



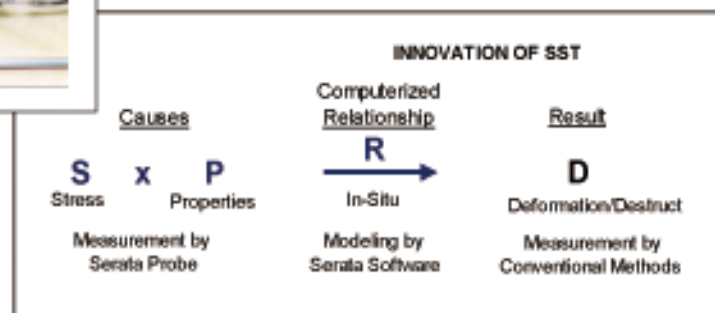
SERATA GEOMECHANICS CORPORATION

Serata Stress Technology for In-situ Earthwork Optimization

SUMMARY



INVENTION TO INNOVATION



There have been rapid advances in computer applications to engineering work on the surface of the earth. In contrast, computer applications to underground earthwork have been left behind advancements made on the surface. This is due to an impasse caused by formidable difficulties in the measurement of two basic inputs required for in-situ computer optimization of earthwork, i.e., stress state (**S**) and material properties (**P**). This impasse, in existence for the past half-century is now totally eliminated by the invention of Serata Probe, which makes **S & P** measurements simple, fast, accurate and repeatable. The invention led to establishment of Serata Stress Technology (SST) that has opened a new era of earthwork optimization. The **SPRD** scheme shown above illustrates the relationship between **S**, **P** and **D** by which the SST earthwork optimization is achieved with in-situ validation.



S: STRESS MEASUREMENT

Serata Probe has opened a new era of SST earthwork optimization by making in-situ stress measurement simple, accurate, fast, automatic and repeatable. The probe has drastically reduced the work requirements for S & P measurement by factors of 100 to 1000 as illustrated below.

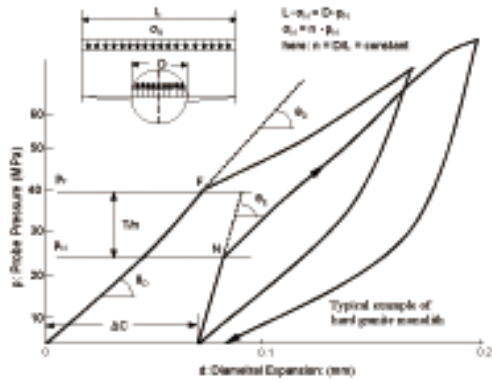
Method Category	Hydrofracturing Method	Overcoring Method	Serata's Method
Simultaneous Measurement of In-situ Material Properties with Stress Measurement	not possible	not possible	yes, automatically done
Repeating Stress Measurement in Relation to Time at Same Position	not possible	not possible	yes, indefinitely repeated
Time Required for Single Measurement	hours and days per measurement, increasing with depth	days and weeks per measurement, increasing with depth	10 to 30 minutes unaffected by depth
Automation of Measurement, Analysis & Graphic Display on Site	not possible	not possible	Yes, all done on-site in real-time
Requirement of Separate Supporting Tasks	high-pressure packer work, water injection & fracture indentation	probe cementation, overcoring & specimen recovery	none at all totally self-sufficient
Requirement of Core Specimen Recovery and Laboratory Testing	Yes	Yes	No
Dependence upon Hypothetical Assumption of Ground Elasticity	Yes	Yes	No
Applicability to Complex Ground	not possible	not possible	applicable
Accuracy in Stress Measurement	± 10 ~ 20% often not possible	± 15 ~ 30% often not possible	± 2% or better as needed by repeating
Application Depth	not applicable at shallow depth	not applicable at great depth	highly effective at all depth
Overall Effectiveness Factor	1 at shallow depth	1 at great depth	100 to 1000 at all depth

* American Standard of Testing Materials

P: PROPERTY MEASUREMENT

Material properties are measured, analyzed and recorded automatically on-site in real time as a co-product of the Serata Probe stress measurement. Typical measurement results are shown by the p-d diagrams below. Ground properties are obtained directly from the automatic read out on-site as illustrated in the upper diagram. The lower diagram compares p-d diagrams of various rock formations ranging from hardest rocks to hard soils. The in-situ data are disclose far more realistic properties than those obtained by core specimen samples tested in laboratory.

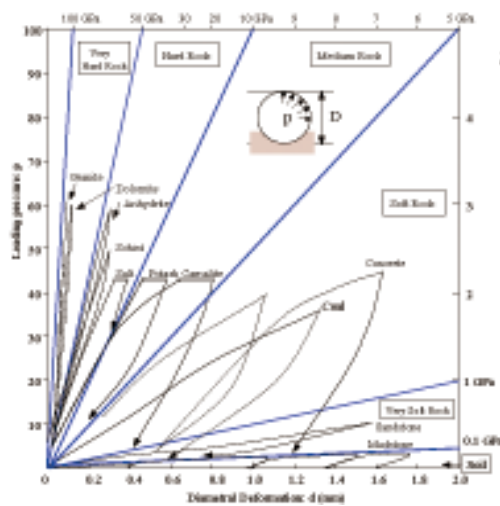
Basic Characteristics of p-d Diagram



- E_E = elastic modulus
= $D (1 + \nu) \tan \theta_E$
- C = consolidation coefficient
= $\Delta C / D / p_{max}$
- T = tensile strength
= $n (p_F - p_R)$

where: D = borehole I.D.
 ν = poisson ratio
 $\tan \theta_E$ = elastic rigidity
 p_F = fracture initiation pressure
 p_R = fracture reopening pressure
 ΔC = ground consolidation

p-d Diagrams of Earth Materials



SST CLASSIFICATION	STIFFNESS RANGE (GPa)
soil	below 0.1
very soft rock	0.1 ~ 1
soft rock	1 ~ 5
medium rock	5 ~ 10
hard rock	10 ~ 50
very hard rock	50 ~ 100
extremely hard rock	over 100

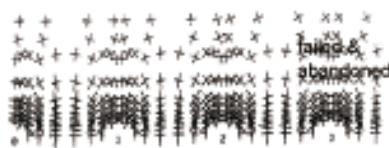
A: APPLICATION OF SST

1. Summary

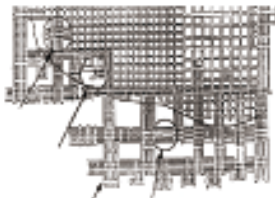
SST together with Serata Probe can achieve major technical and economic gains by optimization of survey design, construction and safety assurance for mine, tunnel, dam, slope & foundation, space utilization projects and earthquake time-prediction.

2. Application Examples

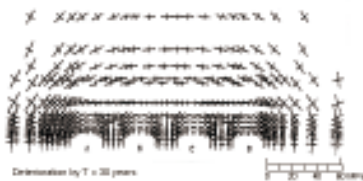
Failing Roof Caused by High Stress Concentration



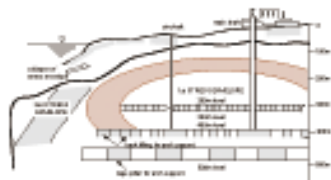
Mine Layout Transition to Safety



Stabilized Roof by SST



Underground Storage



3. How to Utilize

SST is utilized throughout the world by large construction companies as well as by small geotechnical companies with unprecedented gains in technology and economics.

- 1) How to get Started: Your first step is to examine in detail the six categories of TECHNOLOGY given in this Website.
- 2) How to Plan: Serata Geomechanics is ready to assist your adoption of SST by free personal consultations to come up with a successful arrangement for your staff to carry out the field measurements of S&P. Serata is to provide with the Probe and its software. Serata trains your staff to achieve self sufficiency in applying the Technology.
- 3) Plan to Succeed: Serata assumes the responsibility for backup of your staff by providing continuing support to achieve your objectives. For details go to SERVICES.

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