse range of applications, from ballistics protection walls in military conflicts to flood control (seen here) to runoff filtration and sedimentation control. Photo by Typar Geosynthetics/Polymer Group, Inc. Greater Strength

HUESKER's Comtrac®, a high-quality, water-permeable woven for soil reinforcement was one of the world's first geosynthetic reinforcement products. Since it was first used in 1974, the product has proven itself on thousands of projects in a wide variety of applications, such as earthwork reinforcement or sludge lagoon capping. The geotextile features high tensile strength in conjunction with low strain, low creep, high resistance to microorganisms as well as chemical and physical action, and integral separating function. Because of its high strength, low-creep properties, Comtrac® can permanently accommodate high tensile forces even at low elongations.

THE TAKE AWAY

It is impossible to concisely tell the historical and current story of geotextiles. But they continue to be materials that demonstrate extraordinary utility and innovation. Fiber optics are being embedded in them to offer real-time monitoring of installations (e.g., levees in flood zones). Their increasing strengths are blurring the old lines in soil stabilization products. In short, they are doing what they have always done: making engineering and construction stronger and more economical; and providing better environmental performance.

Chris Kelsey is a frequent contributor to Land and Water. He is the editor of Geosynthetica, an online publication that documents geosynthetics and affi liated geotechnical materials and services. www.geosynthetica.net.

(Land and Water, March/April 2014, pp. 8-13, www.landandwater.com)

ΝΕΑ ΑΠΟ ΤΙΣ ΕΛΛΗΝΙΚΕΣ ΚΑΙ ΔΙΕΘΝΕΙΣ ΓΕΩΤΕΧΝΙΚΕΣ ΕΝΩΣΕΙΣ

International Association for Engineering Geology and the Environment

IAEG would like to inform that we have just published in the section of Education and Training of our website (http://www.iaeg.info/index.php/courses/video-lectures), the first IAEG video-lecture. This is the first of a series of three, which have been realized by a professional video-company here in Torino. We have decided to put online as first the lecture delivered by Paul Marinos, because is one of the most well-known representative of the IAEG in the world and of Engineering Geology in general. The title of the lecture is "Rock Mass classification, an engineering geological assessment. Application and limitations".

Σημειώνεται ότι ο Καθηγητής Παύλος Μαρίνος είναι ο πρώτος video lecturer της IAEG.

ΠΡΟΣΕΧΕΙΣ ΕΚΔΗΛΩΣΕΙΣ ΓΕΩΤΕΧΝΙΚΟΥ ΕΝΔΙΑΦΕΡΟΝΤΟΣ ΣΤΗΝ ΕΛΛΑΔΑ

2nd EASTERN EUROPEAN TUNNELLING CONFERENCE

Tunnelling in a challenging environment

ATHENS 30 September - 3 October 2014 Royal Olympic Hotel. Athens, Greece

30 September - 3 October 2014, Athens, Greece
www.eetc2014athens.org

It is our pleasure to inform you that the Greek Tunnelling Society is organizing the 2nd Eastern European Tunnelling Conference in Athens on September 28 – October 1 2014 (EETC2014, Athens).

The Eastern European Tunnelling Conference is a biennial regional traveling conference. It aims to promote the sharing of knowledge, experience, skills, ideas and achievements in the design, financing and contracting, construction, operation and maintenance of tunnels and other underground facilities among the countries of Eastern Europe, on an organized basis and with agreed aims. EETC2014 aims mainly to bring together colleagues from Eastern Europe but people from the rest of the world are also welcome.

The theme of EETC2014 Athens is:

"Tunnelling in a Challenging Environment"
Making tunnelling business in difficult times

The construction of underground projects is becoming increasingly demanding as new challenges are emerging in every aspect and sector of this multidisciplinary and multivarious business. Further to the usual geological, geotechnical, structural and operational challenges, we are now facing a difficult business and financial environment, which requires the deployment of even more intelligent and effective tools and solutions.

I really do hope that the EETC2014 Athens will contribute and further facilitate the growth of the tunnelling business and will be a forum for scientific and professional collaboration.

TOPICS:

- Innovative methods for Analysis and Design
- Tunnelling in difficult ground conditions
- Conventional urban or shallow tunnelling
- Mechanized tunnelling
- Hydraulic tunnels
- Underground complexes
- Caverns for Hydropower or Storage
- Pipe jacking and microtunnelling
- Innovations in tunnelling construction technology
- Tunnels and shafts for mining
- Rehabilitation and repair
- Safety and security in tunnels and tunnelling
- Contractual and financial issues
- Education and training
- Case histories
- Underground space use
- Tunnels and monuments

7° ΠΑΝΕΛΛΗΝΙΟ ΣΥΝΕΔΡΙΟ ΓΕΩΤΕΧΝΙΚΗΣ ΜΗΧΑΝΙΚΗΣ

5 – 7 Νοεμβρίου 2014, ΑΙΓΛΗ Ζαππείου, Αθήνα
http://www.7hcge2014.gr

Η Ελληνική Επιστημονική Εταιρεία Εδαφομηχανικής και Γεωτεχνικής Μηχανικής, στο πλαίσιο των δραστηριοτήτων της, διοργανώνει το 7ο Πανελλήνιο Συνέδριο Γεωτεχνικής Μηχανικής υπό την αιγίδα του Δήμου Αθηναίων και του Τεχνικού Επιμελητηρίου Ελλάδας. Στόχος του Συνεδρίου είναι να καταγράψει τις προόδους της γεωτεχνικής μηχανικής στην Ελλάδα του 21ου αιώνα όπως αντικατοπτρίζονται στα σημαντικά γεωτεχνικά αλλά και άλλα έργα (σιδηροδρομικά, οδοποιίας, λιμενικά, υδραυλικά, κτιριακά, περιβαλλοντικά) με σημαντικό γεωτεχνικό αντικείμενο, που έχουν μελετηθεί και κατασκευαστεί ή κατασκευάζονται, καθώς και στα αποτελέσματα της ερευνητικής δραστηριότητας των ελληνικών πολυτεχνείων και πολυτεχνικών σχολών. Επιδίωξη είναι οι εργασίες του Συνεδρίου να αναδείξουν πρωτότυπα στοιχεία συμβολής της γεωτεχνικής μηχανικής αλλά και να προβάλουν θεωρητικές και πειραματικές έρευνες σε εδαφικά, βραχώδη και ημιβραχώδη υλικά που βρήκαν ή μπορούν να βρουν εφαρμογή στην πράξη."

Θεματικές Ενότητες

1. Συμπεριφορά Εδαφών: Έρευνες Υπαίθρου και Εργαστηρίου
2. Συμπεριφορά Εδαφών: Προσομοιώματα
3. Επιφανειακές και Βαθειές Θεμελιώσεις
4. Αλληλεπίδραση Εδάφους - Κατασκευής
5. Πρανή - Κατολισθήσεις
6. Βαθειές Εκσκαφές - Αντιστηρίξεις
7. Σήραγγες
8. Βελτιώσεις Εδαφών
9. Φράγματα, Άοπλα Επιχώματα
10. Οπλισμένα Επιχώματα
11. Εφαρμογή Ευρωκωδίκων
12. Εφαρμογές Γεωσυνθετικών Υλικών
13. Εδαφοδυναμική / Τεχνική Σεισμολογία
14. Βραχομηχανική
15. Περιβαλλοντική Γεωτεχνική
16. Ενεργειακή Γεωτεχνική (energy geotechnics)
17. Πολιτιστική Κληρονομιά και Γεωτεχνική Μηχανική
18. Διδασκαλία και Μάθηση Γεωτεχνικής Μηχανικής

ΠΡΟΣΕΧΕΙΣ ΓΕΩΤΕΧΝΙΚΕΣ ΕΚΔΗΛΩΣΕΙΣ

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

The 6th International Conference on Unsaturated Soils UNSAT 2014, 02 - 04 July 2014, Sydney, Australia, Adrian Russell, a.russell@unsw.edu.au

2nd International Conference on Vulnerability and Risk Analysis and Management & 6th International Symposium on Uncertainty Modelling and Analysis - Mini-Symposium Simulation-Based Structural Vulnerability Assessment and Risk Quantification in Earthquake Engineering, 13-16 July 2014, Liverpool, United Kingdom, http://www.icvram2014.org

GeoHubei 2014 International Conference Sustainable Civil Infrastructures: Innovative Technologies and Materials, July 20-22, 2014, Hubei, China http://geohubei2014.geoconf.org

ICITG 2014 Second International Conference on Information Technology in Geo-Engineering, 21-22 July 2014, Durham, UK, www.icitg.dur.ac.uk

Second European Conference on Earthquake Engineering and Seismology, 24-29 August 2014, Istanbul, Turkey www.2eceesistanbul.org

TC204 ISSMGE International Symposium on "Geotechnical Aspects of Underground Construction in Soft Ground" - IS-Seoul 2014, 25-27 August 2014, Seoul, Korea, csyoo@skku.edu

ACESD 2014 International Conference on Advances in Civil Engineering for Sustainable Development, 27-29 August 2014, Nakhon Ratchasima, Thailand, http://acesd.sut.ac.th/index.php?acesd=9c847ec878ac085f8c0c829a241d5a35

International Symposium on Geomechanics from Micro to Macro (TC105), 01 - 03 September 2014, Cambridge, United Kingdom, http://is-cambridge.eng.cam.ac.uk

International Conference on Industrial and Hazardous Waste Management "CRETE 2014", September 2nd – 5th, 2014, Chania, Crete, Greece, http://www.hwm-conferences.tuc.gr

Geosynthetics mining solutions 2014, September 8 – 11, 2014, Vancouver, Canada, http://www.geosyntheticssolutions.com

JUBILEE CONFERENCE 50th Anniversary of Danube-European Conferences on Geotechnical Engineering Geotechnics of Roads and Railways, 9 - 11 September 2014, Vienna, Austria, www.decge2014.at

IAEG XII CONGRESS Torino 2014 Engineering Geology for Society and Territory, IAEG 50th Anniversary, September 15-19, 2014, Torino, Italy, www.iaeg2014.com

10th International Conference on Geosynthetics – 10ICG, Berlin, Germany, 21 – 25 September 2014 www.10icg-berlin.com

14th International Conference of the International Association for Computer Methods and Advances in Geomechanics (14IACMAG), September 22 – 25, 2014, Kyoto, Japan, www.14iacmag.org

14th World Conference of the Associated Research Centers for the Urban Underground Space (ACUUS 2014), September 24-26, 2014, Seoul, Korea http://acuus2014.com

EETC 2014 ATHENS 2nd Eastern European Tunnelling Conference, 28 September - 1 October 2014, Athens, Greece, www.eetc2014athens.org

☙ ❧

30 September – 1 October 2014, London, UK

Ground Engineering (GE) is pleased to announce the 7th annual **Basements and Underground Structures Conference**, which will take place on the 30 September – 1 October 2014 in London. This leading industry event will provide you with technical updates, case histories from innovative projects and commercial discussions with key clients and contractors.

Whether you are designing residential basements, delivering complex infrastructure projects or procuring a new commercial development, this is an essential event for you in 2014.

Pre-conference Temporary Works Seminar "**Using temporary works to ensure the safe and efficient delivery of underground projects**", 30 September 2014, London.

Contact Will Fowler on 0203.033.4273 or email geevents@emap.com

☙ ❧

5th International Forum on Opto-electronic Sensor-based Monitoring in Geo-engineering (5th OSMG-2014), Oct 12-14, 2014, Nanjing, China, http://www.osmg2014.com

International Congress Tunnels and Underground Space risks & opportunities, 13-15 October 2014, Lyon, France, www.congres.aftes.asso.fr/en/content/invitation

ARMS 8 - 8th ISRM Rock Mechanics Symposium, 14-16 October 2014, Sapporo, Japan www.rocknet-japan.org/ARMS8/index.htm

9th International Conference on Structural Analysis of Historic Constructions, 14 – 17 October 2014, Mexico City, Mexico, www.linkedin.com/groups/SAHC-2014-Mexico-City-3930057.S.213150607

6th International Conference on Protection of Structures Against Hazards, 16-17 October 2014, Tianjin, China, http://cipremier.com/page.php?764

2nd International Conference Innovations on Bridges and Soil - Bridge Interaction IBSBI 2014, Athens, 16 - 18 October, 2014, http://ibsbi2014.ntua.gr

1st International Conference on Volcanic Landscapes (VOLAND 2014), 16 - 18 October 2014, Santorini Island, Greece, voland@heliotopos.net

1st International Conference on Discrete Fracture Network Engineering, October 19 - 22, 2014, Vancouver, British Columbia, Canada, www.dfne2014.ca

12th International Conference Underground Infrastructure of Urban Areas, 22-23th October 2014, Wroclaw, Poland, http://www.uiua2011.pwr.wroc.pl

☙ ❧

AusRock 2014
3rd Australasian Ground Control in Mining Conference - an ISRM Specialized Conference
5 – 6 November 2014, Sydney, Australia

Contact Person: Sienna Deano
Telephone: +61 3 9658 6126
E-mail: sdeano@usimm.com.au

☙ ❧

3rd ISRM International Young Scholars' Symposium on Rock mechanics - an ISRM Specialized Conference
8 – 11 November 2014, Xi'an, China

Contact

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☙ ❧

7th International Congress on Environmental Geotechnics, 10-14 November 2014, Melbourne, Australia, www.7iceg2014.com

GEOMATE 2014 Fourth International Conference on Geotechnique, Construction Materials + Environment, 19 - 21 Nov. 2014, Brisbane, Australia, www.geomate.org

International Symposium "Geohazards" Science, Engineering & Management, 20-21 November 2014, Kathmandu, Nepal, www.ngeotechs.org/ngs/index.php/geohazards-2014

7th International Conference on Scour and Erosion (ICSE-7), 2nd – 4th December 2014, Perth, Western Australia, http://www.2014icse.com

Third Australasian Ground Control in Mining Conference 2014, Sydney, Australia, www.mining.unsw.edu.au/node/608

Proceedings of the Institution of Civil Engineers, Geotechnical Engineering, THEMED ISSUE 2015, Construction processes and installation effects, Editors: Benoît Jones, University of Warwick, UK and Stuart Haigh, University of Cambridge, UK, sarah.walker@ice.org.uk

IGS Chennai 2015 6th International Geotechnical Symposium on Disaster Mitigation in Special Geoenvironmental Conditions, January 21-23, 2015, IIT Mandras, Chennai, India, http://igschennai.in/6igschennai2015

Geosynthetics 2015, February 15 – 18, 2015, Portland, Oregon, USA, http://geosyntheticsconference.com

12th Australia New Zealand Conference on Geomechanics (ANZ 2015), 22-25 February 2015, Wellington, New Zealand, http://www.anz2015.com

16th African Regional Conference on Soil Mechanics and Geotechnical Engineering, April 27 to 30, 2015 in Hammamet, Tunisia, http://www.cramsg2015.org

ISP7-PRESSIO2015 27 to 30 April 2015, Hammamet, Tunisia, http://www.cramsg2015.org/isp7-pressio2015

13th ISRM International Congress on Rock Mechanics Innovations in Applied and Theoretical Rock Mechanics 10–13 May 2015, Montreal, Canada, www.isrm2015.com

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Shale and Rock Mechanics as Applied to Slopes, Tunnels, Mines and Hydrocarbon Extraction
Special One day Symposium
May 12, 2015, Montreal, Quebec, Canada
http://www.isrm2015.com/Page/PageContent/ShaleSymposium

Four 2-hours sessions. Each session will open with two keynote speakers followed by paper presentations. Themes are:

- Hydrocarbon Extraction
- Slopes
- Tunnels/Mines
- End of day debate: Shale is a Soft Rock - Not a Hard Soil.

Keynote Speakers and Debaters whose visions you will want to hear and discuss per topic:

HYDROCARBON Senior Keynote: Mark Zoback, Professor, Stanford University

EXTRACTION Junior Keynote: Maria-Aikaterini Nikolinakou, University of Texas

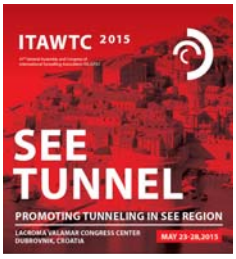
SLOPES Senior Keynote: Doug Stead, Professor, Simon Fraser University, Junior Keynote: Dave Scarpato, Haley & Aldrich, Inc.

TUNNELS AND MINES Senior Keynote: Derek Martin, Professor, University of Alberta, Junior Keynote: Michael Murphy, NIOSH/Office of Mine Safety and Health Research

DEBATE: Shale is a Soft Rock - Not a Hard Soil. The debate will open with formal arguments by the debaters and will be followed by a town hall discussion. Debaters:

Priscilla Nelson, Professor, Colorado School of Mines, Maurice Dusseault, Professor, University of Waterloo, Derek Elsworth, Professor, Pennsylvania State University, Jean-Claude Roegiers, Professor, University of Oklahoma

For further information on the Shale Symposium please contact: Herbert Einstein e-mail: einstein@mit.edu.



World Tunnel Congress 2015
and 41st ITA General Assembly
Promoting Tunnelling in South East European (SEE) Region
22 - 28 May 2015, Dubrovnik, Croatia
http://wtc15.com

Contact
ITA Croatia - Croatian Association for Tunnels and Underground Structures
Davorin KOLIC, Society President
Trnjanska 140
HR-10 000 Zagreb
Croatia
info@itacroatia.eu

83rd ICOLD Annual Meeting
June 2015, Stavanger, Norway

ISFOG 2015 3rd International Symposium on Frontiers in Offshore Geotechnics, Oslo, Norway, 10-12 June 2015, www.isfog2015.no

DMT 15 The 3rd International Conference on the Flat Dilatometer, Rome 15-17 June 2015, www.dmt15.com

ICGE 2015 International Conference in Geotechnical Engineering – Colombo-2015, 10 - 11 August 2015, Colombo, Colombo, Sri Lanka, http://www.slgs.lk/?p=564

16th European Conference on Soil Mechanics and Geotechnical Engineering "Geotechnical Engineering for Infrastructure and Development", 13 - 17 September 2015, Edinburgh, UK, www.xvi-ecsmge-2015.org.uk

Workshop on Volcanic Rocks & Soils, 24 - 25 September 2015, Isle of Ischia, Italy, www.associazionegeotecnica.it

EUROCK 2015
ISRM European Regional Symposium
64th Geomechanics Colloquy
7 – 9 October 2015, Salzburg, Austria

European Conference in Geo-Environment and Construction
GEO-ENVIRONMENT AND CONSTRUCTION

POLIS University, the Albanian Geotechnical Society and Co-PLAN are pleased to invite you to the European Conference on Geo-Environment and Construction. The conference aims to provide a comprehensive coverage of theoretical and practical insights regarding geotechnical engineering, environmental issues and construction. This initiative is supported by the International Society of Soil Mechanics and Geotechnical Engineering. Engineers, researchers and professionals from all over Europe are invited and encouraged to participate in this conference in order to submit written contributions and also to present their works.

TOPICS

The conference topics include all aspects of geo-environment and construction fields. The aim of the conference is to present achievements and on this respect, to evidence what have been the main challenges and to introduce what appropriate approaches can be used. Professional interaction and mutual experience interchange are important aspects of this event. Some of the main conference topics are:

Geotechnical Engineering and Environment

- Infrastructural geotechnical engineering
- Geotechnical engineering related to industrial areas, mining industry and power plants
- Environmental geotechnical engineering
- Irrigation system and environment
- Slope stability and their impact on environment

Construction

- Foundation engineering
- Soil mechanics
- Underground construction and deep excavations
- Impact of geotechnical phenomena in architectural design
- Geotechnical engineering of historical and cultural monuments
- New technologies in geotechnical engineering
- Seismic structural design
- Case studies
- Structural Aesthetic Design
- Coordination between academic and practice experience in construction

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6th International Conference on Earthquake Geotechnical Engineering, 2-4 November 2015, Christchurch, New Zealand, www.6icege.com

The 15th Asian Regional Conference on Soil Mechanics and Geotechnical Engineering, 9-13 November 2015, Fukuoka, Japan, http://www.15arc.org

15th Pan-American Conference on Soil Mechanics and Geotechnical Engineering, 15 - 18 November 2015, Buenos Aires, Argentina, http://conferencesba2015.com.ar

VIII South American Congress on Rocks Mechanics, 15 - 18 November 2015, Buenos Aires, Argentina, http://conferencesba2015.com.ar

Sixth International Conference on Deformation Characteristics of Geomaterials IS Buenos Aires 2015, November 15th to 18th 2015, www.saig.org.ar/ISDCG2015

2015 6th International Conference Recent Advances in Geotechnical Engineering and Soiul Dynamics, December 7-11, 2015, New Delhi (NCR), India, wason2009@gmail.com; wasonfeq@iitr.ernet.in, sharmamukat@gmail.com; mukutfeq@iitr.ernet.in, gvramanaiitdelhi@gmail.com, ajaycbri@gmail.com

3rd PanAmerican Regional Conference on Geosynthetics
11-14 April 2016, Miami South Beach, USA
NAGSDirector05@gmail.com

84th ICOLD Annual Meeting
May 2016, Johannesburg, South Africa

GEOSAFE: 1st International Symposium on Reducing Risks in Site Invertigation, Modelling and Construction for Rock Engineering - an ISRM Specialized Conference
25 – 27 May 2016, Xi'an, China

Contact

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Fax: 0086 27 87198413
E-mail: xtfeng@whrsm.ac.cn

NGM 2016 - The Nordic Geotechnical Meeting, 25 - 28 May 2016, Reykjavik, Iceland, www.ngm2016.com

3rd ICTG International Conference on Transportation Geotechnics
4 - 7 September 2016, Guimaraes, Portugal

The Transportation Geotechnics International Conference series began under the auspices of ISSMGE-TC 3 and was initiated in 2008 at the University of Nottingham, UK, as an International event designed to address the growing requirements of infrastructure for societies. The 2nd International Conference on Transportation Geotechnics took place in 2012, at Sapporo, Japan, under the ISSMGE-TC202 that follows the TC-3 activities for the period 2009-2013. To continue the successful of these conferences and the output of ISSMGE-TC-202, the 3rd was scheduled for 2016, at Guimarães, Portugal. Following the previous one, the challenges addressed by this conference will include a better understanding of the interactions of geotechnics on roads, rails, airports, harbours and other ground transportation infrastructure with the goal of providing safe, economic, environmental, reliable and sustainable infrastructures. The 3rd ICTG will be composed of workshops and several types of sessions, as well as a technical exhibition, to better disseminations of findings and best practices. A special attention will be paid to the publication of all the peer review papers, some of them in specialised international journals. On behalf of the organizing committee I am honoured to invite you to the 3rd ICTG in the City of Guimarães, UNESCO World Heritage (September 4-7, 2016).

Contact person: Prof. A. Gomes Correia (Chair)
Address: University of Minho, School of Engineering, 4800-058, Guimarães, Portugal
Phone: +351253510200
Fax: +351253510217
E-mail: agc@civil.uminho.pt

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EuroGeo 6 – European Regional Conference on Geosynthetics
25 – 29 Sep 2016, Istanbul, Turkey
eguler@boun.edu.tr

☙ ❧

6th Asian Regional Conference on Geosynthetics
November 2016, New Delhi, India
uday@cbip.org

☙ ❧

11th International Conference on Geosynthetics (11ICG)
16 - 20 Sep 2018, Seoul South Korea
csyoo@skku.edu

Laser maps reveal slide risk with startling clarity, but few citizens know they exist

An aerial scanning technique called lidar produces images that strip away vegetation to expose the landforms below. Some counties use them to ID hazardous areas, but others don't.

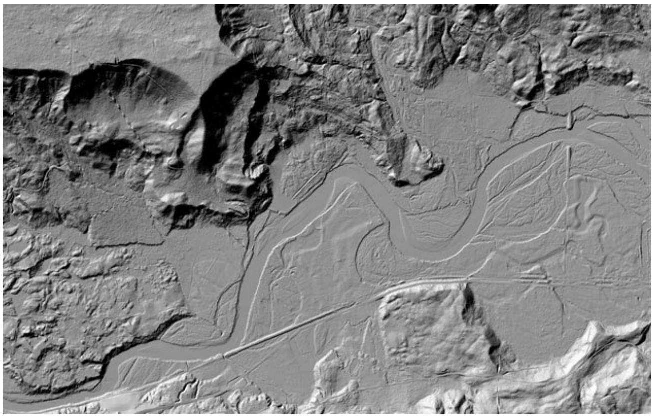
People who lived near the Snohomish County hillside that collapsed last week could see with their own eyes that it had slid before.

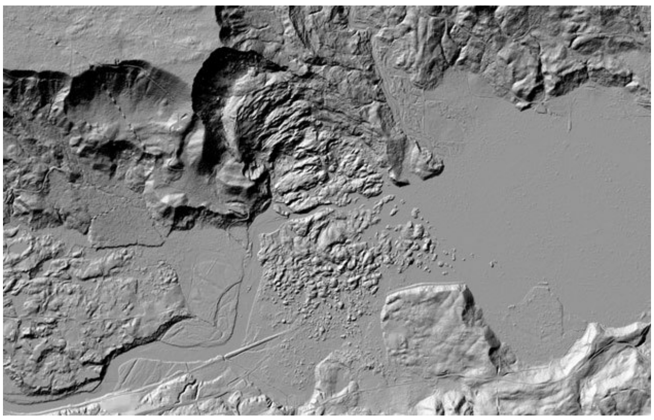
But it takes a more high-tech type of vision to fully grasp the danger along that stretch of the Stillaguamish River.

Maps created by an aerial scanning technique called lidar (lie-dar) reveal with stunning clarity a series of giant scars and piles of debris left by past landslides up and down the valley, including one more than twice as big as the monster that ripped loose Saturday.

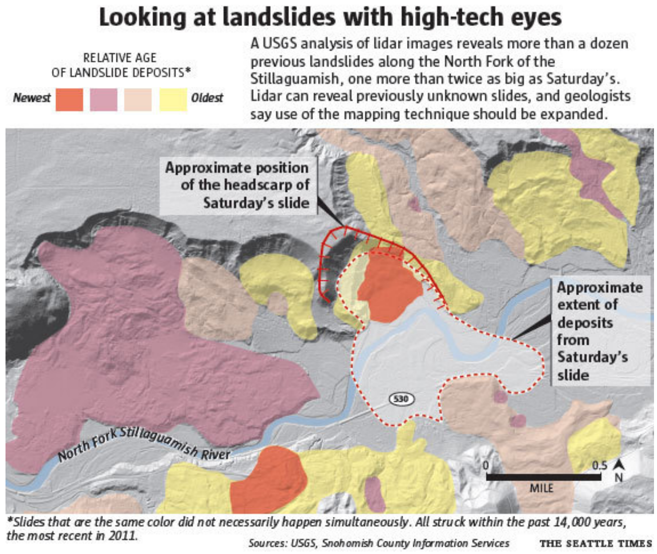
Lidar's ability to peer beneath the region's thick vegetation and lay bare the landscape has made it the go-to source on a wide range of geologic perils, from earthquake faults to flood zones.

But outside the circle of geologists, engineers and land-use experts, few people know the maps exist or how to access them. And though lidar can spot landslides that other surveys miss, counties are inconsistent in the way they incorporate the new information into their hazard planning.





BEFORE AND AFTER: Use the interactive tool above to compare lidar maps of the area before and after the slide.



"We've got all this great new data," said University of Washington geologist David Montgomery. "But if you don't have anybody to digest it and turn it into information that can get out to the public — it's just nice data."

Lidar mapping in Seattle in the early 2000s identified four times the number of landslide zones spotted with aerial surveys.

Several of the slides along the Stillaguamish that pop out in lidar images aren't included in the Washington Department of Natural Resources' (DNR) statewide landslide inventory, said Ralph Haugerud, a lidar expert with the U.S. Geological Survey. And while even some experts were shocked that Saturday's slide plowed across the river, the lidar images show that some of the old slides in the vicinity were clearly powerful enough to have run out even further.

"Lidar is like a new pair of glasses," Montgomery said. "If you can see more, if you have better data, you can better assess the true risks."

The technique has only been widely used in the Northwest for little more than a decade, said Craig Weaver, chief of the Seattle branch of the U.S. Geological Survey (USGS). He estimates nearly a quarter of the state has been mapped, including most of the Puget Sound basin.

To create a map, an airplane equipped with special lasers flies back and forth in a grid, firing up to 150,000 light pulses per second at the Earth. The system calculates how long it takes the pulses to bounce back to the plane, and assembles a topographic profile.

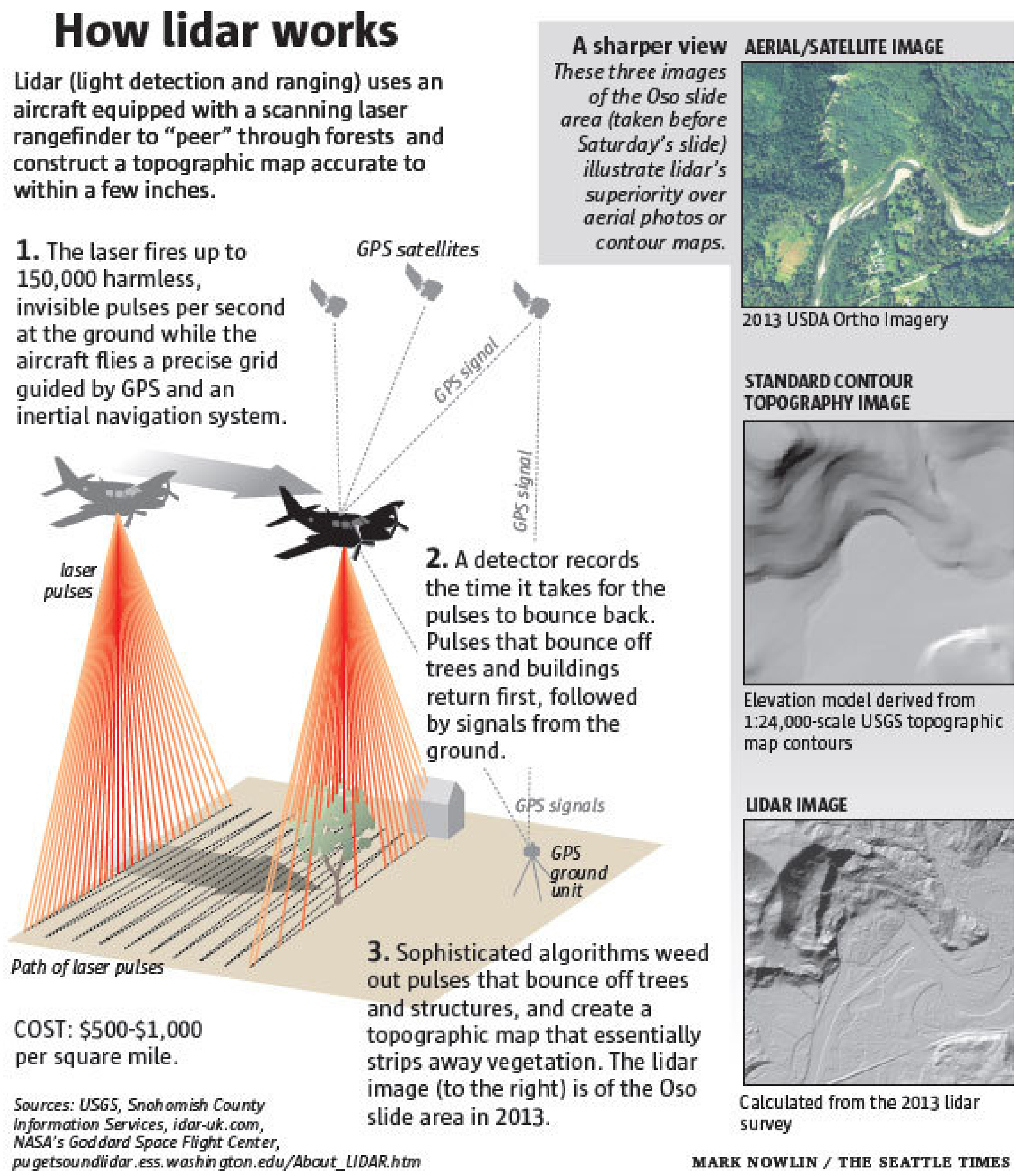
Only about one in seven pulses actually hit the ground, Haugerud explained. The rest bounce off trees, bushes and buildings. A computer program discards those errant signals, essentially erasing the vegetation and generating an image of the bare landscape.

Topographic maps generated by lidar are accurate to within a few inches.

That's far better than traditional contour mapping based on aerial photography. "In heavily forested landscapes you have no idea what the ground surface looks like in detail," Haugerud said. "So all of our topographic maps are kind of fuzzy."

In contrast, lidar images are so crisp features seem to pop off the page.

The first lidar survey in Washington was conducted on Bainbridge Island for land-use planning. But when USGS



scientists got a look at the map, they realized that an odd line cutting across the island was actually a previously hidden earthquake fault.

Since then, the USGS has used the method to identify more than a dozen major faults in the Puget Sound region.

But extending the method to analysis of landslide risk has progressed more slowly.

DNR's inventory was compiled without lidar data, Haugerud said. Most counties rely on lidar to some extent when they review building-permit applications, but few have the resources to analyze the data in detail.

"I hope a lot of counties take a good, hard look at their landscape hazard zones after this," said Dan McShane, an engineering geologist in Bellingham, who blogs at Reading the Washington Landscape.

Seattle was one of the first cities to use lidar for landslide mapping. Initially, there was concern that releasing the information to the public would harm property values and slow development, said former state emergency management director Jim Mullen, who headed Seattle's emergency operations at the time.

"We put it out anyway," Mullen said. "The public needs to know these kinds of things ... and developers who are really smart want to know what the risks and hazards are so they can engineer around them."

King County uses lidar to identify flood-prone areas and slopes where landslides are likely. Some counties, including King and Jefferson, have online tools that allow anyone to zoom in lidar maps down to the parcel level, though the quality and resolution of the images varies.

Snohomish County also has a collection of lidar maps accessible online, including maps of the slide area from 2013.

But across much of the state, it's hard for an average person to find lidar maps or navigate the complex portals where the data is stored.

A group called the Puget Sound Lidar Consortium serves as a kind of clearinghouse for lidar maps and data. But the group operates on a shoestring budget and its website is designed for experts, not lay people.

"Lidar is a powerful tool, and it really needs to be disseminated better," McShane said. Ideally, anyone seeking a building permit or buying a house should be able to examine lidar images of the property for any hidden geologic hazards, he added.

Haugerud and other geologists would like to see a systematic, statewide lidar survey for landslides, followed by on-the-ground geologic studies to help determine how frequently slopes have slid in the past, and how likely they are to slide in the future.

Some of the ominous-looking landslides detected by lidar may be more than 12,000 years old and not much of a threat anymore, he explained. But other slides that predate historic records may still be active and dangerous.

"We would like to be able to look at any parcel and answer the question: What are the odds of being hit by a landslide in the next century?" Haugerud said.

But better landslide inventories and risk assessments won't make any difference unless policymakers act on them, Mullen said.

The landslide risks near Oso were well documented, even before the advent of lidar, yet construction was still allowed in harm's way.

"We need to look at all the tools we have that tell us what are risks are," Mullen said. "Then we need to have some community discussion ... about whether we are prepared to address them."

(Sandi Doughton / Seattle Times, March 27, 2014 - modified April 3, 2014, http://seattletimes.com/html/localnews/2023244512_mudslidelidarxml.html)

GEER Response to Washington Landslide

A team from the Geotechnical Extreme Events Reconnaissance (GEER) Association, supported by the National Science Foundation, is mobilizing to collect information on the effects of a landslide that occurred on March 22, 2014 on a steep slope above the North Fork of the Stillaguamish River adjacent to a rural residential community near Oso, Washington. GEER members and other geotechnical professionals are documenting the effects of the Washington landslide on the built and natural environments. Dr. Jeffrey Keaton, a principal engineering geologist at AMEC Americas and member of the GEER Steering Committee, along with Dr. Joseph Wartman, Associate Professor of Civil and Environmental Engineering at the University of Washington and GEER member, are coordinating the investigation of the geotechnical impacts of the landslide and resulting unchannelized debris flow. Advancing strategies for adapting to climate-triggered geotechnical processes requires that we understand what happened leading to the collapse of the slope so that communities and infrastructure systems can be designed for greater resiliency and enhanced public safety.

Also participating in the investigation are Mr. John de La Chapelle (Golder Associates), Dr. David Montgomery (University of Washington), Dr. Jean Benoît, (University of New Hampshire and GEER member), and Dr. Scott Anderson (Federal Highway Administration and GEER Steering Committee member). These geologists and engineers will benefit from work performed by the Washington State Department of Natural Resources (DNR), Washington State Department of Transportation (WSDOT), U.S. Geological Survey (USGS), U.S. Department of Agriculture – Forest Service, and others. GEER teams focus on documenting geotechnical effects of extreme events as part of a National Science Foundation (NSF) program to turn disaster into knowledge.

The March 22, 2014 Oso Landslide (also known as the Hazel Landslide and the Steelhead Haven Landslide) occurred on a valley slope with a history of intermittent landslide occurrence going back to the 1940s, with the previous landslide movement in 2006 that blocked the river but did not affect any homes. The Oso Landslide is one of many landslides that have occurred on slopes in the valley of the North Fork of the Stillaguamish River. The March 22, 2014 Oso Landslide became a rapidly moving, unchannelized debris flow that spread out as it travelled about ½ mile, damming the North Fork of the Stillaguamish River, destroying and carrying away about 50 homes, and burying about 1 mile of State Highway 530. By March 29, 2014, the confirmed death toll was 17, with another nine bodies found but not identified, and about 30 people still unaccounted for.

Precipitation in March leading up to the Oso Landslide was nearly twice the average amount. At 10:37:22 AM Pacific time on March 22, a seismograph in the Pacific Northwest Seismic Network about 11 km southwest of the landslide recorded vibrations for about 2-1/4 minutes generated as the landslide mobilized from a steep slope above a bend in the North Fork of the Stillaguamish River that separated the landslide from the rural residential community. The landslide dam blocked the river for approximately 24 hours, at which time it started breaching gradually, without releasing a major flood.

Extreme events engineering is an experience-driven field where immediately following the occurrence of an event (e.g., earthquake, tsunami, hurricane, landslide, or flood), perishable data that can be used to advance our understanding is systematically collected. Observations of actual events are particularly important in the field of geo-engineering, because it is difficult to replicate in the laboratory soil deposits built by nature over thousands of years and sediment-water slurries that include large boulders. Detailed mapping and surveying of damaged areas provides the data for well-documented case histories that drive the development of many of the design procedures used by engineers. Documenting and sharing the key lessons learned from major events around the world contributes significantly to advancing research and practice in engineering.

After the Oso Landslide field investigation is complete, observations and findings will be posted on the GEER website. Images from the various investigators also will be posted on the website and visible through Google Earth. Additional information is available on the GEER website at: http://www.geerassociation.org

(April 29, 2014, http://www.geosynthetica.net/geer-response-washington-landslide)

Geosynthetic Soil Makes for Superior Bridges

Engineers are using geosynthetic reinforced soils to ensure that bridges can retain consistent surface levels at the points where they connect to embankments.

A perennial problem for road engineering is the frequent disparity in surface levels which arises at the juncture between a bridge and the embankment to which it connects, caused by the bridge structure rising slightly higher as it exerts pressure upon the soil below its surface.

The “bump in the road” that this creates is more than just a minor annoyance for engineers and drivers. The surface level discrepancy between the bridge deck and the embankment can damage vehicles traversing the bridge and can create hazardous road conditions, which increases the likelihood of accidents.

The height disparity also makes the bridge junction far more difficult to lay asphalt upon or repair, and in places which experience severe cold weather can leave the bridge deck susceptible to damage from snow ploughs.

Engineers from the University of Wisconsin-Madison believe they have now found a solution to this problem through the use of geosynthetic materials to put the bridge and embankment on an even playing field.

UWM Civil and Environmental Engineering associate professor Dante Fratta proposes dispensing with the traditional method of supporting the bridge and road via separate structures, with the bridge deck propped up using rigid piles and embankments borne by compactable soil.

He advocates placing both the bridge and the embankment on a single support which is firmed up using geosynthetic reinforced soils (GRS), in order to ensure their surface levels are always consistent.

According to Fratta, the use of a single foundational support means that the bridge deck and the embankment will always remain at the same level, even in the case of deformation of the pavement.

Fratta and a team of engineering colleagues have already trialled the technique in the real world, testing it on a small bridge which traverses a creek on State Highway 40 to the south of Bloomer in Wisconsin’s Chippewa County.

The Wisconsin Department of Transportation (WisDOT) adopted Fratta’s approach during the construction of the bridge in the summer of 2012, creating a 36-metre long foundation to bear both the bridge deck and the roadway embankment simultaneously.

The location of the bridge makes it an outstanding test subject given that the frac sand mining boom in the west of the state has resulted in an increased amount of heavy vehicle traffic along the highway route.

WisDOT has monitored the bridge to assess its performance when subjected to the rigours of heavy cargo traffic, as well as whether the geosynthetic soil is capable of withstanding the erosion and scour which occurs on waterways and river banks.

Initial surveys have found that the Bloomer bridge is performing well, with the only glitch being the embankment rising above the bridge deck by around three centimetres in winter as a result of water penetrating the soil and freezing solid.

Fratta believes the problem can be easily remedied, however, by altering the composition of soils in the embankment, and using gravel instead of fine particles to reduce the incidence of swelling.

(Sourceable / 21 May 2014, http://sourceable.net/geosynthetic-soil-makes-for-superior-bridges, http://sourceable.net/geosynthetic-soil-makes-for-superior-bridges/#sthash.DP37DRxH.dpuf)

Decrepit Dams Could Spell Disaster in the US

Civil engineers in the United States warn that the poor condition of the nation’s ageing dams poses an increasing hazard to communities and physical assets located within their immediate downstream vicinities.

Lori Spragens, executive director of the Association of State Dam Safety Officials (ASDSO), said billions of dollars in spending is required in order to remedy the problem of the country’s hazardous dams.

Much of America's ageing dam infrastructure is in urgent need of replacement or upgrade.

According to Spragens, the cost of upgrading the country's high-hazard dams alone – defined as those whose failure has the potential to lead to loss of human life – could run as high as $18 billion. The bill for providing upgrades to all dams in country which require them would be a staggering $53.69 billion.

ASDSO estimates that during the eight-year period from January 1, 2005 to June 30, 2013 the US suffered from 173 failures, as well as a further 587 incidents which "would likely have resulted in dam failure" without timely intervention.

The failures include those of the Big Bay Lake Dam in Mississippi in 2004, which left approximately 100 homes either damaged or destroyed, and the Ka Loko Reservoir Dam in Hawaii in 2006, which resulted in the deaths of seven people as well as the destruction of state highways assets, houses and farms.

A study conducted in 2012 by the Center for American Progress found that in addition to causing an average of 94 deaths per annum, the shoddy state of US water infrastructure was costing the country approximately $7.2 billion in damages each year.

The study, entitled *Ensuring Public Safety by Investing in Our Nation's Critical Dams and Levees*, found that over 28,000 dams – equivalent to a third of the US total – were more than 50 years old, which is generally deemed to be the threshold of sound usage for such infrastructure. A further 14,000 dams were also categorised by the centre as "high-hazard."

States listed by the centre as having the the greatest number of "high-hazard dams in need of repair" included Georgia, Pennsylvania, Colorado, Ohio, North Carolina, Indiana, Mississippi, Massachusetts, New Mexico and New Jersey.

The problem of decrepit dams is just part of the broader dilemma of ageing and dilapidated US infrastructure, which was given an abysmal D grade by the American Society of Civil Engineers (ASCE) in its 2013 report card.

"The nation's dams are ageing and the number of high-hazard dams is on the rise," said the ASCE in its annual assessment.

The ASCE noted that as a result of population expansion and the growth of formerly rural communities, the threat to life and property posed by high hazard dams was becoming increasingly acute.

"Many of these dams were built as low-hazard dams protecting undeveloped agricultural land," the organisation said. "However, with an increasing population and greater development below dams, the overall number of high-hazard dams continues to increase."

(Marc Howe / Sourceable, 05 June 2014, http://sourceable.net/decrepit-dams-could-spell-disaster-in-the-us/#sthash.XQTkhkY6.dpuf)

Post Office rail tunnel turned into high-tech sensor lab

Installing underground infrastructure in cities could become cheaper and faster thanks to technology being tested in part of the old London Post Office railway.

Cambridge University engineers have turned a section of the capital's former underground delivery line into a "smart tunnel" laboratory for trialling a range of new sensors that measure disturbances coming from nearby construction works.

The tunnel runs very close to developments for the new Crossrail underground railway and the new technology will enable the researchers to study how existing infrastructure can move and come under strain from other construction.

An array of sensors is being used to monitor movement, acceleration, tilt, temperature and humidity in the tunnel.

Being able to better predict what impact a new tunnel would have could make the construction process much more efficient, said PhD student Mehdi Alhaddad, a researcher at the Cambridge Centre for Smart Infrastructure and Construction (CISC).

'When you design a tunnel, you're conservative because of all the unpredictable things you can't measure when you excavate,' he told *The Engineer*.

'But if you could measure how much the existing tunnels will move, how much the buildings on top will move with high level of confidence, then you could be more efficient in construction, you could be quicker, use less material, loosen the safety procedures and that would save huge amounts of money.'

The Post Office tunnel, which was used for 75 years to transport letters across London and a part of which is now due to be opened to the public, is just over 2.5m in diameter, while the Crossrail tunnel is 11m wide and the two are just 20cm apart in certain places.

The sensors have been designed to use minimal power so can be left in place for potentially years before the batteries run out.

Like most existing London Underground tunnels, the Post Office subway is made of cast iron, which can become brittle over time, and movement of just 1cm could cause it to crack, said Alhaddad.

The researchers say the four new sensors being trialled represent a lower cost monitoring system than existing technology.

Optical fibre installed along the length of the tunnel can show if it deforms or bends, while wireless displacement transducers measure displacement of one part of the tunnel relative to the next and transmit the data to a receiving station.

The Post Office railway tunnel is in places just 20cm from the new Crossrail tunnel works.

PhD student Heba Bevan used her experience working for microchip designers ARM to develop an electronics architecture and manufacturing techniques for an ultra low-power sensor that measure temperature, humidity, acceleration and tilt.

The 20g sensor's long lifetime makes it ideal for underground monitoring, said Bevan. 'It uses a 220 miliamp battery and has so far lasted 14 months. The current sensor is the size of a brick and uses a 19 amp battery that needs changing every two months.'

Part of its low-power operation is down to software that allows it to shut down much of its functionality until it detects movement, which it then records and transmits wirelessly – rather than constantly making and sending data.

Better monitoring of existing tunnels could help improve the design of new ones.

The final sensor uses photogrammetry, or computer vision, to visually detect movements as small as 0.1mm in the tunnel, using off-the-shelf digital camera equipment much cheaper than conventional technology, which can cost tens of thousands of pounds.

Instead of firing a laser between a number of prisms set along the tunnel to detect movement, the new sensor uses algorithms to calculate movement as captured in camera images. Its low cost also means it can be deployed in large numbers and collect data about more of the tunnel.

The trial has been underway for over a year and is due to carry on for at least six more months. Alhaddad said he couldn't yet reveal what the findings were but said the results were meaningful.

The sensors' low-cost means they can be deployed more widely than existing technology.

'This will change the way we look at tunnels when they are going to be affected by construction,' he said. 'I think it will change not only the design but also the monitoring.'

(Stephen Harris / theengineer, 12 June 2014, http://www.theengineer.co.uk/civil-and-structural/news/post-office-rail-tunnel-turned-into-high-tech-sensor-lab/1018746.article?cmpid=tenews_340424#video)

ΕΝΔΙΑΦΕΡΟΝΤΑ - ΣΕΙΣΜΟΙ

Earthquakes & Tsunamis: Causes & Information

Almost every year, a large earthquake occurs somewhere in the world and captures the public's attention. But it's not the only one—thousands of smaller tremors happen on a daily basis and often go unnoticed by most people. Although we usually consider the ground to be solid and stable, the earth is, in fact, constantly shifting under our feet.

What causes earthquakes?

Earth's crust ranges from 3 to 45 miles deep (5 to 70 kilometers), a thin shell. The crust is divided into several pieces, known as tectonic plates, that are constantly in motion, sliding past one another in regions known as faults or fault planes.

But the plates are jagged, not smooth. As they slide, pieces from one plate often snag on another. As the plates continue moving, they pull at the entangled sections until finally tearing them apart. Energy from this separation radiates outward in all directions, including towards the surface, where it is felt as an earthquake.

A large earthquake is often followed by aftershocks, smaller quakes that result from the crust adjusting to the main shock. These aftershocks can help scientists target the origin of the main quake, but can create problems for those suffering its aftermath.

In this photo taken by tourist Eric Skitzi from England, tourists watch as tsunami waves hit the shore from a safe place inside Casuarina Beach Hotel resort in Penang, northwestern Malaysia on Sunday, Dec. 26, 2004 as the greatest tsunami in recent history came ashore. The resort hotel lifeguards noticed waves were huge and sounded warning to all tourists around the hotel beach area to run to the safety area.

If the earthquake occurs in or near the ocean, it can push up powerful waves, known as tsunamis.

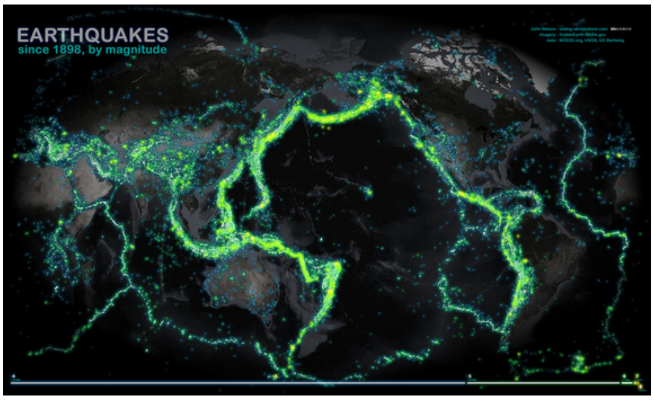
Measuring earthquakes

An earthquake's size, or magnitude, depends on how large its parent fault is and how much it has slipped. Because these faults are several miles deep, geologists can't simply visit the source to calculate these numbers. Instead, they rely on a tool known as a seismograph, which measures how much the earth moves over the course of a quake.

An earthquake's magnitude is ranked on a scale. Earthquakes with magnitudes less than 3 occur daily, and are generally not felt by people at the surface, though millions occur annually. A magnitude of 3 to 5 is considered minor, while a quake with a magnitude of 5 to 7 is moderate to strong. At the higher end, these quakes can be destructive to cities. Earthquakes from 7 to 8 are major; about fifteen of these occur annually. Every year, at least one earthquake with a magnitude over 8 – a "great" quake – wrecks havoc. An earthquake with a magnitude of 10 has never been measured, but it would create widespread devastation.

By using the readings from at least three seismographs, geologists can triangulate the origin of the earthquake. At the fault, that origin is called the hypocenter; on the surface, the epicenter.

Although minor earthquakes occur around the world, most of the major ones are centered on well-known fault lines. Californians, for instance, are unlikely to be shocked if they feel the ground shuddering beneath their feet. But a map released by the United States Geological Survey in 2011 reveals that 39 out of the 50 states have a moderate to high seismic hazard risk. Many of these are due to the 'New Madrid' fault in the center of the country, which runs from St. Louis to Memphis.



More than 100 years of earthquakes glow on a world map.

Preparing for disaster

Scientists have not yet come up with a way to forecast earthquakes. Although animals are reputed to have a sixth sense when it comes to these vibrations, there has been no research to confirm it, much less determine how such predictions might occur.

However, there are some basic things that can be done to prepare for an earthquake. The Federal Emergency Management Agency recommends that all families everywhere should have an emergency kit in their home and car, and communicate with your loved ones a plan for any type of disaster (not just for earthquakes). Such preparation can make a difference not only physically but emotionally.

If you live in known earthquake territory, make sure your shelves are firmly attached to the walls, with heavy objects on lower shelves. Keep heavy hanging objects away from beds and sitting areas, and brace overhead lighting fixtures. Locate a safe place in each room, under a sturdy desk or table, where you can seek refuge from falling objects. Reinforced doorways can be a safe shelter, but most indoor doorways are not strong enough; a sturdy desk is likely to provide more protection.

If you are outside, get into an open area, away from structures or bridges. According to FEMA, many deaths in the

1933 Long Beach earthquake occurred when people ran outside, only to be crushed by falling debris from collapsing structures. Remember that the shaking ground rarely causes injury or death; instead, it is the falling objects that result from the quake. If you are in a car, stop as soon as you are able, but stay inside the car. If you are at or near the beach, move quickly inland to avoid potential waves from tsunamis.

After an earthquake, proceed with caution. Remember that most earthquakes are generally followed by aftershocks. Keep an eye (and a nose) out for gas leaks. If you were inside during the quake, move outside. Listen for public service announcements; a battery-powered radio is ideal for your emergency kit.

Famous quakes

1811-1812 — Missouri. In the early nineteenth century, a series of several earthquakes spread through the center of the United States. No seismographs existed at the time, so researchers used data to determine that the magnitudes of the quakes ranged between 7 and 8. The ground rose and fell, and huge waves formed on the Mississippi, causing some portions of the river to appear to flow backwards.

1906 — San Francisco, California, Magnitude: 8. Approximately 3,000 people died from the earthquake and resulting fire. The fault line causing the quake was exposed at the surface, a rare occurrence.

Great San Francisco Fire and Earthquake - April 18, 1906

1923 — Tokyo, Japan, Magnitude: 8.25. One of the world's most destructive earthquakes, over 142,000 people died from collapsing buildings and the resulting firestorm. The quake also resulted in enormous waves.

1960 — Chile, Magnitude: 9.5. The largest earthquake in the world, the 1960 quake in Chile killed over 1,600 people, with many of the deaths resulting from tsunamis along the coast. Waves reached 38 feet (11.5 meters) and carried debris as far as two miles inland.

1970 — Peru, Magnitude: 7.9. Approximately 66,000 people died, many from collapsed buildings and the resulting avalanche.

2004 — Indonesia, Magnitude: 9.1. The third largest earthquake in the world in the last century killed over 227,000 people. The shaking of the ground resulted in powerful waves that ravaged 12 Asian countries.

2011 — Japan, Magnitude: 9.0. Over 20,000 people were killed when an earthquake in northern Japan triggered a giant tsunami. The shaking damaged several nuclear reactors, creating new problems to people in the midst of destruction.

(Nola Taylor Redd / licescience.com, July 09, 2012, http://www.livescience.com/21486-earthquakes-causes.html)

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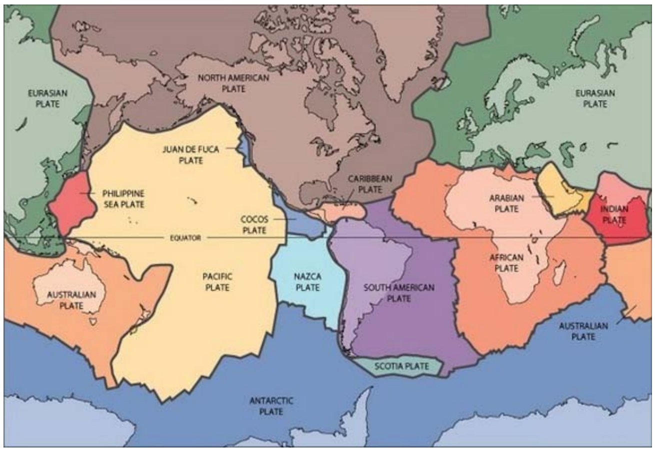
Buried 'Soda Fizz' May Solve Mystery of Coasting Tectonic Plates



Tectonic plates of the Earth.

The carbon dioxide that makes soft drinks fizz could help solve the mystery of why rocks melt the way they do beneath the seafloor, researchers say.

These findings could help explain the motion of the giant tectonic plates that surf over Earth's mantle (the rocky inner layer above the core). By understanding these movements, scientists can get a better picture of how the continents have drifted over time, as well as gain more insight into disasters such as earthquakes and volcanic eruptions.

Scientists think a layer of relatively soft, weak rock in Earth's upper mantle layer sits right underneath the planet's crust, or outer layer. This layer would help lubricate the motion of tectonic plates and explain how they can move as freely as researchers have observed.

A popular candidate for the source of this lubrication is a very small degree of melting of the upper mantle. Such melting would also explain the high electrical conductivity seen in the rock below the plates, as well as the low speed or velocities of seismic waves rippling through them.

However, this idea has run into trouble, because computer models had suggested a relatively large amount of molten rock was needed to explain the electrical properties and seismic velocities seen under the oceanic tectonic plates. Such large amounts of molten rock could escape from the surrounding rock, which is not what investigators have seen.

To help solve this mystery, researchers analyzed in the lab what happened if the kind of silicate rock found in the mantle was rich in both water and carbon dioxide, the basic ingredients of soda water. Surface rock that is rich in water and carbon dioxide gets driven into the mantle at the borders of tectonic plates.In lab experiments, the investigators subjected this "juice, a molten mixture of carbon dioxide, water and silicate," to the kinds of high pressures and high temperatures found in the mantle, said study author Fabrice Gaillard, a geoscientist at the University of Orleans in France.

The scientists found this melted rock was highly electrically conductive. Their computer models suggest that very small amounts of such molten rock — making up less than 0.5 percent of the mantle's volume — could explain both the electrical properties and seismic velocities seen under oceanic plates.

"Such a small amount of melt could have a major impact on large-scale processes — a bit like David winning against Goliath," Gaillard told Live Science.

The scientists detail their findings in the May 1 issue of the journal Nature.

(Charles Q. Choi / livescience.com, April 30, 2014, http://www.livescience.com/45246-plate-tectonics-mystery-solfved.html)

Types of Faults

Faults are fractures in Earth's crust where rocks on either side of the crack have slid past each other.

Sometimes the cracks are tiny, as thin as hair, with barely noticeable movement between the rock layers. But faults can also be hundreds of miles long, such as the San Andreas Fault in California and the Anatolian Fault in Turkey, both of which are visible from space.

Fault lines are usually much thinner than their length or depth. Earthquakes that occur on faults are generally about 375 miles (600 kilometers) deep. Below that, rocks are probably too warm for faults to generate enough friction to create earthquakes.

Three types of faults

There are three kinds of faults: strike-slip, normal and reverse faults. Each type is the outcome of different forces pushing or pulling on the crust, causing rocks to slide up, down or past each other.

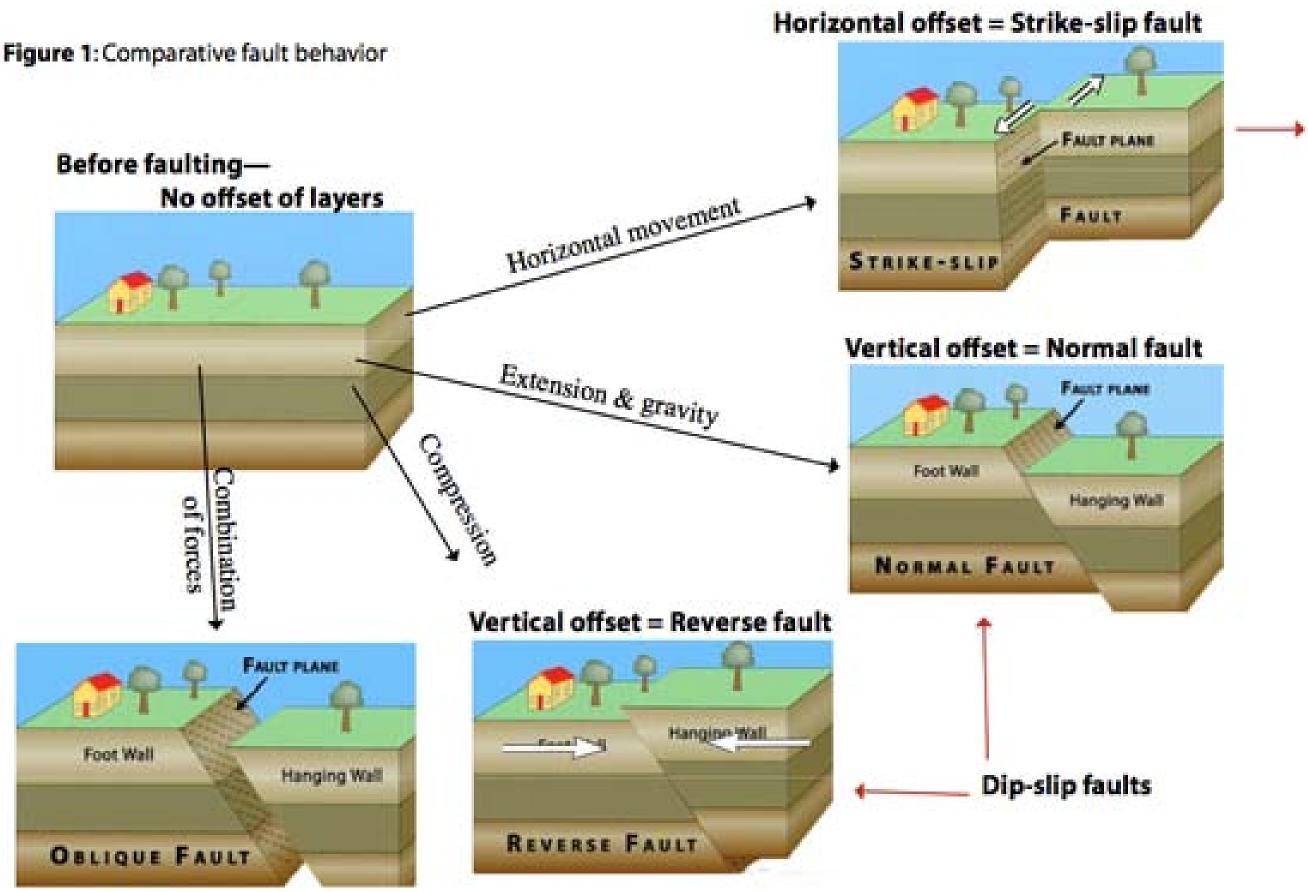
Strike-slip faults indicate rocks are sliding past each other, with little to no vertical movement. Both the San Andreas and Anatolian Faults are strike-slip.

Normal faults create space. Two blocks of crust pull apart, extending the crust. The Basin and Range Province in North America and the East African Rift Zone are two well-known regions where normal faults are spreading apart Earth's crust.

Reverse faults, also called thrust faults, squeeze the crust, pushing two blocks of crust on top of each other. These faults are commonly found in mountain ranges such as the Himalayas and the Rocky Mountains.

Strike-slip faults are usually vertical, while normal and reverse faults are often at an angle to the surface of the Earth. The different styles of faulting can also combine in a single earthquake, with one fault moving in a vertical and strike-slip motion.

(Becky Oskin / OurAmazingPlanet Staff Writer, May 31, 2013, http://www.livescience.com/37052-types-of-faults.html)



Faults are categorized into three general groups based on the sense of slip or movement.

New origin seen for Earth's tectonic plates

Continual diving of crust into mantle is sufficient to explain formation of plate boundaries.

The San Andreas fault in California marks the meeting of the Pacific and North American tectonic plates.

Earth's tectonic plates may have taken as long as 1 billion years to form, researchers report today in *Nature*[1].

The plates — interlocking slabs of crust that float on Earth's viscous upper mantle — were created by a process similar to the subduction seen today when one plate dives below another, the report says.

Starting roughly 4 billion years ago, cooler parts of Earth's crust were pulled downwards into the warmer upper mantle, damaging and weakening the surrounding crust. The process happened again and again, the authors say, until the weak areas formed plate boundaries. Other researchers have estimated that a global tectonic plate system emerged around 3 billion years ago.

The finding offers a possible answer to an enduring puzzle in geology: how Earth's tectonic plates emerged. The subsequent movement of the plates has erased much of the evidence of their origin, says Paul Tackley, a geophysicist at Swiss Federal Institute of Technology (ETH) in Zurich, Switzerland.

Prior studies suggested the age of the plates, based on evidence of subduction gathered from minerals preserved in ancient rocks. The oldest such specimens are 4-billion-year-old zircons found in the Jack Hills of Australia, which appear to have formed at temperatures and pressures that are indicative of subduction.

Grains of time

To go a step further and investigate how the plates formed, the study's authors developed a computer model of Earth's crust as it may have existed billions of years ago, on the basis of mineral grains found in mantle rock. The model included a low-pressure zone at the base of the crust, which caused a piece of the crust to sink into the upper mantle — mimicking conditions thought to have occurred early in Earth's history.

As the process repeated over time, it created a large tectonic plate with an active subduction zone. Over a much longer period, the same process could have created many tectonic plates, says co-author David Bercovici, a geophysicist at Yale University in New Haven, Connecticut. "We've got a physical mechanism to explain how it could have happened," he says.

This stands in contrast to conditions on Venus, where similar subduction occurs but has not produced tectonic plates. Conditions on Venus are much warmer, allowing the crust to better heal after a piece sinks down into the mantle. Bercovici's model suggests that early subduction created weak spots in Earth's crust that are now plate boundaries. Plate tectonics is defined by the idea that strong plates are separated by weak boundaries, and action at those boundaries creates geological phenomena such as volcanoes, mountains and earthquakes, he notes.

"They produce a model that plausibly explains what we see," says Michael Brown, a petrologist at the University of Maryland in College Park. It shows how to start subduction and how that could have progressed to global tectonics, and it provides an amount of time between the two — 1 billion years — that is consistent with the rock record, he adds.

Robert Stern, a geologist at the University of Texas in Dallas, contends that there is no firm evidence of plate tectonics earlier than 1 billion years ago, but says that their theory of the mechanism behind plate formation is "the first interesting example of how it might have occurred".

Nature, doi:10.1038/nature.2014.14993

References

Bercovici, D. & Yanick, R. *Nature* http://dx.doi.org/10.1038/nature13072 (2014).

(Jessica Morrison / nature, 06 April 2014, http://www.nature.com/news/new-origin-seen-for-earth-s-tectonic-plates-1.14993)

Big Earthquakes Come From Old, Strong Faults

A collapsed building after the Aug. 26, 1999 Izmit, Turkey earthquake.
Credit: USGS

When forecasting the much-feared "Big One" — the next devastatingly large earthquake — scientists should look to the oldest parts of a dangerous fault, researchers said here today (April 30) at the annual meeting of the Seismological Society of America.

To pinpoint the earthquake risk from big faults, the kind that slice across hundreds of miles of Earth's crust, researchers examined 2,000 years of historical earthquakes on Turkey's North Anatolian Fault Zone. The largest earthquakes struck on the older, eastern section of the North Anatolian Fault, said lead study author Marco Bohnhoff, a seismologist at the GFZ German Research Center for Geosciences in Potsdam.

Geoscientists, Bohnhoff said, have argued for a relationship between fault age and earthquake size for decades, but it has never been confirmed with historical records. The research team also looked at more recent instrumental records, from earthquake monitors called seismometers to geologic studies of sudden earth shifts during past quakes.

In the older, eastern portion of the fault, past earthquakes were no larger than magnitude 8.0, on average, the researchers found. The western, younger segments triggered quakes no larger than magnitude 7.4. (A magnitude-8.0 earthquake is eight times stronger than a magnitude-7.4 earthquake.)

Older faults are more likely to unleash larger earthquakes, because they are smoother and better organized than their younger counterparts, said U.S. Geological Survey geologist David Schwartz, who was not involved in the study. This smoothness helps a fault unzip farther during an earthquake, releasing more damaging energy. For example, young faults are rough and may have several branches, or interlinked fractures, which limit earthquake size. Over time, repeated earthquakes smooth these rough surfaces and link up the fractures into one primary fault.

The North Anatolian Fault was born about 12 million years ago, when the Eurasian and Anatolian tectonic plates started sliding past one another. Today, the 745-mile-long (1,200 km) fault is one of the biggest strike-slip faults in the world, similar in length to California's San Andreas Fault.

Turkey's largest city, Istanbul, lies at the younger, western end of the North Anatolian Fault. The findings suggest the seismic hazard for Istanbul probably does not exceed an earthquake greater than magnitude 7.4, Bohnhoff told Live Science's Our Amazing Planet. However, the city is still at significant risk from future earthquakes because of non-earthquake-resistant building construction, Bohnhoff said.

"This is one more piece in better understanding the earthquake machine," Bohnhoff said. "Understanding where we can expect shaking can help us to build more stable buildings."

(Becky Oskin, Senior Writer / LiveScience.com, April 30, 2014, http://www.livescience.com/45258-old-faults-cause-biggest-earthquakes.html)

Are scientists getting closer to predicting major earthquakes?

Looking at seismic activity that preceded last month's 8.2-magnitude earthquake in northern Chile, a pair of geologists says it might be possible to predict large quakes.

"Statistical models of interacting earthquakes suggest that big earthquakes are most likely to happen when regional earthquake activity is high," write Emily Brodsky and Thorne Lay in a research article published May 16 in Science. However, even though small earthquakes often precede large ones, they are not always followed by a bigger quake. The trick for scientists is figuring out when they're a sign of something worse to come.

"As far as different precursors being studied around the world, there's about a dozen of them," said David Nabhan, author of the 2013 book "Earthquake Prediction: Answers in Plain Sight." The methods under investigation include pyroelectric effect, which measures electrical signals generated by crystals deep in the Earth's core when they are put under immense pressure; looking at differences in conductivity along fault lines; changes in water level; monitoring geo-hydrochemical gases as they are vented; and studying high-energy proton bursts.

Brodsky and Lay's approach looks at recent seismic activity coupled with history of large-scale quakes in the area. Looking at the activity preceded the April 1 quake in northern Chile and a 2011 quake that hit Tohoku, Japan, they found that "combining the seismic signals with the tectonic context may provide a guide as to whether such sequences are foreshocks" preceding an imminent, major earthquake.

When a series of quakes happens in an area where the plate boundary is frictionally locked, as happened in Tohoku and northern Chile, they are likely a precursor to a larger quake. In northern Chile, nearly 2 weeks of moderate to large offshore quakes preceded the main quake. There had not been a massive quake in either northern Chile or Tohoku, Japan, in more than a century.

They compared these two cases to a series of quakes that hit Coquimbo, Chile, in 1997, an area of central Chile that had experienced a massive quake in 1943. That sequence did not end in a massive quake.

Brodsky and Lay indicate that this is evidence to support the theory that more pressure, due to locked plate boundaries, leads smaller sequences of quakes to foreshadow a massive quake. Areas that have recently experienced large quakes are less at risk. "With a relatively short time since the last large event, less strain should have built up," they wrote.

They do not claim to have the perfect formula, though, concluding that "whether earthquakes are predictable or not is still an open question, but perhaps there is now some cause for optimism."

The only way to determine if they are predictable, says Lay, is is to add more seismic-activity measuring devices offshore, where early-warning clues are most likely to be found. It's a massive investment, he says, adding that the article is a call for better instrumentation.

(Danielle Elliot / CBS NEWS**,** May 16, 2014, http://www.cbsnews.com/news/are-scientists-getting-closer-to-predicting-major-earthquakes)

Recognizing Foreshocks from the 1 April 2014 Chile Earthquake

Emily E. Brodsky, Thorne Lay

Are there measurable, distinctive precursors that can warn us in advance of the planet's largest earthquakes? Foreshocks have long been considered the most promising candidates for predicting earthquakes. At least half of large earthquakes have foreshocks, but these foreshocks are difficult or even impossible to distinguish from nonprecursory seismic activity. The foreshocks for the 1 April 2014 Chile event and other recent large earthquakes suggest that observable precursors may exist before large earthquakes.

Science 16 May 2014: Vol. 344 no. 6185 pp. 700-702, DOI: 10.1126/science.1255202

http://www.sciencemag.org/content/344/6185/700

Κεφαλονιά: Ο σεισμός του Ιανουαρίου «γέννησε» νέες παραλίες

Ο σεισμός των 5,8 Ρίχτερ του Ιανουαρίου δεν έφερε μόνο καταστροφές και πόνο για την Κεφαλονιά αλλά και «δημιουργία» νέων παραλιών**.**

Στο νότιο άκρο της χερσονήσου της Παλικής εκεί που πρώτα η θάλασσα έφθανε μέχρι το βράχο, σε ύψος όπως φαίνεται και από το σημάδι που έχει αφήσει

Σύμφωνα με μελέτη ερευνητικής ομάδας του Πανεπιστημίου Αθηνών με επικεφαλής τον αναπληρωτή καθηγητή Π. Παπαδόπουλο στην περιοχή της Παλικής, η γη σε ορισμένα σημεία έχει ανυψωθεί έως και κατά 20 εκατοστά δημιουργώντας παραλίες εκεί που δεν υπήρχαν.

Η πιο μεγάλη και εμφανής αλλαγή καταγράφηκ στη θέση Λιβάδι όπου εκεί που υπήρχε μια στενή παραλία, τώρα υπάρχει μια παραλία αρκετών μέτρων με κλίση. Η τεράστια αυτή επέκταση οφείλεται στο γεγονός ότι η θάλασσα εκεί ήταν πολύ ρηχή.

Η παραλία στο Λιβάδι πριν τον σεισμό

Η παραλία στο Λιβάδι μετά το σεισμό

Αντίστοιχα στον υδροβιότοπο που βρίσκεται στην πίσω πλευρά της παραλίας έχει ανέβει η στάθμη του νερού.

Η ομάδα του κ. Παπαδημητρίου, (ο επίκουρος καθηγητής Ι. Κασσάρας, οι μεταπτυχιακές φοιτήτριες Β. Μητροπούλου και Α. Λαγοπάτη, και ο προπτυχιακός φοιτητής Ν. Γαλανός) σάρωσε την περιοχή της Παλικής κουβαλώντας παντού ειδικό εξοπλισμό λαμβάνοντας μετρήσεις με σεισμογράφο κάθε δυο χιλιόμετρα για τον προσδιορισμό του μικροθορύβου.

Σύμφωνα με τα δεδομένα που συνέλεξαν, και φέρνει στη δημοσιότητα «Το ΒΗΜΑ», η εδαφική επιτάχυνση απο τη δόνηση ήταν διπλάσια της προβλεπόμενης στον αντισεισμικό κανονισμό για την τρίτη ζώνη στην οποία εντάσσεται η Κεφαλονιά.

«Σημειώνεται ότι οι καταγραφές επιταχυνσιογράφων στην Παλική (Ληξούρι, Χαβριάτα) παρουσίασαν αξιοσημείωτη υπέρβαση της ανώτατης τιμής (0,36 g) που προβλέπει ο Νέος Αντισεισμικός Κανονισμός (ΝΕΑΚ). Οι τιμές της επιτάχυνσης ήταν 0,6 g και 0,8 g στο Ληξούρι και στα Χαβριάτα αντίστοιχα.

Αντίστοιχη εικόνα είχαμε για τις βλάβες κατασκευών και τις εδαφικές αστοχίες (μακροσεισμικές παρατηρήσεις), όταν σε γειτονικές περιοχές η κατανομή των βλαβών ήταν ανομοιόμορφη, κάποιες περιοχές παρουσίασαν εκτεταμένες, άλλες λιγότερες και άλλες ελάχιστες βλάβες ή αστοχίες» σημειώνει ο κ. Παπαδόπουλος.

(02.06.2014, http://infognomonpolitics.blogspot.gr/2014/06/blog-post_3006.html?utm_source=feedburner&utm_medium=email&utm_campaign=Feed:+InfognomonPolitics+(InfognomonPolitics)#.U44CanJ_t6E)

Σεισμοί στο μεγαλύτερο κοίτασμα αερίου στην Ευρώπη

Αγρόκτημα 110 ετών, που υπέστη ζημιές από σεισμό στην ευρύτερη περιοχή του Χρόνινγκεν.

Κάτω από τα πράσινα λιβάδια της βορειοανατολικής Ολλανδίας βρίσκεται το κοίτασμα του Χρόνινγκεν, το μεγαλύτερο κοίτασμα φυσικού αερίου στην Ευρώπη, που παράγει ασταμάτητα από το 1959.

Καθώς το κοίτασμα γερνάει, η πίεση του αερίου μειώνεται και οι σεισμοί πληθαίνουν. Πάνω από 120 σεισμοί έγιναν πέρυσι και τουλάχιστον 40 μέχρι στιγμής φέτος. Οι σεισμοί δεν έχουν προξενήσει σοβαρούς τραυματισμούς ή θανάτους, αλλά έχουν προξενήσει σημαντικές ζημιές σε κτίρια, έχουν θέσει σε κίνδυνο τους γειτονικούς υδατοφράκτες και έχουν προξενήσει φόβο και οργή στους κατοίκους.

Λόγω των προβλημάτων, η ολλανδική κυβέρνηση ζήτησε από την κοινοπραξία της Shell και της Exxon Mobil, που εκμεταλλεύεται το κοίτασμα, να μειώσει την παραγωγή κατά 20% και να επανεπενδύσει μέρος των κερδών στην τοπική οικονομία. Πάνω από το κοίτασμα, που καταλαμβάνει έκταση 900 τετραγωνικών χιλιομέτρων, ζουν 150.000 άνθρωποι.

Η ολλανδική κυβέρνηση προσπαθεί να αποφύγει περαιτέρω μείωση της παραγωγής, καθώς το κοίτασμα συνεισφέρει 12 δισ. ευρώ τον χρόνο στον κρατικό προϋπολογισμό. Η Shell και η Exxon δεν ανακοινώνουν τα κέρδη τους από το Χρόνινγκεν, αλλά, σύμφωνα με εκτιμήσεις, τα κέρδη τους από το κοίτασμα ανέρχονται σε 1 δισ. ευρώ τον χρόνο.

Η άντληση αερίου στο Χρόνινγκεν γίνεται με συμβατικές μεθόδους, αλλά τα γεωλογικά προβλήματα της άντλησης προσφέρουν νέα επιχειρήματα εναντίον της υδραυλικής άντλησης αερίου από σχιστόλιθο, η οποία επίσης προξενεί σεισμούς.

Παρά τις κυβερνητικές ενέργειες, πολλοί κάτοικοι αμφιβάλλουν αν θα αλλάξει κάτι. Οι σεισμοί, που ξεκίνησαν στις αρχές της δεκαετίας του 1990, γίνονται προοδευτικά συχνότεροι και ισχυρότεροι. Τον Αύγουστο του 2012 η περιοχή πέρασε ένα «σεισμικό κατώφλι», με σεισμό 3,6 βαθμών της κλίμακας Ρίχτερ. «Τη στιγμή εκείνη, η περιοχή κατάλαβε τον πραγματικό κίνδυνο», είπε ο δήμαρχος του Λόπερσουμ, Αλμπερτ Ρόντενμπογκ.

Καθώς το αέριο φεύγει από τον πορώδη ασβεστόλιθο και ανεβαίνει στην επιφάνεια, το πέτρωμα συρρικνώνεται σαν πιεσμένο σφουγγάρι. Σε κάποιες περιοχές, το φαινόμενο αυτό έχει βυθίσει το έδαφος κατά 35 εκατοστά, υποχρεώνοντας την κοινοπραξία των Shell και Exxon να επενδύσει σημαντικά ποσά σε σταθμούς άντλησης υδάτων και άλλα συστήματα διαχείρισης.

Μετά τον σεισμό του 2012, το μετεωρολογικό ινστιτούτο της Ολλανδίας ανέβασε τις εκτιμήσεις για το ανώτατο πιθανό μέγεθος σεισμού στα 5 Ρίχτερ, δηλαδή 30 φορές πάνω από τις προηγούμενες εκτιμήσεις. Οι σεισμοί είναι επιφανειακοί, κάτι που τους κάνει πιο καταστροφικούς, ενώ το γεγονός ότι η περιοχή δεν ήταν σεισμογενής σημαίνει ότι δεν έχει αντισεισμικές κατασκευές.

Η Ντανιέλα Μπλάνκεν, γραμματέας τοπικής ένωσης κατοίκων, σημειώνει ότι η παραγωγή πρέπει να μειωθεί κατά 40% και να υπάρξει ανεξάρτητη επίβλεψη της κοινοπραξίας. «Ο κόσμος δεν θεωρεί την κοινοπραξία ως γείτονα αλλά ως εισβολέα», λέει η Μπλάνκεν.

Οι σεισμολόγοι εκτιμούν πως αν μειωθεί η άντληση αερίου στο επίκεντρο πιθανώς θα μειωθεί η σεισμικότητα, αλλά τονίζουν ότι αυτό είναι κάτι που θα φανεί συν τω χρόνω. Οι κάτοικοι τονίζουν ότι αυτό το τεστ δεν μπορεί να αποτύχει. «Εστω και ένας άνθρωπος να πεθάνει», τονίζει η Μπλάνκεν, «η περιοχή θα πάρει φωτιά».

(Η ΚΑΘΗΜΕΡΙΝΗ – Stanley Reed / THE NEW YORK TIMES, 06.06.2014, http://www.kathimerini.gr/770667/article/epikairothta/kosmos/seismoi-sto-megalytero-koitasma-aerioy-sthn-eyrwph)

ΕΝΔΙΑΦΕΡΟΝΤΑ - ΠΕΡΙΒΑΛΛΟΝ

ICE Case Study – Strata SE1

Post-tensioned slabs used to achieve greater flexibility, speed up construction and reduce CO2

Strata SE1 is a 147 metre high, 43-storey residential development which forms the focal point of the £1.5 billion, 170 acre regeneration of the Elephant and Castle area in central London. The innovative design of the structure creates a dramatic landmark on the London skyline and is the first building in the world to have three integral wind turbines, each nine metres in diameter, which are housed in the twenty metre section at the top of the tower. This 36,600m2 development comprises 408 apartments which have far-reaching views across the Capital. Post-tensioning specialist CCL was commissioned to undertake the specialist post-tensioning design, supply and installation.

Design Objective

The objective for the design provided by CCL was to create a flat soffit within minimal floor to floor heights whilst at the same time maintaining an optimal slab thickness. A 200mm thick floor slab was achievable for typical residential floor spans - 3000mm structural floor-to-floor height; 2500mm floor-to-ceiling height to living rooms and bedroom.

How post-tensioning was used

The use of post-tensioning on this project made it possible to achieve long spans with difficult plan geometry, to maintain a structural depth of typically 200mm on spans of up to nine metres. This slab depth would have proved impossible using traditional reinforced concrete construction methods. At the same time the post-tensioned slabs provided deflection and crack control for these spans across the tower.

In terms of value for money, the post-tensioned floors produced savings of at least 15 per cent of the costs of the superstructure materials alone and further cost reductions would have been achieved because of the rapid construction schedule CCL was able to realise (just over one floor per week) and the use of climbing screens and a formwork hoist.

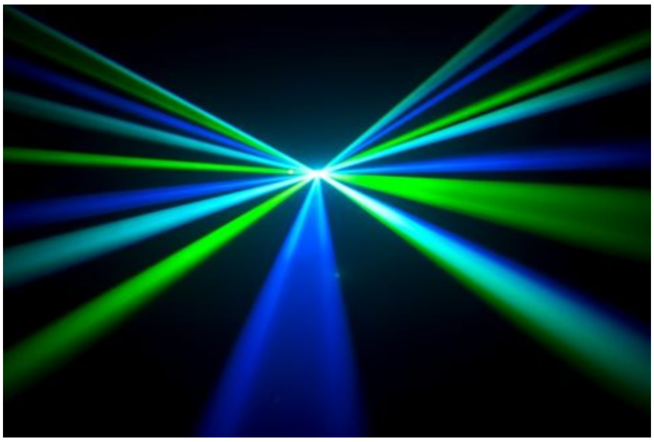
Minimal quantities of traditional reinforcement were required which in turn minimised the financial risk to the client over a long construction period in an uncertain market. Waste materials were kept to a minimum and all such items were recyclable.

Source of further information: www.cclint.com

Keywords: Strata, CCL, post-tensioning, post-tensioned slabs, long spans, flexibility, flat slab

ΕΝΔΙΑΦΕΡΟΝΤΑ - ΛΟΙΠΑ

Εν αρχή ην ο Αϊνστάιν
Έπειτα από αναζήτηση 80 ετών, μέθοδος για τη μετατροπή του φωτός σε ύλη



Από το φως εγένετο μάζα. Μέχρι σήμερα, κανείς δεν έχει αποδείξει πειραματικά τη θεωρία των Μπρέιτ και Ουίλερ για τη μετατροπή.

Η μάζα είναι ισοδύναμη της ενέργειας, προέβλεψε ο Αϊνστάιν. Βάσει αυτής της θεωρίας, οι θεωρητικοί φυσικοί πρότειναν αργότερα την ιδέα της μετατροπής του φωτός σε ύλη. Ογδόντα χρόνια μετά, ερευνητές στη Βρετανία και τη Γερμανία υποστηρίζουν ότι επινόησαν μια πειραματική διάταξη που θα αποδείξει για πρώτη φορά τη θεωρία.

Η ιδέα της ισοδυναμίας μάζας και ενέργειας, δηλαδή η ιδέα ότι η μάζα ενός αντικειμένου αποτελεί μέτρο του περιεχομένου του σε ενέργεια, συμπυκνώνεται στη διάσημη εξίσωση $E=mc^2$, η οποία διατυπώθηκε το 1905 από τον Άλμπερτ Άινσταιν στο πλαίσιο της Γενικής Σχετικότητας.

Λίγα χρόνια αργότερα, το 1934, οι φυσικοί Γκρέγκορι Μπρέιτ και Τζον Ουίλερ περιέγραψαν μια θεωρητική διαδικασία για τη μετατροπή του φωτός -μιας μορφής ενέργειας- σε ύλη, μια διαδικασία που θα αποτελούσε ορατή έκφραση της ισοδυναμίας του Άινσταιν.

Οι υπολογισμοί των Μπρέτ και Ουίλερ έδειχναν ότι ο απλούστερος τρόπος για τη μετατροπή του φωτός σε ύλη είναι οι συγκρούσεις ανάμεσα σε φωτόνια υψηλής ενέργειας, από τις οποίες θα προέκυπταν ζευγάρια ηλεκτρονίων και ποζιτρονίων (αντι-ηλεκτρονίων). Τα φωτόνια δεν έχουν μάζα, ενώ τα ηλεκτρόνια και τα ποζιτρόνια έχουν και επομένως θεωρούνται υλικά σωματίδια.

«Παρά το γεγονός ότι όλοι οι φυσικοί αποδέχονται τη θεωρία ως ορθή, οι ίδιοι οι Μπρέιτ και Ουίλερ δήλωναν ότι δεν περίμεναν ποτέ να τη δουν να αποδεικνύεται στο εργαστήριο. Σήμερα, σχεδόν 80 χρόνια μετά, αποδεικνύουμε ότι έκαναν λάθος» υπερηφανεύεται ο καθηγητής Στιβ Ρόουζ του Imperial College στο Λονδίνο.

Σε συνεργασία με ερευνητές του Ινστιτούτου Πυρηνικής Φυσικής Max Planck στη Γερμανία, η ομάδα του Ρόουζ περιγράφει τη νέα ιδέα στην επιθεώρηση Nature Photonics.

Η πειραματική διάταξη που φαντάστηκαν αποτελείται από δύο βασικά τμήματα, καθένα από τα οποία παράγει μια δέσμη φωτονίων με εξαιρετικά μικρό μήκος κύματος, μήκος κύματος που αντιστοιχεί στο φάσμα των ακτίνων γάμμα.

Στο πρώτο τμήμα της διάταξης, μια πολύ ισχυρή δέσμη λέιζερ επιταχύνει ηλεκτρόνια σχεδόν μέχρι την ταχύτητα του φωτός και τα αναγκάζει να συγκρουστούν με μια πλάκα από χρυσό, οπότε δημιουργείται η πρώτη δέσμη φωτονίων.

Στο δεύτερο τμήμα της διάταξης, η δέσμη φωτονίων παράγεται από μια δέσμη λέιζερ που βομβαρδίζει μια μικρή συσκευή από χρυσό που χρησιμοποιείται σε πειράματα πυρηνικής σύντηξης και ονομάζεται holhraum («άδειο δωμάτιο» στα γερμανικά).

Η δέσμη φωτονίων που παράγεται από το βομβαρδισμό του holhraum αναγκάζεται να συγκρουστεί με την πρώτη δέσμη φωτονίων, οπότε παράγονται ζεύγη ηλεκτρονίων και ποζιτρονίων τα οποία μπορούν να ανιχνευθούν με σχετική ευκολία.

Οι ερευνητές διαβεβαιώνουν ότι το πείραμα είναι «σχετικά εύκολο» να πραγματοποιηθεί με τις σημερινές τεχνολογίες. Και αυτό σημαίνει ότι τα επόμενα χρόνια ο Άινσταϊν και οι Μπρετ-Ουίλερ θα μπορούσαν να δικαιωθούν οριστικά.

Όπως μάλιστα υποστηρίζουν οι ερευνητές, η απόδειξη της θεωρίας Μπρετ-Ουίλερ θα έβαζε το τελευταίο κομμάτι σε ένα παζλ φυσικής που περιγράφει τους τρόπους με τους οποίους το φως αλληλεπιδρά με την ύλη.

Τα άλλα κομμάτια του παζλ, όπως η θεωρία του Άισταϊν για το φωτοηλεκτρικό φαινόμενο και η θεωρία του Πολ Ντιράκ για την αμοιβαία εξουδετέρωση των ηλεκτρονίων και ποζιτρονίων, προέκυψαν από μελέτες που τελικά βραβεύτηκαν με Νόμπελ.

(Βαγγέλης Πρατικάκης / Newsroom ΔΟΛ, 19 Μαϊ. 2014, http://news.in.gr/science-technology/article/?aid=1231320326)

Scientists discover how to turn light into matter after 80-year quest

Imperial physicists have discovered how to create matter from light - a feat thought impossible when the idea was first theorised 80 years ago.

In just one day over several cups of coffee in a tiny office in Imperial's Blackett Physics Laboratory, three physicists worked out a relatively simple way to physically prove a theory first devised by scientists Breit and Wheeler in 1934.

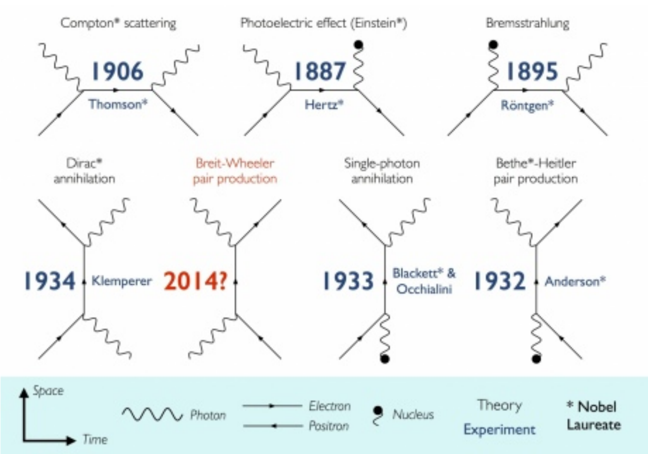
Breit and Wheeler suggested that it should be possible to turn light into matter by smashing together only two particles of light (photons), to create an electron and a positron – the simplest method of turning light into matter ever predicted. The calculation was found to be theoretically sound but Breit and Wheeler said that they never expected anybody to physically demonstrate their prediction. It has never been observed in the laboratory and past experiments to test it have required the addition of massive high-energy particles.

The new research, published in Nature Photonics, shows for the first time how Breit and Wheeler's theory could be proven in practice. This 'photon-photon collider', which would convert light directly into matter using technology that is already available, would be a new type of high-energy physics experiment. This experiment would recreate a process that was important in the first 100 seconds of the universe and that is also seen in gamma ray bursts, which are the biggest explosions in the universe and one of physics' greatest unsolved mysteries.

The scientists had been investigating unrelated problems in fusion energy when they realised what they were working on could be applied to the Breit-Wheeler theory. The breakthrough was achieved in collaboration with a fellow theoretical physicist from the Max Planck Institute for Nuclear Physics, who happened to be visiting Imperial.

Demonstrating the Breit-Wheeler theory would provide the final jigsaw piece of a physics puzzle which describes the simplest ways in which light and matter interact (see image). The six other pieces in that puzzle, including Dirac's 1930 theory on the annihilation of electrons and positrons and Einstein's 1905 theory on the photoelectric effect, are all associated with Nobel Prize-winning research (see image).

Professor Steve Rose from the Department of Physics at Imperial College London said: "Despite all physicists accepting the theory to be true, when Breit and Wheeler first proposed the theory, they said that they never expected it be shown in the laboratory. Today, nearly 80 years later, we prove them wrong. What was so surprising to us was the discovery of how we can create matter directly from light using the technology that we have today in the UK. As we are theorists we are now talking to others who can use our ideas to undertake this landmark experiment."



Theories describing light and matter interactions.
Credit: Oliver Pike, Imperial College London

The collider experiment that the scientists have proposed involves two key steps. First, the scientists would use an extremely powerful high-intensity laser to speed up electrons to just below the speed of light. They would then fire these electrons into a slab of gold to create a beam of photons a billion times more energetic than visible light.

The next stage of the experiment involves a tiny gold can called a hohlraum (German for 'empty room'). Scientists would fire a high-energy laser at the inner surface of this gold can, to create a thermal radiation field, generating light similar to the light emitted by stars.

They would then direct the photon beam from the first stage of the experiment through the centre of the can, causing the photons from the two sources to collide and form electrons and positrons. It would then be possible to detect the formation of the electrons and positrons when they exited the can.

Lead researcher Oliver Pike who is currently completing his PhD in plasma physics, said: "Although the theory is conceptually simple, it has been very difficult to verify experimentally. We were able to develop the idea for the collider very quickly, but the experimental design we propose can be carried out with relative ease and with existing technology. Within a few hours of looking for applications of hohlraums outside their traditional role in fusion energy research, we were astonished to find they provided the perfect conditions for creating a photon collider. The race to carry out and complete the experiment is on!"

The research was funded by the *Engineering and Physical Sciences Research Council (EPSRC)*, the John Adams Institute for Accelerator Science, and the Atomic Weapons Establishment (AWE), and was carried out in collaboration with Max-Planck-Institut für Kernphysik.

Reference: Pike, O, J. et al. 2014. 'A photon–photon collider in a vacuum hohlraum'. Nature Photonics, 18 May 2014.

(Gail Wilson / Imperial News, 19 May 2014, http://www3.imperial.ac.uk/newsandeventspggrp/imperialcollege/newssummary/news_16-5-2014-15-32-44)

A photon–photon collider in a vacuum hohlraum

O. J. Pike, F. Mackenroth, E. G. Hill & S. J. Rose

Nature Photonics (2014) doi:10.1038/nphoton.2014.95

The ability to create matter from light is amongst the most striking predictions of quantum electrodynamics. Experimental signatures of this have been reported in the scattering of ultra-relativistic electron beams with laser beams[1, 2], intense laser–plasma interactions[3] and laser-driven solid target scattering[4]. However, all such routes involve massive particles. The simplest mechanism by which pure light can be transformed into matter, Breit–Wheeler pair production ($\gamma\gamma' \rightarrow e^+e^-$)[5], has never been observed in the laboratory. Here, we present the design of a new class of photon–photon collider in which a gamma-ray beam is fired into the high-temperature radiation field of a laser-heated hohlraum. Matching experimental parameters to current-generation facilities, Monte Carlo simulations suggest that this scheme is capable of producing of the order of 10^5 Breit–Wheeler pairs in a single shot. This would provide the first realization of a pure photon–photon collider, representing the advent of a new type of high-energy physics experiment.

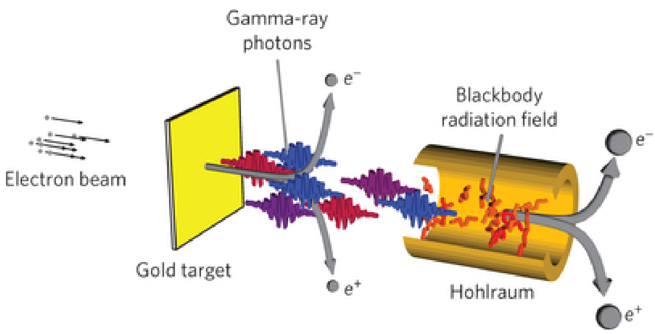


Figure 1: Schematic of the photon–photon collider.

Bremsstrahlung emission of ultra-relativistic electrons passing through a solid gold target is used to create a high-energy photon beam. This is fired into a vacuum hohlraum, where it interacts with a high-temperature thermal radiation…

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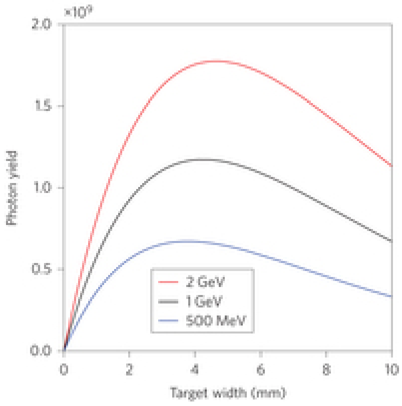


Figure 2: High-energy photons emitted from the back surface of the gold target.

Photons emitted above 100 MeV as a function of target width, for 1×10^9 incident electrons of energy 500 MeV (blue), 1 GeV (black) and 2 GeV (red).

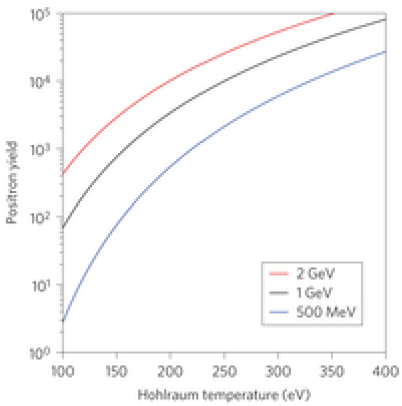


Figure 3: Positrons produced via photon–photon scattering in the hohlraum.

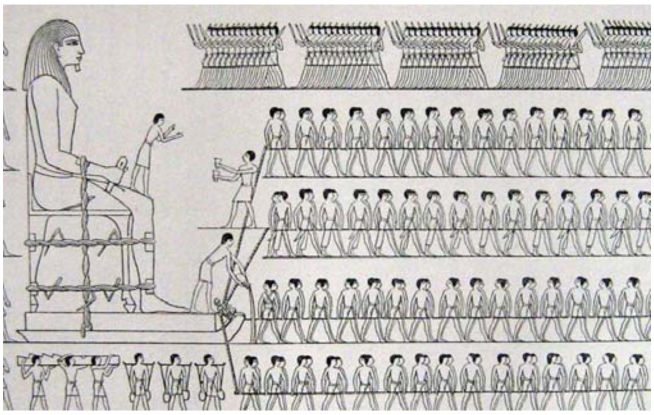
The 500 MeV (blue), 1 GeV (black) and 2 GeV (red) electron beams, each containing 1×10^9 particles, are coupled to high-energy photon beams through a gold target of optimal thickness. The yield scales linearly with hohlraum length, wh…

☙ ❧

Νέο σενάριο μεταφοράς υλικών για τις πυραμίδες

Ανθρωποι ή εξωγήινοι; Εργάτες ή σκλάβοι; Ράμπες ή γερανοί; Πλωτά μέσα ή έλκηθρα;

Εδώ και πολλές δεκαετίες, αρχαιολόγοι, μηχανικοί, αρχιτέκτονες και άλλοι ειδικοί παρουσιάζουν διαφορετικά και συνήθως αντικρουόμενα σενάρια σχετικά με το πώς χτίστηκαν οι πυραμίδες της Αιγύπτου. Μια νέα έρευνα όμως φυσικών επιστημόνων από το Πανεπιστήμιο του Αμστερνταμ και το ερευνητικό ινστιτούτο επιστήμης υλικών FOM Foundation, έρχεται να δώσει απάντηση σε ένα άλλο μυστήριο, όχι αυτό της κατασκευής των πυραμίδων, αλλά της μεταφοράς των ογκολίθων βάρους πολλών τόνων ο καθένας από τα γειτονικά λατομεία πάνω στην άμμο της ερήμου.



Σχηματική αποτύπωση της σκηνής μεταφοράς του αγάλματος του τοπικού ηγεμόνα Τζεχουτιχότεπ πάνω σε ξύλινο έλκηθρο.

Το μυστικό των Αιγυπτίων, σύμφωνα με τους Ολλανδούς επιστήμονες, κρύβεται στη βρεγμένη άμμο και συγκεκριμένα στην ιδανική εκείνη αναλογία νερού-άμμου που κάνει την επιφάνεια πιο συμπαγή και μειώνει έως και στο ήμισυ τη δύναμη που απαιτείται για να συρθεί πάνω σε αυτή ένα βαρύ αντικείμενο. «Αυτό το βλέπεις και με τα μάτια σου όταν περπατάς στην παραλία. Προτιμάς να πατάς στο βρεγμένο κομμάτι της άμμου, παρά στο στεγνό, γιατί αλλιώς κουράζεσαι πιο γρήγορα», λέει στην «Κ» ο καθηγητής Φυσικής στο Πανεπιστήμιο του Αμστερνταμ, Ντάνιελ Μπον, και επικεφαλής της ολλανδικής ερευνητικής ομάδας. Οπως δημοσίευσαν οι επιστήμονες στο τέλος Απριλίου στο επιστημονικό περιοδικό Physical Review Letters, η ιδανική αναλογία νερού στην άμμο της Αιγύπτου, η οποία μειώνει στο μισό την τριβή, και άρα τη δύναμη που απαιτείται για τη μετακίνηση του όγκου, είναι 5%.

Αρχαιολογικά ευρήματα και τοιχογραφίες των Αιγυπτίων καταδεικνύουν τη χρήση πλωτών αλλά και χερσαίων μέσων, όπως ξύλινα έλκηθρα, για τη μεταφορά ογκωδών αντικειμένων. «Το πείραμα των Ολλανδών επιστημόνων αναφέρεται σε χαλαρό αμμώδες έδαφος, που ενδέχεται να υπήρχε στην απόσταση μεταφοράς προς τον τελικό προορισμό των λίθων», λέει η Αννα Μιχαηλίδου, ομότιμη διευθύντρια Ερευνών στο Ινστιτούτο Ιστορικών Ερευνών του Εθνικού Ιδρύματος Ερευνών. Ενώ οι Αιγύπτιοι φαίνεται να χρησιμοποιούσαν επίσης ξύλινα καρούλια στις βαριές μεταφορές, η δρ Μιχαηλίδου επισημαίνει ότι το μεταφορικό μέσο του ελκήθρου παρουσίαζε συγκεκριμένα πλεονεκτήματα, αφού ενδείκνυται για μεγάλες αποστάσεις, προσφέρει καλύτερο έλεγχο στην κίνηση και το φορτίο είναι καλά στερεωμένο και περισσότερο προστατευμένο απέναντι στους κινδύνους μεταφοράς. «Οπως φαίνεται σε διάφορες τοιχογραφίες, η φόρτωση κιόνων και οβελίσκων στα ποταμόπλοια μεταφοράς στον Νείλο γινόταν συχνά μαζί με το έλκηθρο», προσθέτει η ίδια.

Οι μεταφορές όμως με έλκηθρα παρουσίαζαν και μειονεκτήματα. «Οταν σέρνεις ένα αντικείμενο πάνω σε στεγνή άμμο, μπροστά του δημιουργείται ένα χείλος άμμου. Η δύναμη λοιπόν που χρειάζεται να ασκήσεις για να το μετακινήσεις είναι πολύ μεγάλη, αφού τραβώντας το μετατοπίζεις μαζί και τη συσσωρευμένη άμμο», λέει ο δρ Μπον.

Το πείραμα

Για να υποστηρίξουν την υπόθεσή τους, ότι δηλαδή η τριβή μειώνεται όταν η άμμος πάνω στην οποία κινείται ένα αντικείμενο είναι ελαφρώς βρεγμένη, οι ερευνητές σχεδίασαν ένα πείραμα στο οποίο προσομοίωσαν την αναπαράσταση μιας αιγυπτιακής τοιχογραφίας του 1880 π.Χ. Στην τοιχογραφία αυτή παρουσιάζεται η μεταφορά του κολοσσιαίου αγάλματος του τοπικού ηγεμόνα Τζεχουτιχότεπ πάνω σε ξύλινο έλκηθρο, ενώ επίσης διακρίνεται ένας άνθρωπος που στέκεται στο μπροστινό μέρος του ελκήθρου και χύνει ένα υγρό.

Στο πείραμά τους, οι επιστήμονες τοποθέτησαν σε άμμο, η οποία μοιάζει με αυτή της Αιγύπτου, μία τραχιά επιφάνεια με ένα βάρος, και δοκίμασαν να σύρουν το αντικείμενο, μετρώντας κάθε φορά τη δύναμη που απαιτείται για τη μετακίνησή του πάνω σε στεγνή, λίγο ή πολύ βρεγμένη άμμο. Με έκπληξη οι ερευνητές διαπίστωσαν ότι όταν η άμμος περιέχει μόνο 5% νερό, η δύναμη που απαιτείται για να μετακινηθεί πάνω σε αυτή το αντικείμενο είναι η μισή σε σύγκριση με τη στεγνή άμμο. «Αυτό είχε ιδιαίτερα οφέλη για τους Αιγύπτιους, αφού χρειάζονταν μόνο τα μισά άτομα για να μεταφέρουν έναν ογκόλιθο», λέει ο δρ Μπον.

«Παρότι μας είναι γνωστό ότι όταν καταβρέχουμε το χώμα αυτό «κάθεται», η πρωτοτυπία σε αυτή την έρευνα έγκειται στο ότι βρέθηκε η ακριβής συγκέντρωση νερού που μπορεί να μειώσει πολύ τις τριβές», λέει ο κ. Δημήτρης Βλασσόπουλος, καθηγητής στο Τμήμα Επιστήμης και Τεχνολογίας Υλικών του Πανεπιστήμιο Κρήτης και στο Ιδρυμα Τεχνολογίας και Ερευνας. Η εξήγηση κρύβεται στη μικροσκοπική κλίμακα, στο επίπεδο δηλαδή των κόκκων. Οταν το νερό βρέχει τους κόκκους της άμμου, δημιουργεί έλξεις, δηλαδή γέφυρες μεταξύ τους, με αποτέλεσμα αυτοί να συγκρατούνται ενωμένοι και η επιφάνεια να σκληραίνει. Οταν όμως το νερό που προστεθεί υπερβεί τη σωστή αναλογία, τότε η άμμος γίνεται πάλι μαλακή, σαν λάσπη, με αποτέλεσμα το έλκηθρο να βουλιάζει.

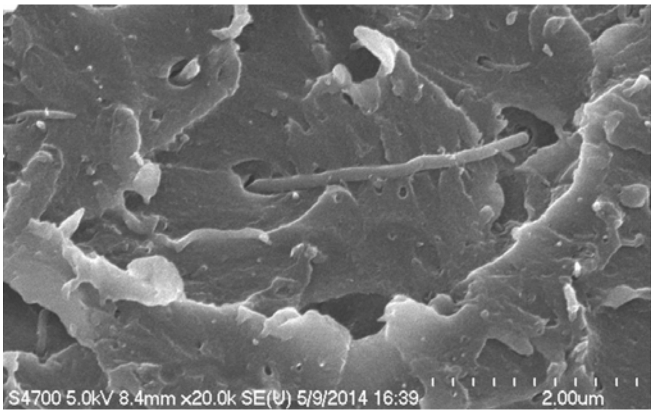
«Το πείραμα της ολλανδικής ομάδας ενισχύει την άποψη ότι η ρίψη νερού μπροστά στο έλκηθρο δεν είναι μια απλή τελετουργική πράξη, αλλά εξυπηρετεί κυρίως πρακτικούς σκοπούς», λέει η δρ Μιχαηλίδου. «Ενώ πράγματι η προσφορά νερού ή γάλακτος στην αρχαία Αίγυπτο θα μπορούσε να έχει τελετουργικό χαρακτήρα, υπήρχαν κάποια σημάδια στην τοιχογραφία που βρέθηκε στον τάφο του Τζεχουτιχότεπ που μας είχαν προδιαθέσει ότι πιθανώς να μην ισχύει κάτι τέτοιο», λέει στην «Κ» ο αρχαιολόγος και ερευνητής της αρχαίας Αιγύπτου Μπεν βαν ντεν Μπέρκεν, ο οποίος προσέφερε τις επιστημονικές του γνώσεις στην ερευνητική ομάδα του δρος Μπον. Οι Αιγύπτιοι στις τελετές τους, εξηγεί ο κ. Βαν ντεν Μπέρκεν, χρησιμοποιούσαν συνήθως περίτεχνα αγγεία, ενώ στην τοιχογραφία φαίνεται ότι το υγρό φυλάσσεται μέσα σε ένα κοινό δοχείο. «Η απλότητα του σκεύους δείχνει ότι μάλλον είχε πρακτικούς σκοπούς», προσθέτει.

«Το σενάριο που προτάσσουν οι Ολλανδοί ερευνητές είναι πιθανό», λέει ο Νικόλαος Λαζαρίδης, αιγυπτιολόγος και καθηγητής Αρχαίας Ιστορίας στο Πανεπιστήμιο της Πολιτείας της Καλιφόρνιας στο Σακραμέντο. «Βέβαια η θεωρία, από αρχαιολογικής άποψης, στηρίζεται σε μία μόνο εικονογραφική ένδειξη από τον συγκεκριμένο τάφο, ενώ επίσης από την απεικόνιση δεν μπορεί κανείς να διακρίνει αν χρησιμοποιείται νερό ή κάποιο άλλο υγρό», προσθέτει ο δρ Λαζαρίδης. «Παρότι από πλευράς φυσικής είναι δόκιμο και λογικό, δεν σημαίνει απαραίτητα ότι αυτή είναι και η εξήγηση για τη μεταφορά των ογκολίθων των πυραμίδων», προσθέτει ο δρ Βλασσόπουλος.

Ο δρ Μπον όμως δεν μένει μόνο στην αρχαιολογική αξία των ευρημάτων τους. «Η τριβή σήμερα ευθύνεται για το 30% της κατανάλωσης ενέργειας πάνω στη Γη. Παρ' όλα αυτά, δεν έχει μελετηθεί ακόμα επαρκώς», λέει ο δρ Μπον, ο οποίος συνεργάζεται ήδη με την εταιρεία ελαστικών Michelin, αναζητώντας το υλικό εκείνο που «ευθύνεται» για την αντίσταση που βρίσκουν τα ελαστικά των αυτοκινήτων κατά την περιστροφή τους.

(Ασπασία Δασκαλοπούλου / Η ΚΑΘΗΜΕΡΙΝΗ, 24.05.2014, http://www.kathimerini.gr/768602/article/epikairothta/episthmh/neo-senario-metaforas-ylikwn-gia-tis-pyramides)

Σφάλμα στο εργαστήριο οδηγεί σε νέα οικογένεια υλικών



Ενα από τα δύο νέα υπέρσκληρα πολυμερή, όπως φαίνεται μέσα από το ηλεκτρονικό μικροσκόπιο. Τα υλικά αυτά πιθανώς να βρουν εφαρμογές στις μεταφορές, αλλά και σε καταναλωτικά προϊόντα και συσκευασίες.

Ως ερευνήτρια σε ένα εργαστήριο της IBM, η χημικός Ζανέτ Γκαρσία περνάει τις μέρες της αναμειγνύοντας και θερμαίνοντας χημικές ουσίες, αναζητώντας πιο ανθεκτικά και εύκολα ανακυκλώσιμα πλαστικά. Πρόσφατα, ενώ ακολούθησε μια απλή συνταγή που απαιτούσε την ανάμειξη τριών συστατικών σε ένα δοχείο πειραμάτων, παρέλειψε κατά λάθος ένα στάδιο, αφήνοντας έξω ένα χημικό συστατικό. Επιστρέφοντας ύστερα από λίγο στον εργαστηριακό της πάγκο, διαπίστωσε ότι το δοχείο ήταν γεμάτο από ένα σκληρό άσπρο πλαστικό, το οποίο είχε εγκλωβίσει μέσα του μέχρι και τον αναδευτήρα.

Η δρ Γκαρσία προσπάθησε να θρυμματίσει το μυστηριώδες υλικό, χωρίς όμως αποτέλεσμα. Στη συνέχεια, πήρε ένα σφυρί και έσπασε το δοχείο για να το απελευθερώσει. Αυτό το εργαστηριακό σφάλμα οδήγησε στην ανακάλυψη μιας νέας οικογένειας υλικών τα οποία είναι ασυνήθιστα σκληρά και ελαφριά, παρουσιάζουν αυτο-ιάσιμες ιδιότητες και μπορούν εύκολα να ανακυκλωθούν.

Τα δύο νέα αυτά ανθεκτικά πολυμερή θα μπορούσαν να βρουν εφαρμογές στις μεταφορές. Εξαιτίας της ικανότητάς τους να ανακυκλώνονται, θα μπορούσαν επίσης να αξιοποιηθούν και σε προϊόντα καθημερινής χρήσης, όπως επίσης και στη βιομηχανία για τη συσκευασία τεχνολογιών μικροηλεκτρονικής. Τα ευρήματα της IBM δημοσιεύθηκαν στο προηγούμενο τεύχος του επιστημονικού περιοδικού Science από την ερευνητική ομάδα της εταιρείας στο Σαν Χοσέ της Καλιφόρνιας.

Τα τελευταία χρόνια έχει παρατηρηθεί μια έκρηξη στην ανακάλυψη νέων πολυμερών υλικών, όμως τα περισσότερα από αυτά είναι παραλλαγές υπαρχόντων συνθετικών κλάσεων που χαρακτηρίζονται από μακριές αλυσίδες απλούστερων μορίων, τα οποία συνδέονται μέσω χημικών δεσμών. Τα υλικά σήμερα βρίσκονται παντού στη σύγχρονη ζωή, από τα χρώματα μέχρι τους φακούς επαφής και από τα ρούχα μέχρι τις μπαταρίες. «Είναι η εποχή των πολυμερών», λέει ο Τζέιμς Χέντρικ, ερευνητής προηγμένων οργανικών υλικών στο ίδιο εργαστήριο της IBM.

Οι επιστήμονες της IBM λένε ότι αυτή είναι η πρώτη πραγματικά καινούργια οικογένεια πολυμερών που ανακαλύπτεται τις τελευταίες δεκαετίες. Παρότι δεν έχουν δώσει ακόμα όνομα σε αυτή τη νέα οικογένεια υλικών, χρησιμοποιούν τις κωδικές ονομασίες «Titan» και «Hydro». Τα υλικά αυτά δεν είναι ακόμα έτοιμα για εμπορική χρήση, παρ' όλα αυτά, οι επιστήμονες είπαν ότι συνεργάζονται ήδη με αρκετά πανεπιστήμια πάνω σε σύνθετες εφαρμογές, οι οποίες θα μπορούσαν να επηρεάσουν τις κατασκευές στον τομέα των μεταφορών, της αεροναυπηγικής και της μικροηλεκτρονικής.

Τα υλικά αυτά είναι γνωστά ως θερμοσκληρυνόμενα, επειδή για τον σχηματισμό τους απαιτείται θέρμανση. Η σκληρότητά τους οφείλεται στο τρισδιάστατο δίκτυο που σχηματίζουν οι χημικοί τους δεσμοί. Η ακαμψία των πολυμερών είναι ίδια με αυτή του κόκαλου, το οποίο είναι ένα από τα πιο σκληρά βιολογικά υλικά, και μπορούν να γίνουν μέχρι και 50% σκληρότερα αν αναμειχθούν με υλικά όπως νανοσωλήνες άνθρακα. Φαίνεται επίσης να έχουν καλύτερη απόδοση σε συνθήκες υψηλών θερμοκρασιών σε σχέση με άλλα είδη πολυμερών.

Το περιστατικό αυτό στην IBM θυμίζει την ανακάλυψη της ουσίας Teflon που χρησιμοποιείται στα αντικολλητικά σκεύη, λέει ο Τίμοθι Λονγκ, καθηγητής Χημείας στο Πολυτεχνείο της Βιρτζίνια. «Το "κατά τύχη" είναι η μητέρα της εφεύρεσης», προσθέτει. Το 1938, ο Ρόι Πλάνκετ, ερευνητής στην εταιρεία χημικών DuPont, πολυμέρισε κατά λάθος τετραφθοροαιθυλένιο, δημιουργώντας τυχαία ένα από τα πιο ολισθηρά υλικά.

Ο δρ Λονγκ, σε ένα επεξηγηματικό άρθρο που συνόδευε τη δημοσίευση στο επιστημονικό περιοδικό Science, υποστηρίζει ότι το νέο υλικό παρουσιάζει ένα σημαντικό πλεονέκτημα στην κατασκευή εύκολα ανακυκλώσιμων καταναλωτικών προϊόντων, ειδικά ηλεκτρονικών, αφού τα ηλεκτρονικά απόβλητα αποτελούν πια μεγάλο πρόβλημα.

«Τα θερμοσκληρυνόμενα υλικά είναι σχεδιασμένα ώστε να είναι εξαιρετικά ανθεκτικά σε μεγάλες διακυμάνσεις θερμοκρασίας και έχουν σταθερές μηχανικές ιδιότητες. Δεν έχουν σχεδιαστεί για να είναι αναστρέψιμα», λέει ο δρ Λονγκ. «Το να έχεις όλες αυτές τις ιδιότητες σε ένα υλικό που είναι επίσης ανακυκλώσιμο είναι μεγάλη πρόοδος», προσθέτει.

(John Markoff / THE NEW YORK TIMES / Η ΚΑΘΗΜΕΡΙΝΗ, 24.05.2015, http://www.kathimerini.gr/768603/article/epikairothta/episthmh/sfalma-sto-ergasthrio-odhgei-se-nea-oikogeneia-ylikwn)

ΕΚΤΕΛΕΣΤΙΚΗ ΕΠΙΤΡΟΠΗ ΕΕΕΕΓΜ (2012 – 2015)

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