Marchetti Flat Dilatometer (DMT)

An innovative Italian contribution to in situ testing

Prof. Silvano Lucio Marchetti (1943 – 2016)

Inventor of the Marchetti Flat Plate Dilatometer (1980)

Main activities of Prof. Silvano Marchetti

Consultant Geotechnical Design: Shallow Foundations, Deep Sea Offshore Platforms, Caissons and Quay Walls, Piles subjected to Vertical and Horizontal Loads, Wave Equation Analysis of Driven Piles, Slope Stability, Diaphragm Walls and Retaining Structures, Geotechnical Instrumentation, In situ determination of Design Parameters, Monitoring Densification effectiveness

Publications 100+ in geotechnical journals and conference proceedings

Original 1980 DMT paper is one of the 78 reprinted Historical Papers ASCE 2003: 'A History of progress: Selected U.S. papers in Geotechnical Engineering', which include papers written by Terzaghi, Proctor, Casagrande and Peck

Lectures in International Conferences: General Reporter / Panelist: Milano (1973), Brighton (1979), S. Francisco (1985), ESOPT II Amsterdam (1982), ISOPT I Orlando (1988), Taormina (1989), ..

3 DMT International Conferences: Edmonton 1983, Washington D.C. (2006), Rome 2015 (conference organizer and proceedings editor)

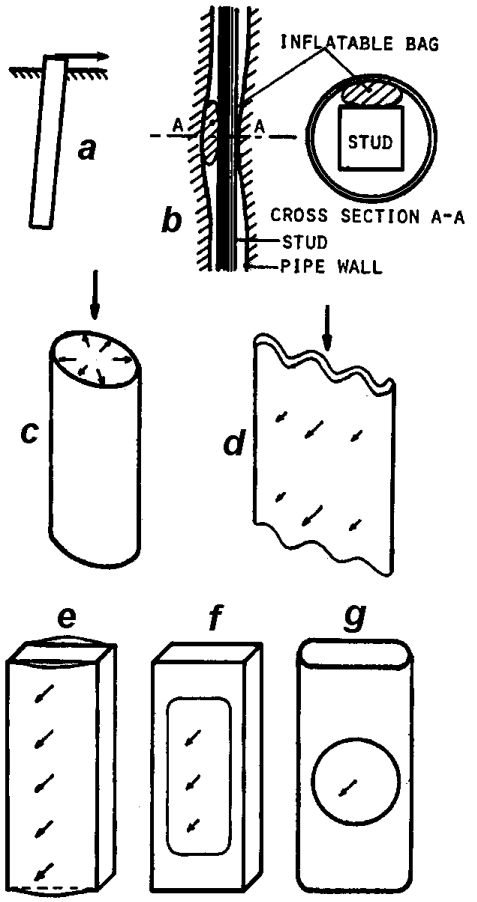
Invited speaker in International Universities and Research Institutes: Ghent State University, NGI Oslo, Nanyang University Singapore, University of British Columbia Vancouver, Research Dept. McClelland Engineering Houston, Yangtse River Scientific Institute in Wuhan China, Catolica Rio de Janeiro, FTI Budapest, Varsavia University, Standard Inst. of Israel in Tel Aviv, Technion Haifa, Cairo University,..

Memberships: ISSMGE, AGI, CNR, Eurocode 7, TC16 (today TC102)

Original stimulus for the development of the Flat Dilatometer

The DMT was originally conceived by Prof. Marchetti to measure parameters for the design of Laterally Loaded Piles.

Marchetti (1977) *"Devices for In Situ Determination of Soil Modulus Es", Proceedings of 9th ICSMFE, Tokyo 1977*



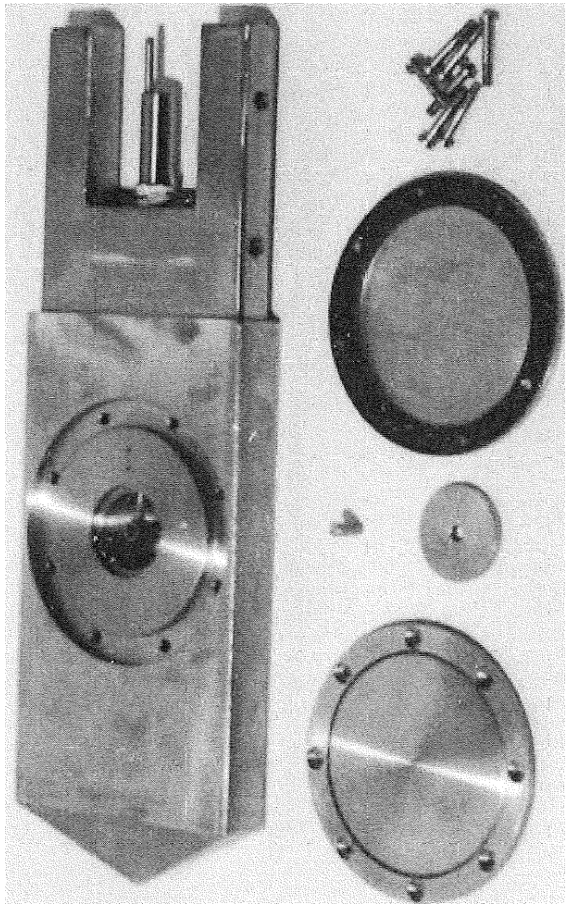
Similarity DMT – LL PILES

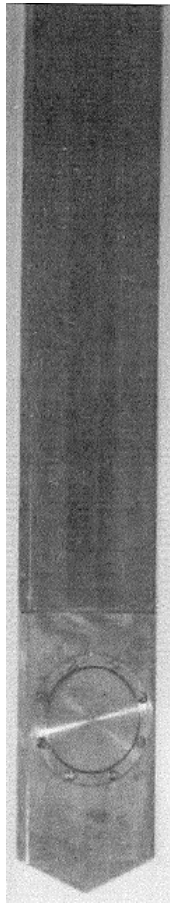
- Structural elements installed in soil
- LATERAL deformation

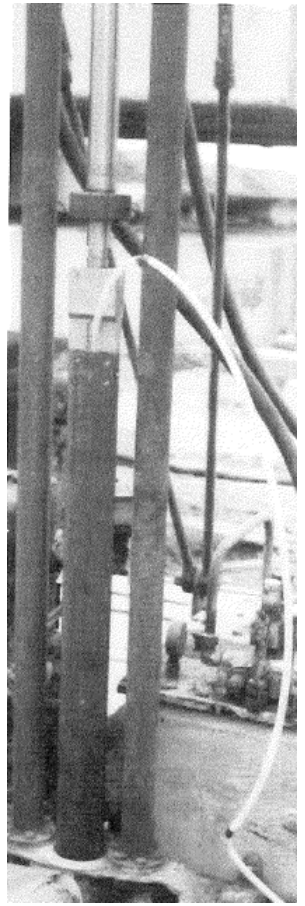
First version of the DMT blade (1974)

Main Characteristics:

- DMT tip with cuspidal shape
- Two copper membranes: one on each side
- Push rods with rectangular cross section
- Coaxial tube (exhaust through anular interspace)







No. 4043186

THE UNITED STATES OF AMERICA

TO ALL TO WHOM THESE PRESENTS SHALL COME:

Whereas, THERE HAS BEEN PRESENTED TO THE

Commissioner of Patents and Trademarks

A PETITION PRAYING FOR THE GRANT OF LETTERS PATENT FOR AN ALLEGED NEW AND USEFUL INVENTION THE TITLE AND DESCRIPTION OF WHICH ARE CONTAINED IN THE SPECIFICATIONS OF WHICH A COPY IS HEREUNTO ANNEXED AND MADE A PART HEREOF, AND THE VARIOUS REQUIREMENTS OF LAW IN SUCH CASES MADE AND PROVIDED HAVE BEEN COMPLIED WITH, AND THE TITLE THERETO IS, FROM THE RECORDS OF THE PATENT AND TRADEMARK OFFICE IN THE CLAIMANT(S) INDICATED IN THE SAID COPY, AND WHEREAS, UPON DUE EXAMINATION MADE, THE SAID CLAIMANT(S) IS (ARE) ADJUDGED TO BE ENTITLED TO A PATENT UNDER THE LAW.

NOW, THEREFORE, THESE Letters Patent ARE TO GRANT UNTO THE SAID CLAIMANT(S) AND THE SUCCESSORS, HEIRS OR ASSIGNS OF THE SAID CLAIMANT(S) FOR THE TERM OF SEVENTEEN YEARS FROM THE DATE OF THIS GRANT, SUBJECT TO THE PAYMENT OF ISSUE FEES AS PROVIDED BY LAW, THE RIGHT TO EXCLUDE ...THERS FROM MAKING, USING OR SELLING THE SAID INVENTION THROUGHOUT THE ...ITED STATES.

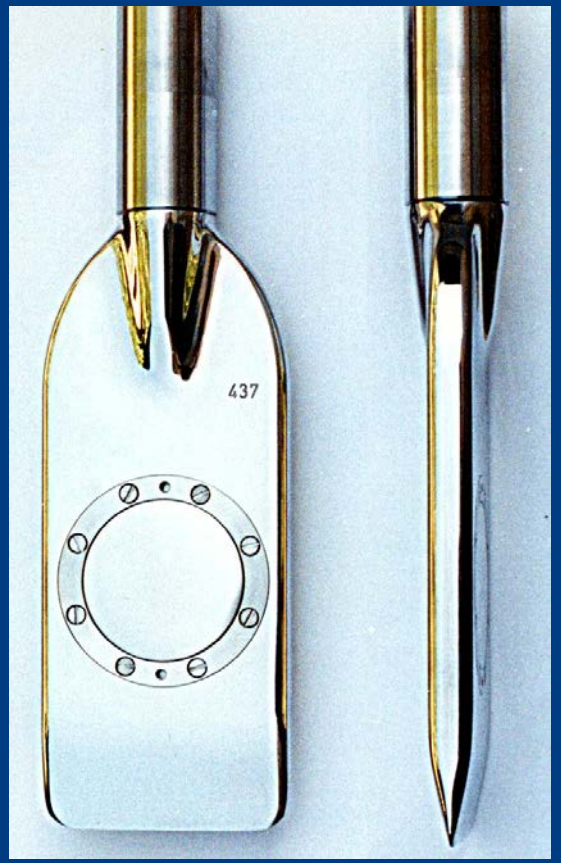
In testimony whereof I have hereunto set my hand and caused the seal of the Patent and Trademark Office to be affixed at the City of Washington this twenty-third day of August in the year of our Lord one thousand nine hundred and seventy-seven, and of the Independence of the United States of America the two hundredth and second.

Attest: Ruth C. Mason
Attesting Officer.

C. Marshall Dann
Commissioner of Patents and Trademarks.

August 23rd 1977

Patent of the Flat Dilatometer in USA



JOURNAL OF THE GEOTECHNICAL ENGINEERING DIVISION

IN SITU TESTS BY FLAT DILATOMETER

By Silvano Marchetti[1]

INTRODUCTION

This paper describes the flat dilatometer, a recently developed device (18) for in situ investigation of soil properties, and presents a series of empirical correlations between test results and some geotechnical parameters used in design.

The information presented is based on the experience gained in performing dilatometer tests (DMT) at over 40 sites. The correlations have been established based on DMT performed at selected sites reasonably homogeneous and geotechnically well documented.

DESCRIPTION OF TEST

The flat dilatometer [Figs. 1(*a*) and 1(*b*)] consists of a stainless steel blade with a thin flat circular expandable steel membrane on one side. When at rest, the external surface of the membrane is flush with the surrounding flat surface of the blade. The blade is jacked into the ground using a penetrometer rig [Fig. 1(*c*)] or a ballasted drilling rig. The blade is connected to a control unit on the surface by a nylon tube containing an electrical wire. The tube runs through the penetrometer rods. At 20-cm depth intervals jacking is stopped and, without delay, the membrane is inflated by means of pressurized gas. Readings are taken of the *A* pressure required to just begin to move the membrane and of the *B* pressure required to move its center 1.00 mm into the soil. The rate of pressure increase is set so that the expansion occurs in 15 sec–30 sec. The total time needed for obtaining a 30-m profile, if no obstructions are encountered, is about 2 h.

Note.—Discussion open until August 1, 1980. To extend the closing date one month, a written request must be filed with the Manager of Technical and Professional Publications, ASCE. This paper is part of the copyrighted Journal of the Geotechnical Engineering Division, Proceedings of the American Society of Civil Engineers, Vol. 106, No. GT3, March, 1980. Manuscript was submitted for review for possible publication on March 29, 1977.

[1]Assoc. Prof. of Soil Mech., Faculty of Engrg., L'Aquila Univ., Italy.

ASCE Pubblication 1980

first publication on the Flat Dilatometer:

In Situ Tests by Flat Dilatometer

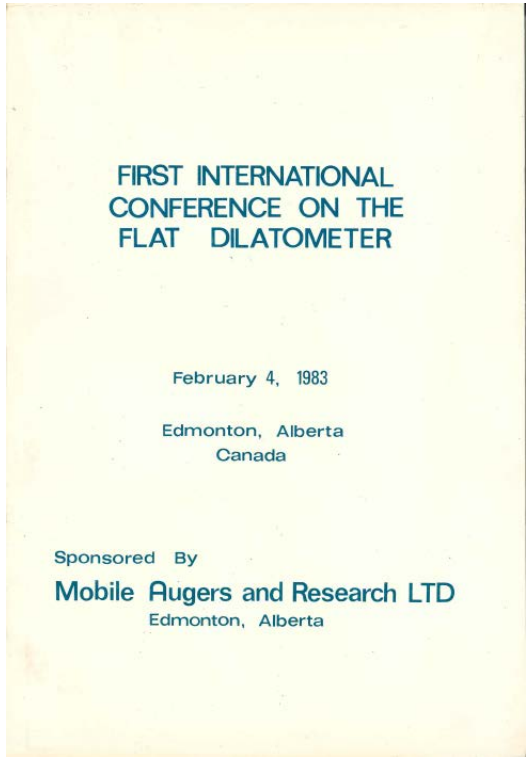
by Silvano Marchetti

Jnl. American Society of Civil Engineers vol. 106 n. GT3 Mar 1980

Included in the 78 reprinted Historical Papers ASCE 2003:

'A History of progress: Selected U.S. papers in Geotechnical Engineering', which include authors like Terzaghi, Proctor, Casagrande, Peck

First International Conference on the Flat Dilatometer
Edmonton - Canada (1983)



In 1983 (February 4th), a small group of 45 engineers convened in Edmonton, Canada to present their findings at the First International Conference on the Flat Dilatometer.

1980-2000 DMT world wide diffusion

DMT expands from mainly Europe & North America to Oceania, South America & Africa

Initially primarily in Universities & Research Institutes, gradually also in the industry for large to medium scale projects

DMT Interpretation formulae (1980) confirmed in numerous published case histories in world-wide projects

Over 1000 Publications in journals and conference proceedings on a wide range of geotechnical applications: settlements, QA of ground improvement, liquefaction resistance, landslides, G-gamma decay curves, laterally loaded piles, diaphragm walls, etc

MO.SE Project in Venice Lagoon

safeguard against high tides

March-April 2003 & September 2003

Offshore DMT testing

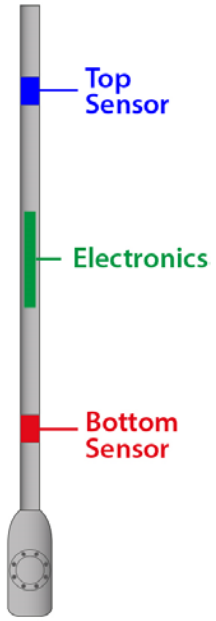
Drill rig on Jackup

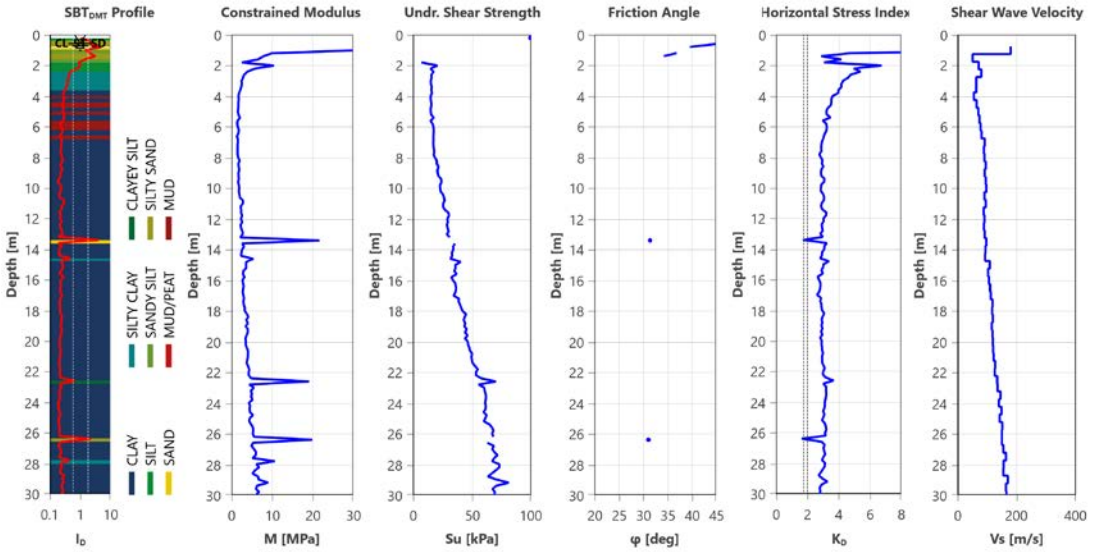
6 DMT tests in Bocca di Lido (VE)

3 DMT tests in Bocca di Chioggia (VE)

Water depth ~ 5-10 m

Test depth from seafloor ~ 40-45 m





Sesimic Dilatometer (SDMT)

I° validation of Shear Wave Velocity (Vs)

June 23rd 2004

Telespazio Space Center (Fucino - Italy)

Italian National Research test site

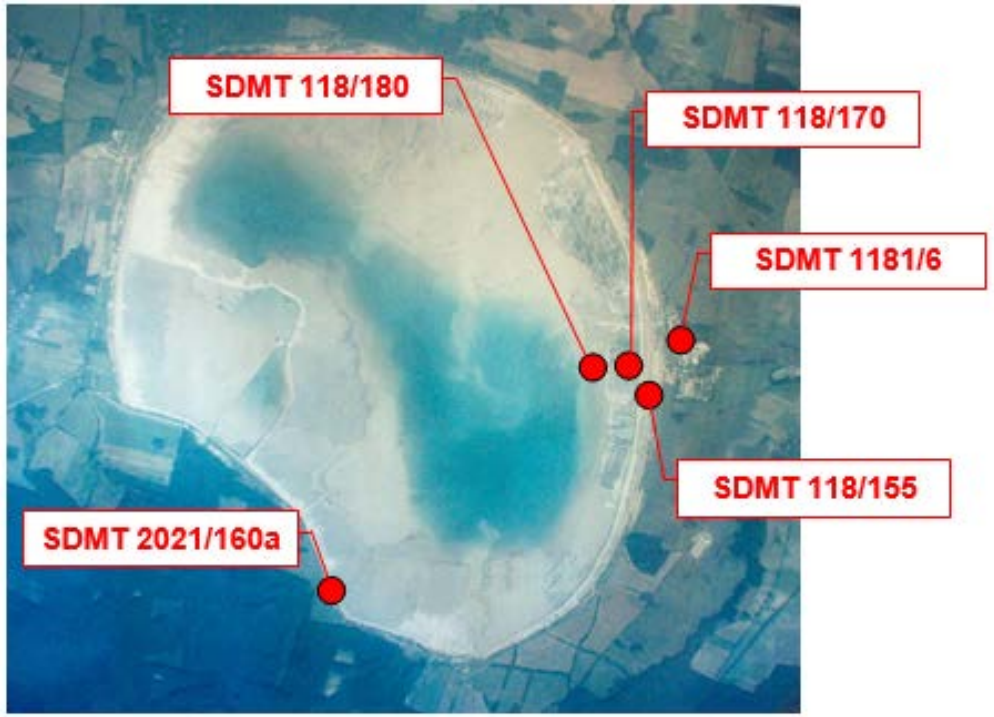
well documented with many different field tests by international researchers

1 SDMT test to 30 m

SDMT in a Tailings Dam

5 Seismic Dilatometer tests

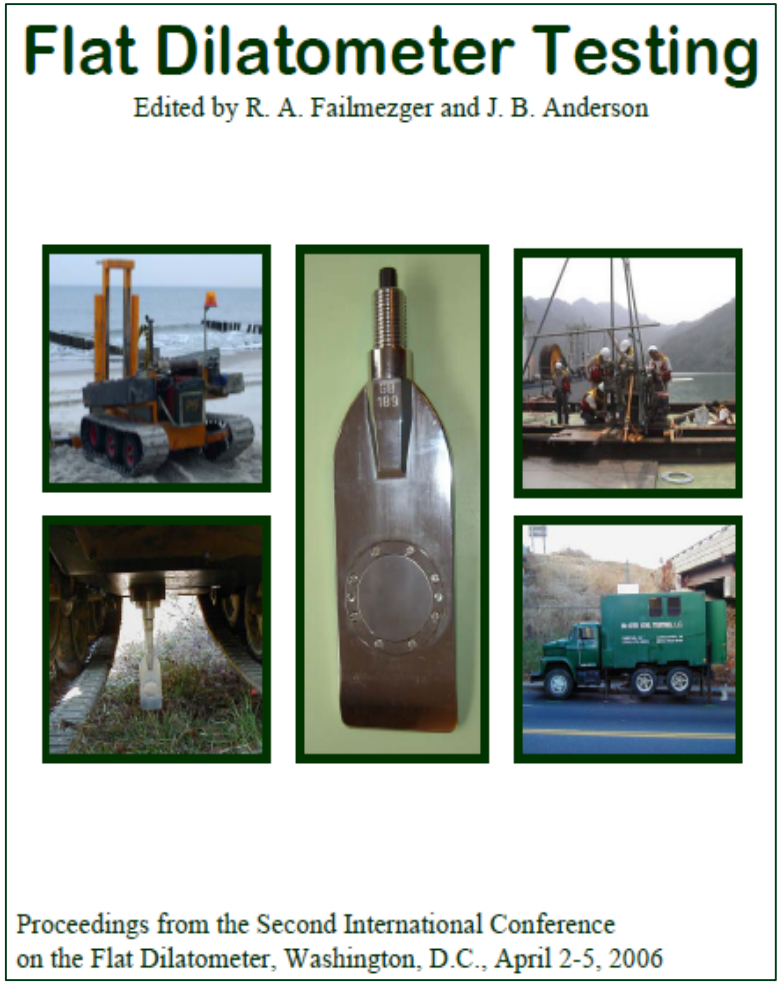
June 2005



Zelazny Most - Poland

Geomaterial:	wastes copper mine
Maximum dam height:	66+ m
Total volume stored:	558x106 m^3
Storage rate:	29x106 m^3/year
Area covered:	14.0 km^2
Total Dam's length:	14.3 km
Operation time:	1977-2042

II° International DMT Conference Washington (April 2-5 2006)



Schmertmann's dinner lecture

Mike Jamiolkowski and Silvano Marchetti at the gala dinner

- 48 papers involving over 80 authors
- 120 participants
- 3 Keynote lectures + dinner lecture

The United States of America

The Director of the United States Patent and Trademark Office

Has received an application for a patent for a new and useful invention. The title and description of the invention are enclosed. The requirements of law have been complied with, and it has been determined that a patent on the invention shall be granted under the law.

Therefore, this

United States Patent

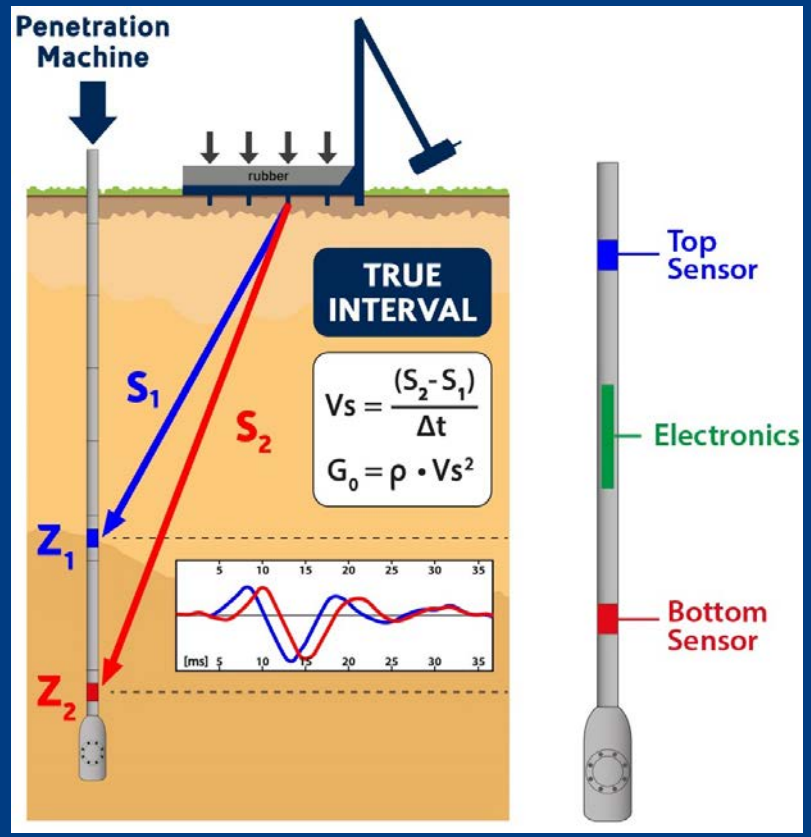
Grants to the person(s) having title to this patent the right to exclude others from making, using, offering for sale, or selling the invention throughout the United States of America or importing the invention into the United States of America, and if the invention is a process, of the right to exclude others from using, offering for sale or selling throughout the United States of America, or importing into the United States of America, products made by that process, for the term set forth in 35 U.S.C. 154(a)(2) or (c)(1), subject to the payment of maintenance fees as provided by 35 U.S.C. 41(b). See the Maintenance Fee Notice on the inside of the cover.

David J. Kappos

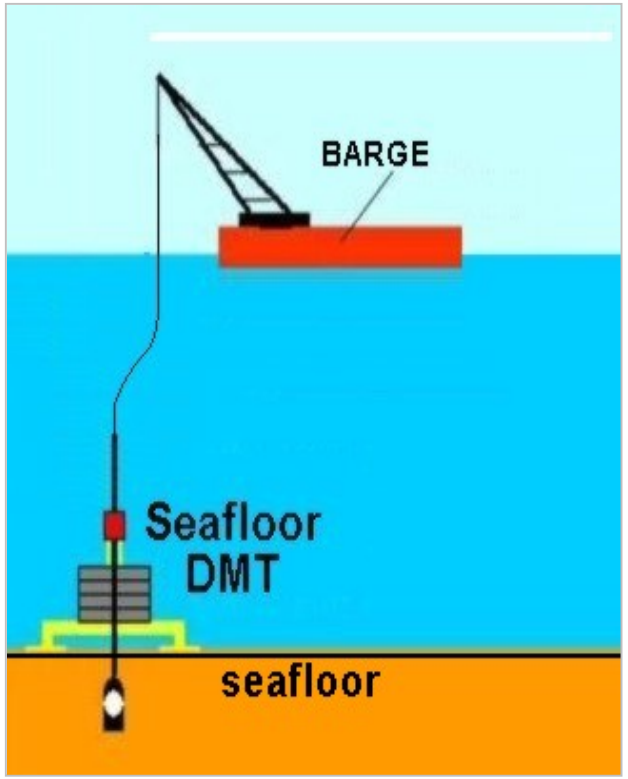
Director of the United States Patent and Trademark Office

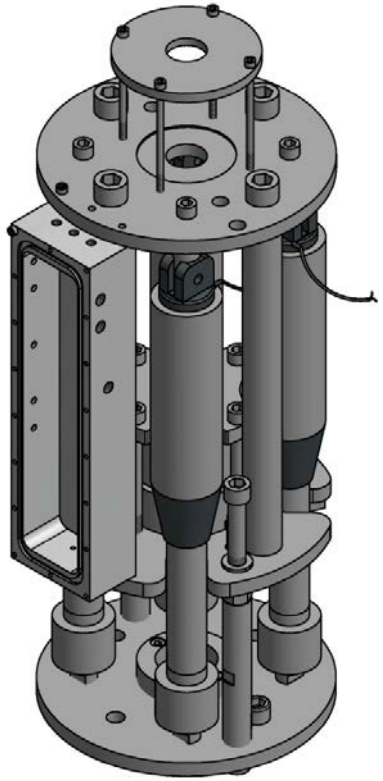
March 1st 2011

Patent of Seismic Dilatometer (SDMT)



2012–2014 Prototype & Patent of Seafloor DMT penetrometer





Electric Seafloor penetrometer for Dilatometer Tests (onshore and offshore)

MEDUSA DMT
ONSHORE AND OFFSHORE SOIL TESTING

The United States of America

The Director of the United States Patent and Trademark Office

Has received an application for a patent for a new and useful invention. The title and description of the invention are enclosed. The requirements of law have been complied with, and it has been determined that a patent on the invention shall be granted under the law.

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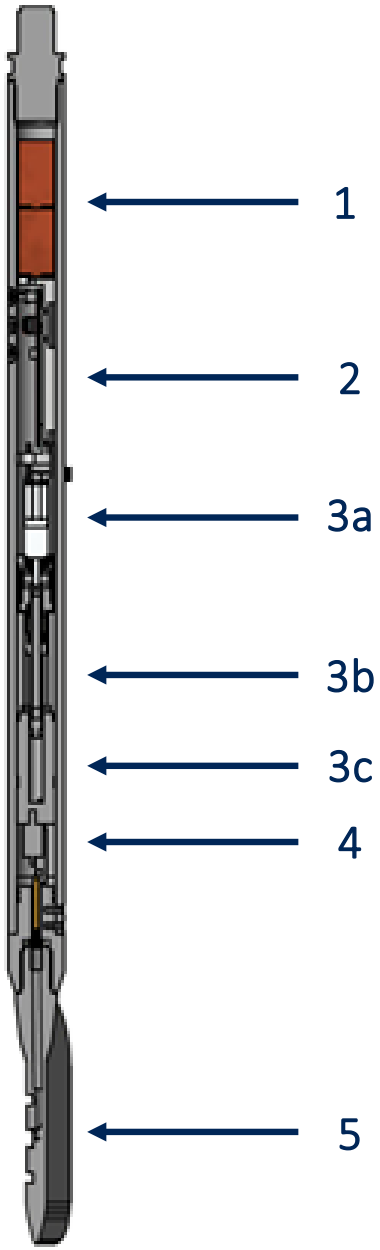
Grants to the person(s) having title to this patent the right to exclude others from making, using, offering for sale, or selling the invention throughout the United States of America or importing the invention into the United States of America, and if the invention is a process, of the right to exclude others from using, offering for sale or selling throughout the United States of America, or importing into the United States of America, products made by that process, for the term set forth in 35 U.S.C. 154(a)(2) or (c)(1), subject to the payment of maintenance fees as provided by 35 U.S.C. 41(b). See the Maintenance Fee Notice on the inside of the cover.

Michelle K. Lee

Deputy Director of the United States Patent and Trademark Office



Fully Automated Dilatometer Medusa DMT

Prototype and Patent (2014)

Legend

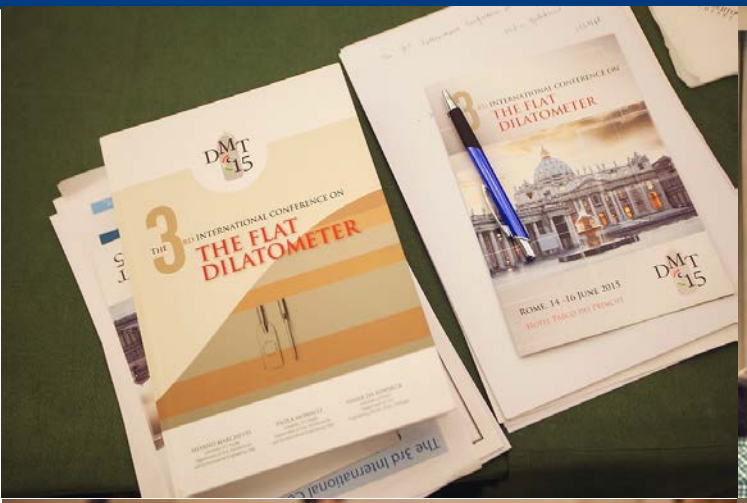
1. Battery Power Pack
2. Electronic Board
3. Hydraulic Motorized Syringe:
   a. Electric Engine
   b. Piston
   c. Cylinder
4. Pressure Transducer
5. DMT blade (standard dimensions)

III° International Conference on DMT (June 2015)

DMT '15

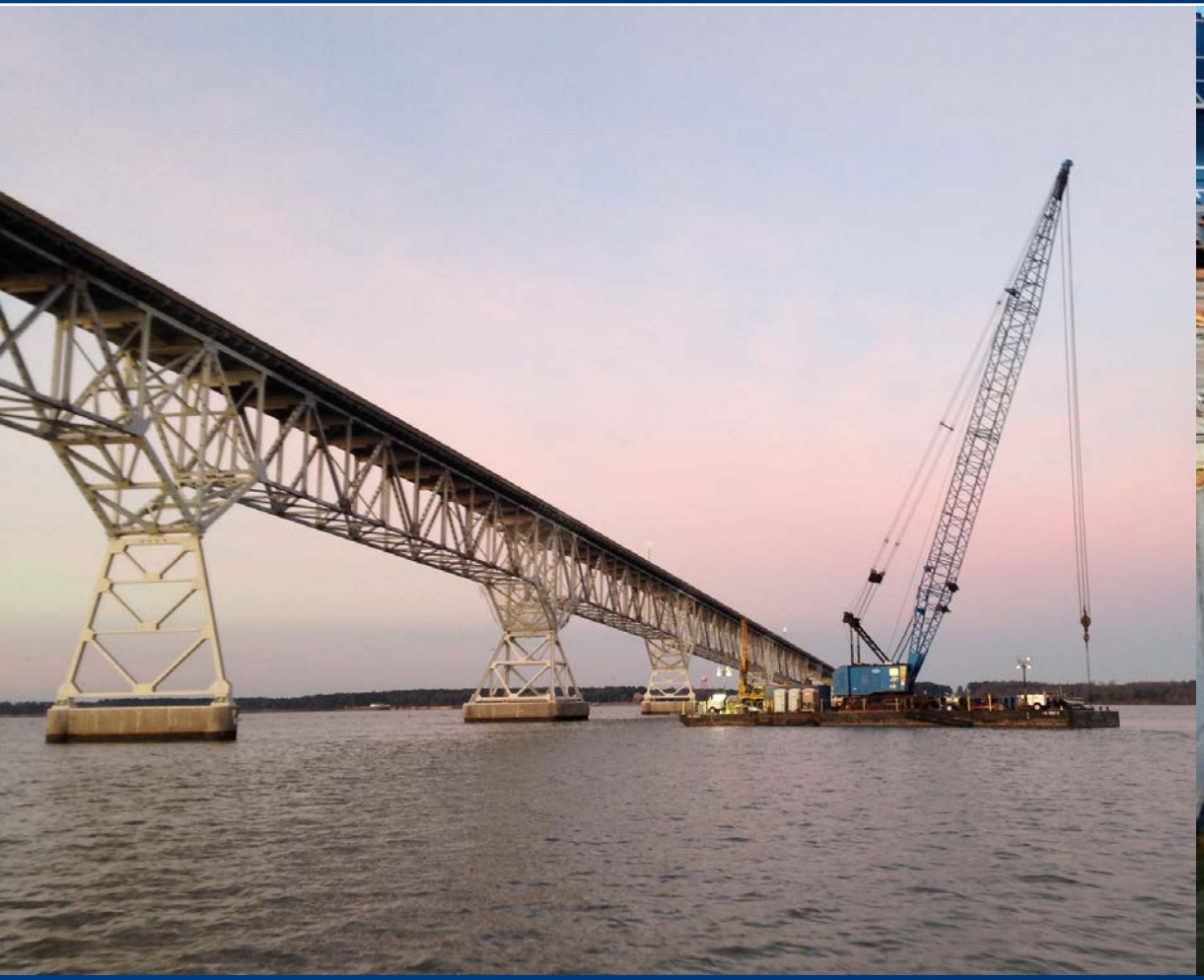
- 135 papers involving over 200 authors
- 140 participants
- 3 Keynote lectures (Jamiolkowski, Schnaid, Marchetti)

III° International Conference on DMT (June 2015)

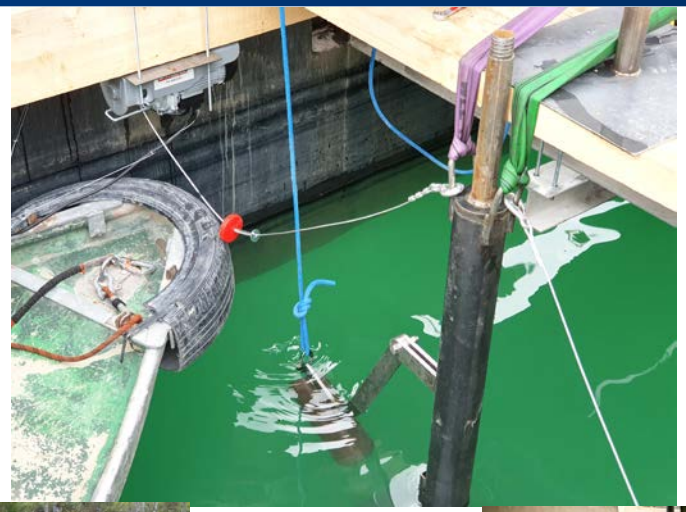


DMT '15

SDMT at bridge on the East Coast (USA) January 2016



Medusa SDMT offshore – Raggal, Austria (May 2021)



Spitzbergen, Norway (November 2021)

Medusa DMT was integrated with the Manta 200 for operability up to 1500 m water depth

Data transmission through Manta umbilical

(S)DMT coded in International Standards

EUROCODE 7 (2007). Standard Test Method, European Committee for Standardization, Part 3: Design Assisted by Field Testing, Section 9: Flat Dilatometer Test (DMT), 9 pp.

***ISO* (2017).** ISO/TS 22476-11, Geotechnical investigation and testing - Field testing Part 11: The Flat Dilatometer Test, 9 pp

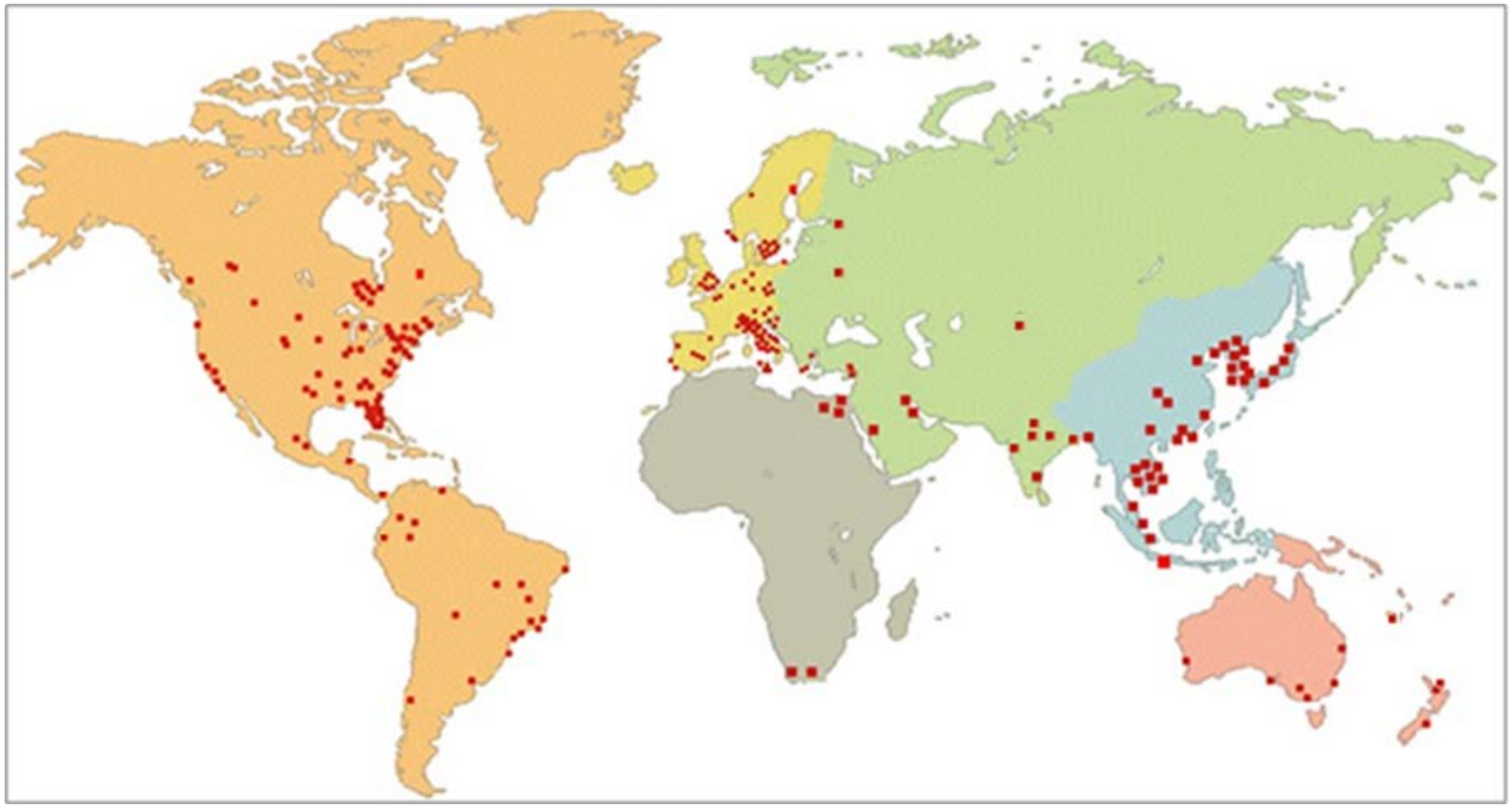
ASTM (2016). Standard Test Method D6635-15, American Society for Testing and Materials. Standard test method for performing the Flat Dilatometer Test (DMT), 14 pp.

TC16 / TC102 (2001). "The DMT in soil Investigations", ISSMGE Technical Committee on Ground Property, Characterization from in-situ testing, 41 pp.

NATIONAL STANDARDS:

- Italy: Consiglio Superiore Lavori Pubblici (2009), Protezione Civile (2008)
- Sweden: Swedish Geotechnical Society SGF report (1994)
- France: ISO/TS 22476-11:2005(F)
- China: TB10018 (2003), GB50021 (2003), DGJ08-37 (2012)
- ..

(S)DMT users in over 80 countries (°)



(°) Algeria, Angola, Argentina, Australia, Austria, Bahrain, Bangladesh, Belgium, Bolivia, Bosnia, Brazil, Bulgaria, Canada, Czech Republic, China, Chile, Cyprus, Colombia, Costa Rica, Croatia, Denmark, Ecuador, Egypt, United Arab Emirates, Estonia, Finland, France, Germany, Greece, Guadalupe, Guatemala, Honduras, Hong Kong, Hungary, India, Indonesia, Iran, Ireland, Israel, Italy, Japan, Kazhakstan, Korea, Kosovo, Kuwait, Lithuania, Malaysia, Mauritius, Mexico, Myanmar, Netherland, New Zealand, Norway, Oman, Panama, Peru, Paraguay, Philippines, Poland, Portugal, Romania, Russia, Saudi Arabia, Serbia, Singapore, Slovenia, South Africa, Spain, Sri Lanka, Sweden, Switzerland, Taiwan, Tanzania, Thailand, Tunisia, Turkey, United Kingdom, United States of America, Venezuela, Vietnam.