MAKING SENSE OF SOIL TESTING DATA

STEVEN ANDERSON

GEOTECHNICS

THE JOURNEY

Technician

Performs a test complying with the method

Senior Technician

Experience with different materials, problem solving, understands method limitations

Subject Matter Expert SME

Understands principles and background of a test. Correlates data and methods. Difficult materials.

Data

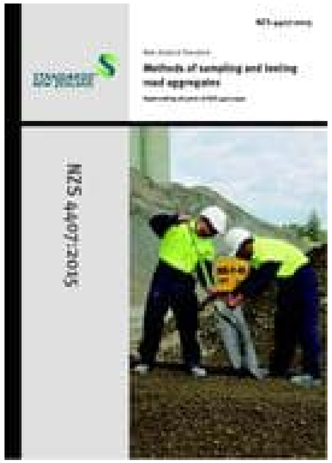
Capturing and sharing

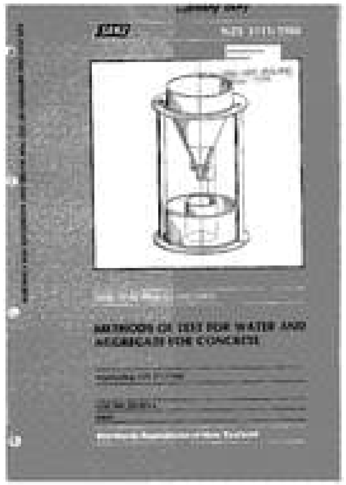
Power of Data

Making sense -interpretation

TECHNICIAN

- Safety
- Methods
- Quality





References: Standards NZ and IANZ

WHAT DOES THE DATA MEAN?

Water Content

- % of dry mass, therefore a ratio of water to dry mass

Material	Natural Water Content (%)
Gravel (GAP40 or GAP65)	~4 - ~8
Sand	~6 - ~12
Silt	~24 - ~35
Clay	~30 – ~50
Ash	~45 – ~100+
Peat	~200 - ~2500

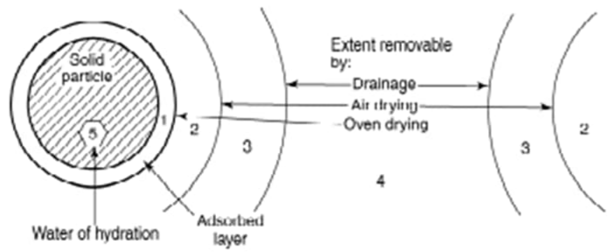
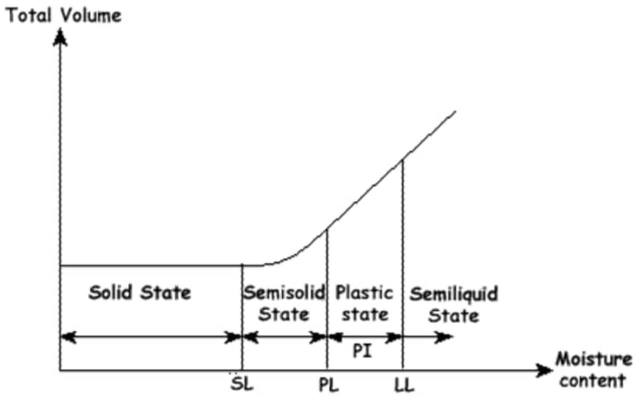


Figure 2.1 Representation of categories of water surrounding clay particles

References: KH Head – Manual of Soil Testing

SENIOR TECHNICIAN

Atterberg limits



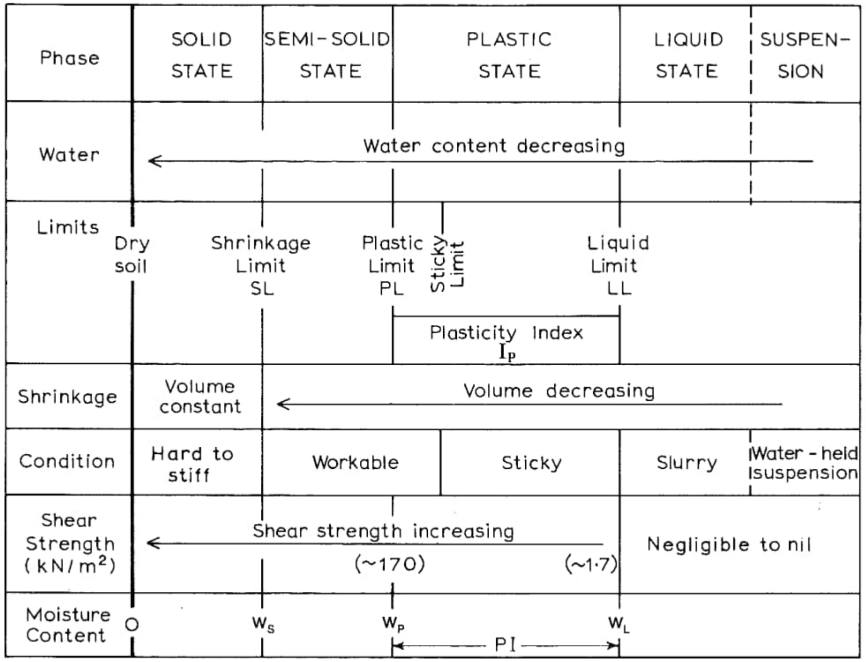


Fig. 2.2 Phases of soil and the Atterberg limits

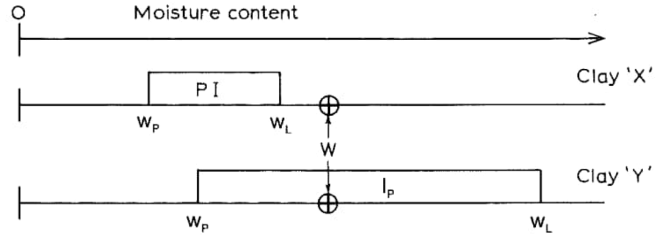
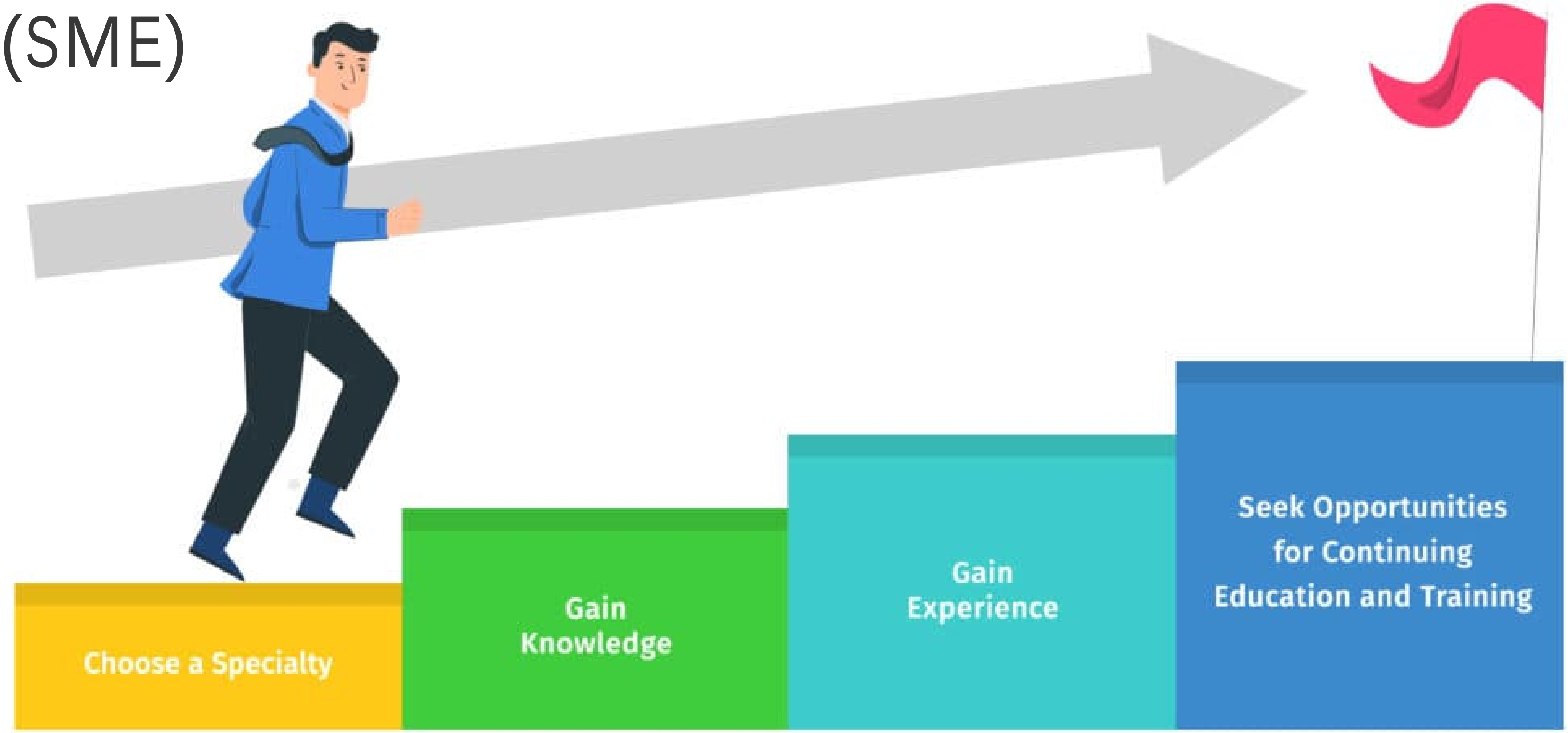


Fig. 2.3 Consistencies of two clays

References: KH Head – Manual of Soil Testing

SUBJECT MATTER EXPERT (SME)



CETANZ

Civil Engineering Testing Association of New Zealand

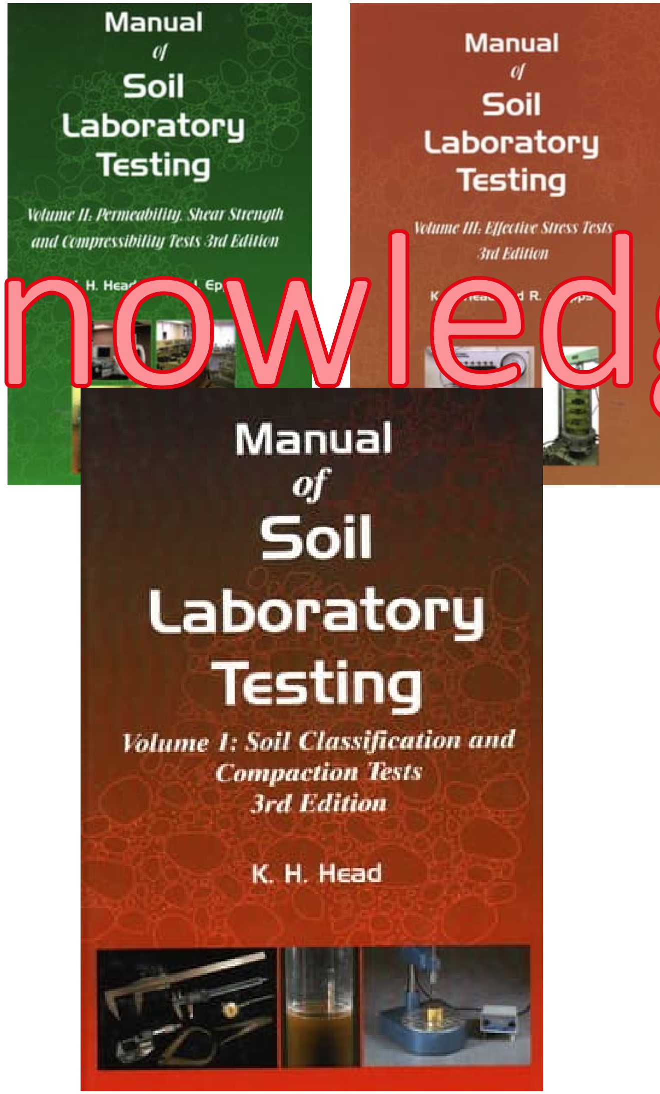
ASTM INTERNATIONAL

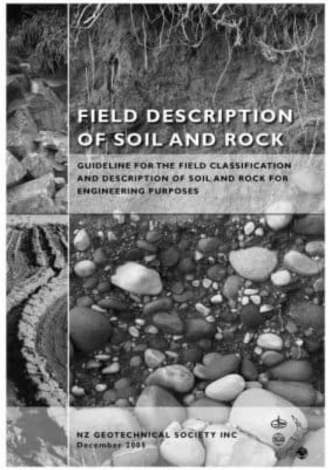
New Zealand Geotechnical Society

AASHTO

Google

Knowledge





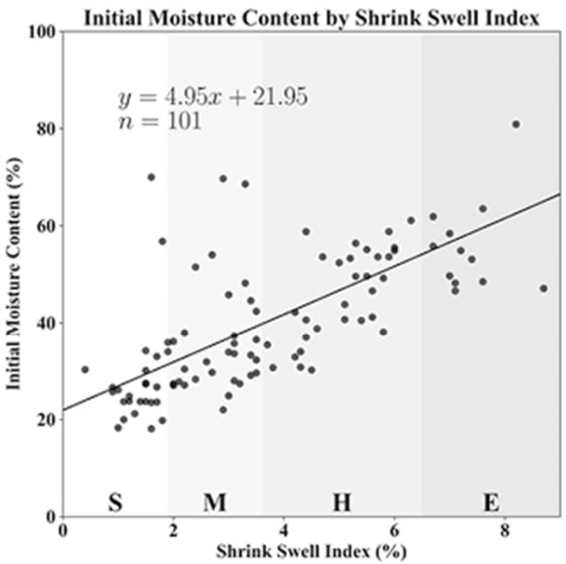
AGS GUIDE

THE SELECTION OF GEOTECHNICAL SOIL LABORATORY TESTING

AGS Association of Geotechnical & Geoenvironmental Specialists

SCHMIDT HAMMER TEST

SHRINK SWELL INDEX



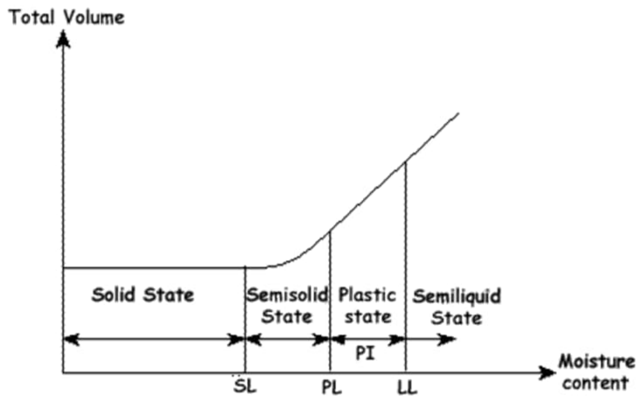


Figure 26: Plot of the shrink swell index against initial moisture content for the Auckland 1 site

References: NZGS & KH Head – Manual of Soil Testing

BACK TO ATTERBERG LIMITS

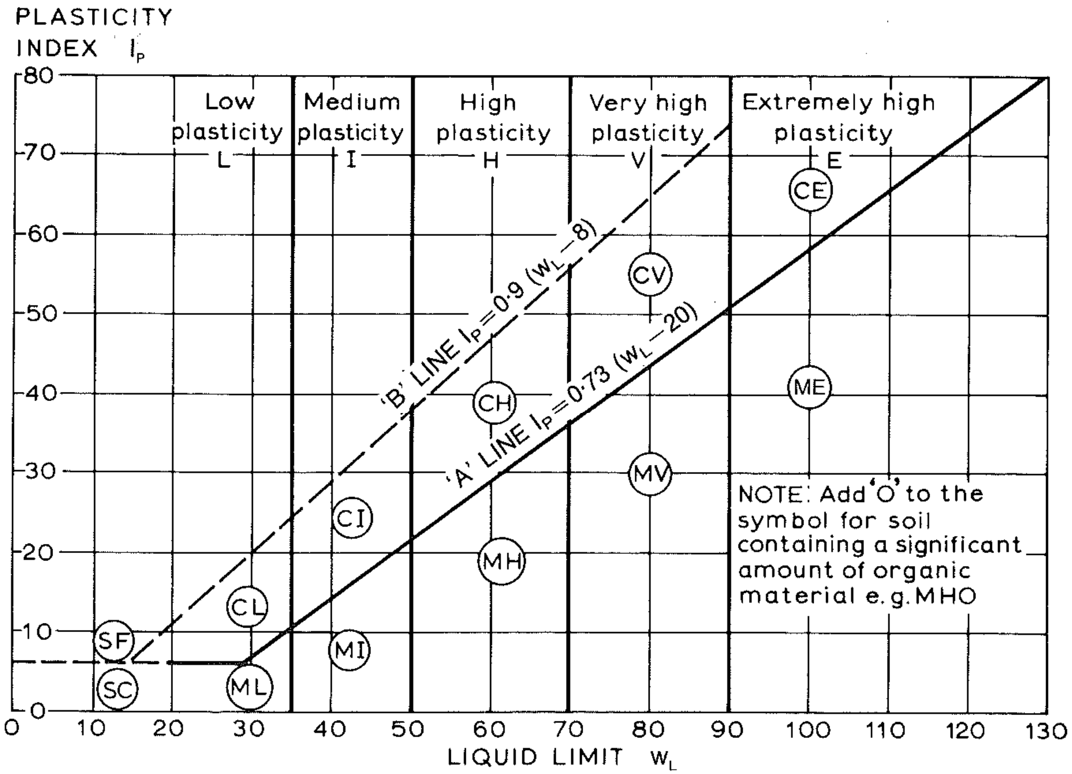


Fig. 2.6 Plasticity chart

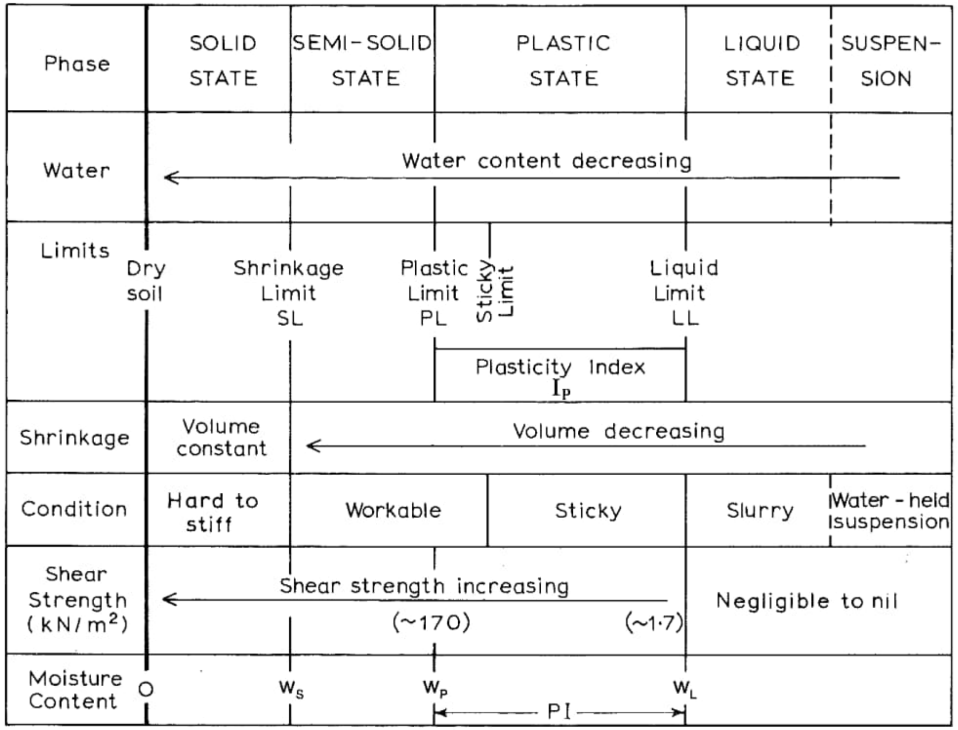


Fig. 2.2 Phases of soil and the Atterberg limits

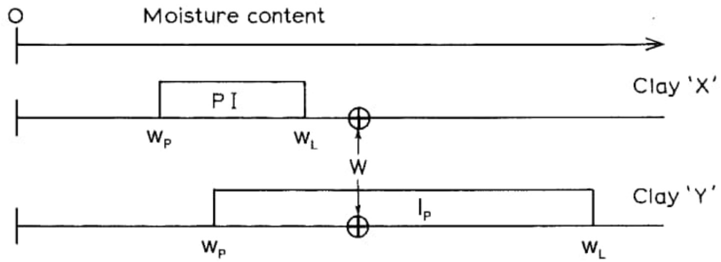


Fig. 2.3 Consistencies of two clays

References: KH Head – Manual of Soil Testing

DESCRIPTIONS

- Hand Descriptions Based on Behaviour
- Coarse soils (sands up) – properties are based on particle size
- Fine soils- (Silts and clays) – properties based on hand description and atterberg limits, due to influence of both size and composition.
- Clay is cohesive and not dilatant
- Silt is dilatant (has a quick behaviour)
- Full descriptions to Field Description of Soil and Rock, NZGS, December 2005

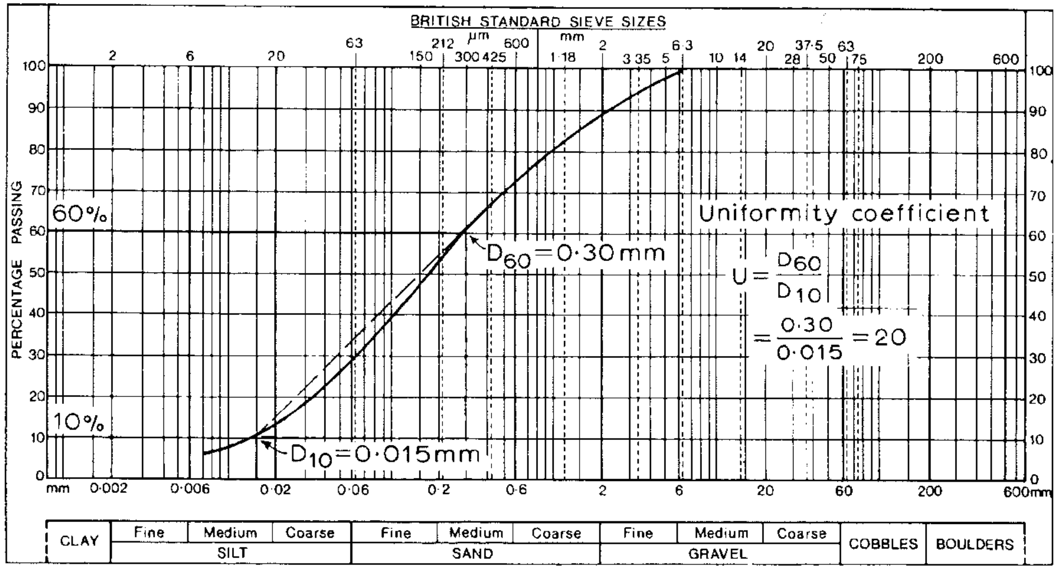


Fig. 4.1(a) Particle size distribution chart

References: KH Head – Manual of Soil Testing

LABORATORY TESTING

- Advantages
- Can control the test conditions in the laboratory.
- More accuracy in measurement.

Disadvantages
- Small test sample representing a large volume.
- Oversize material not accounted for
- Blending homogeneity
- Does not measure macro features, i.e. soil fabric, structure, discontinuities.
- Sample disturbance inhibits determining exact field parameters.

COMPACTION TESTS PUTTING IT ALL TOGETHER

Material	Compaction Effort	Maximum Dry Density (t/m3)	Optimum Water Content (%)
CLAY / silty CLAY	Standard Compaction	~1.40 - ~1.60	~32 - ~ 36
Clayey SILT	Standard Compaction	~1.35 – ~1.55	~26 - ~32
Sandy SILT	Standard Compaction	~1.6	~20 - ~22
SAND – well graded	Standard Compaction	~1.45 - ~1.60	~14 - ~18
GAP 65/GAP 40 Greywacke	Vibrating Compaction	~2.30	~5.5
TNZ M4 Greywacke	Vibrating Compaction	~2.38	~5.0
GAP 65 Greywacke Poor Quality	Vibrating Compaction	~2.20	~6.5
Ash	Standard Compaction	~0.90 - ~1.20	~45 - ~60
Peaty soil	Standard Compaction	~0.70 - ~1.10	~70 - ~100

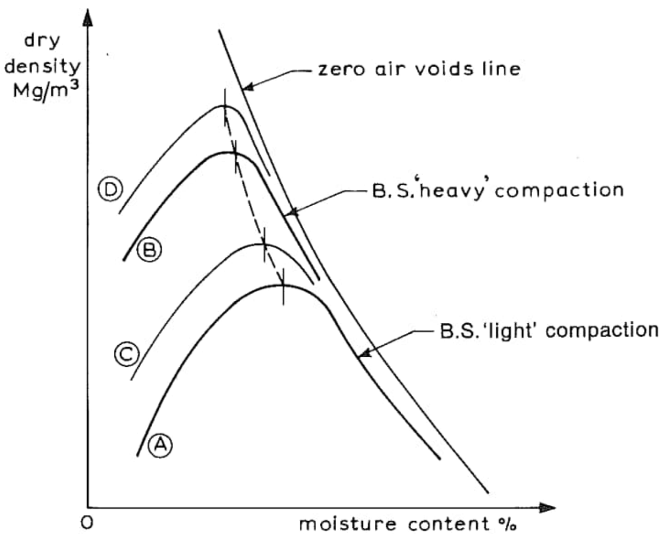
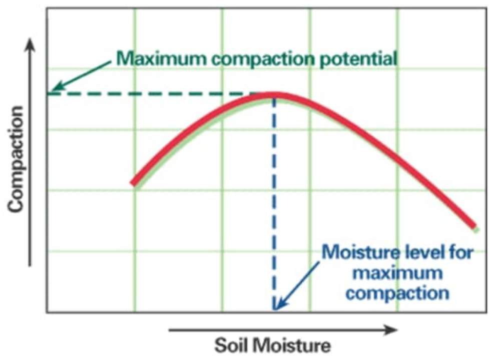
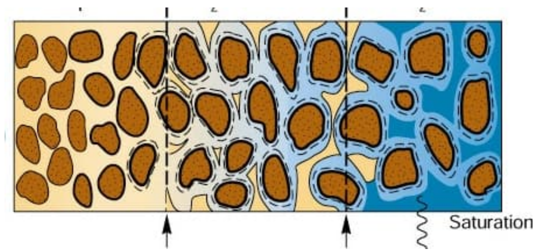


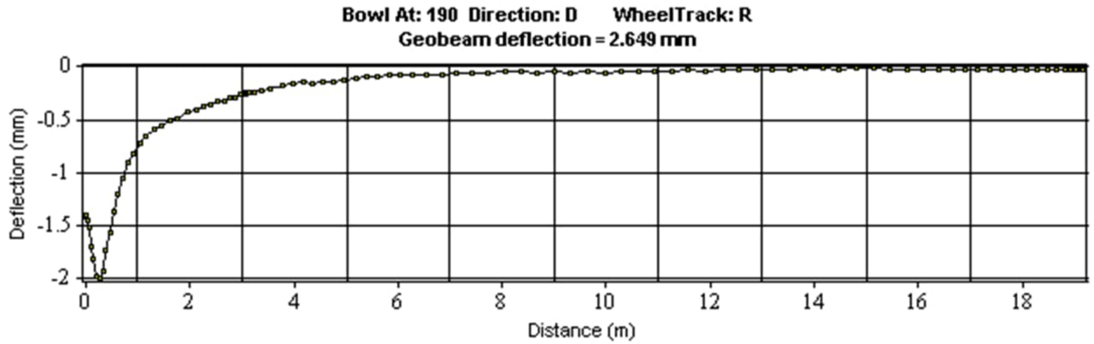
Fig. 6.3 Dry density–moisture curves for various compactive efforts

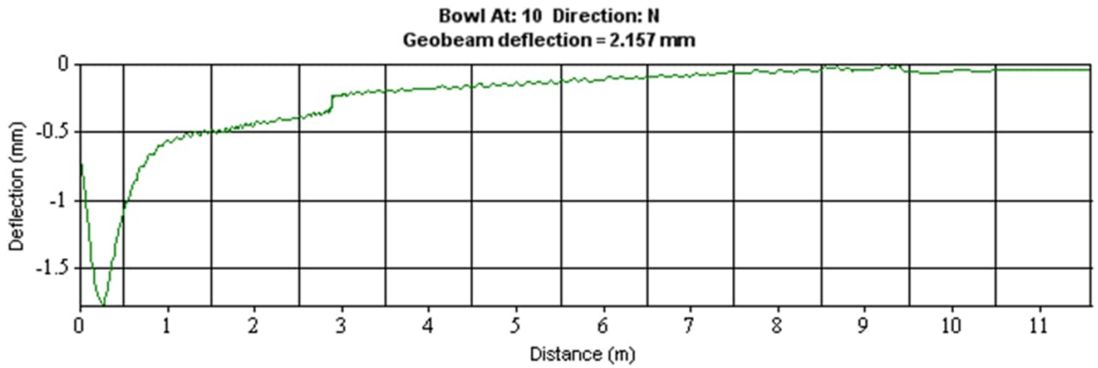


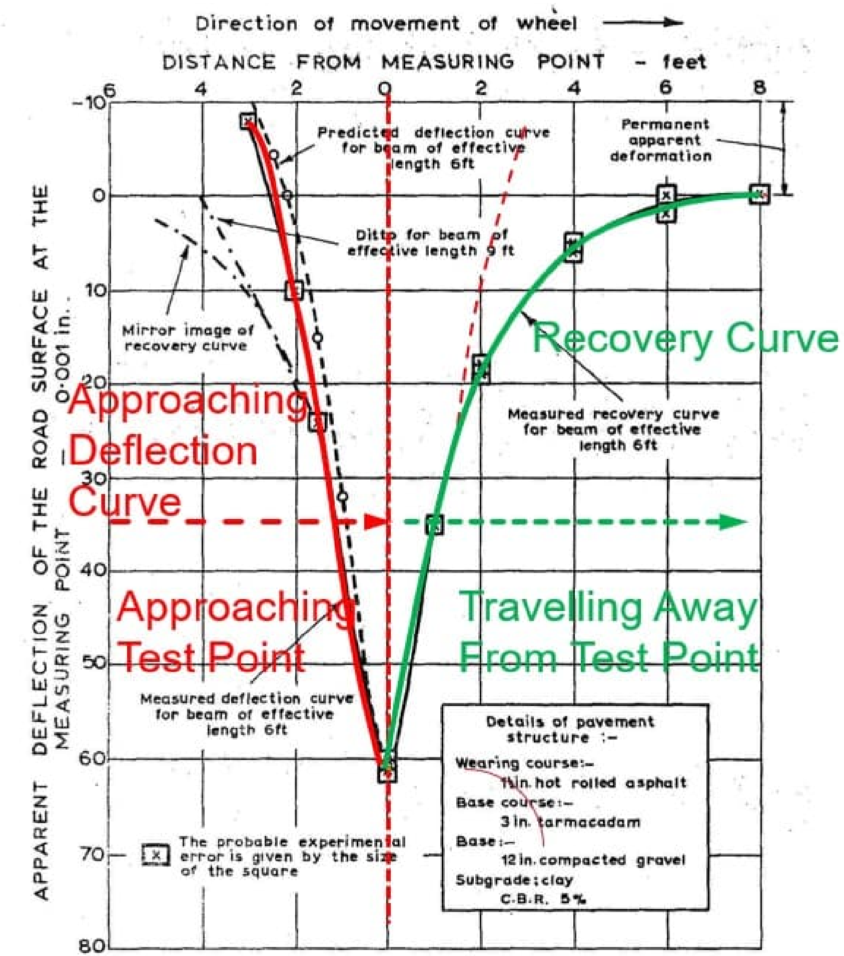


References: KH Head – Manual of Soil Testing

CONTINUOUS DATA







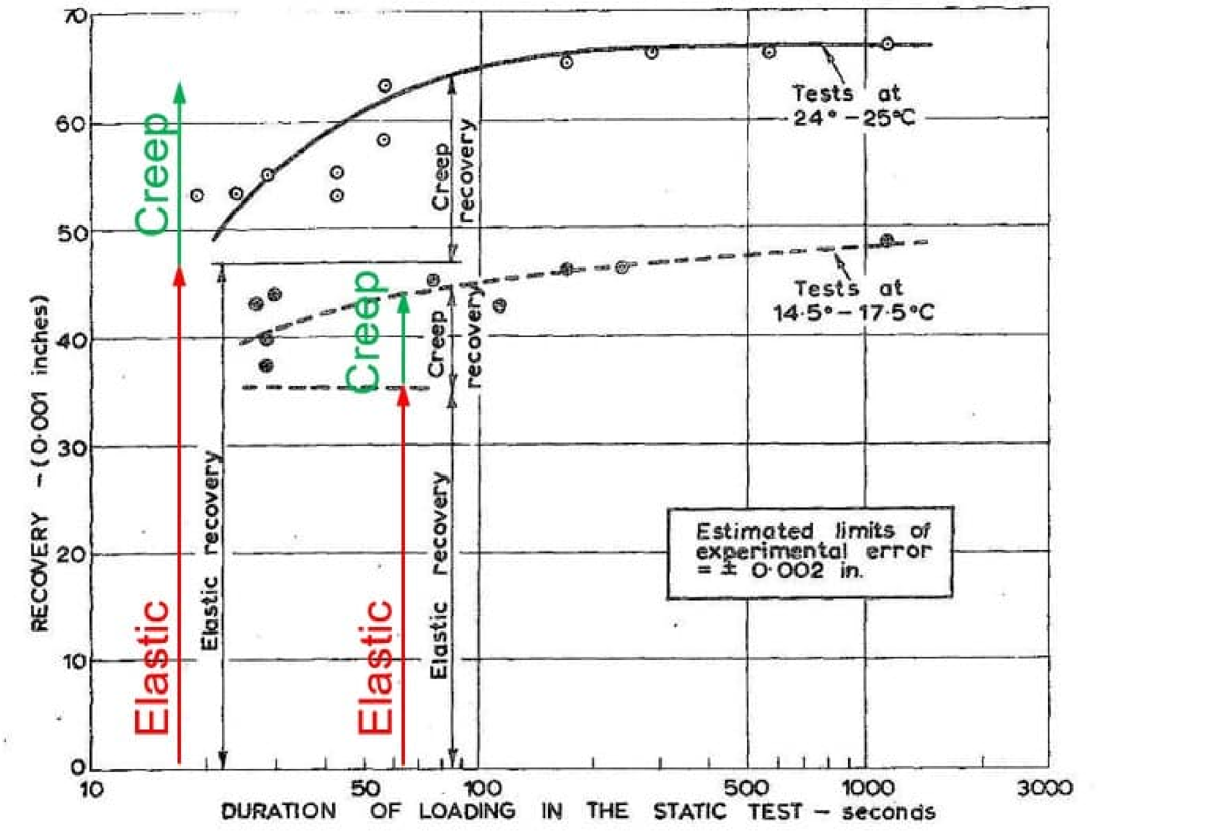
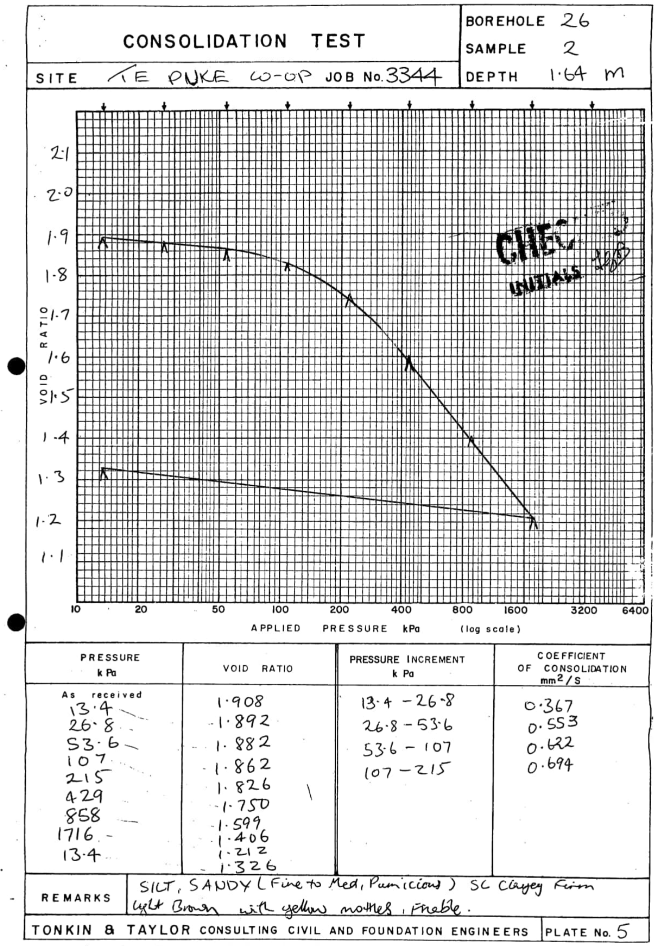
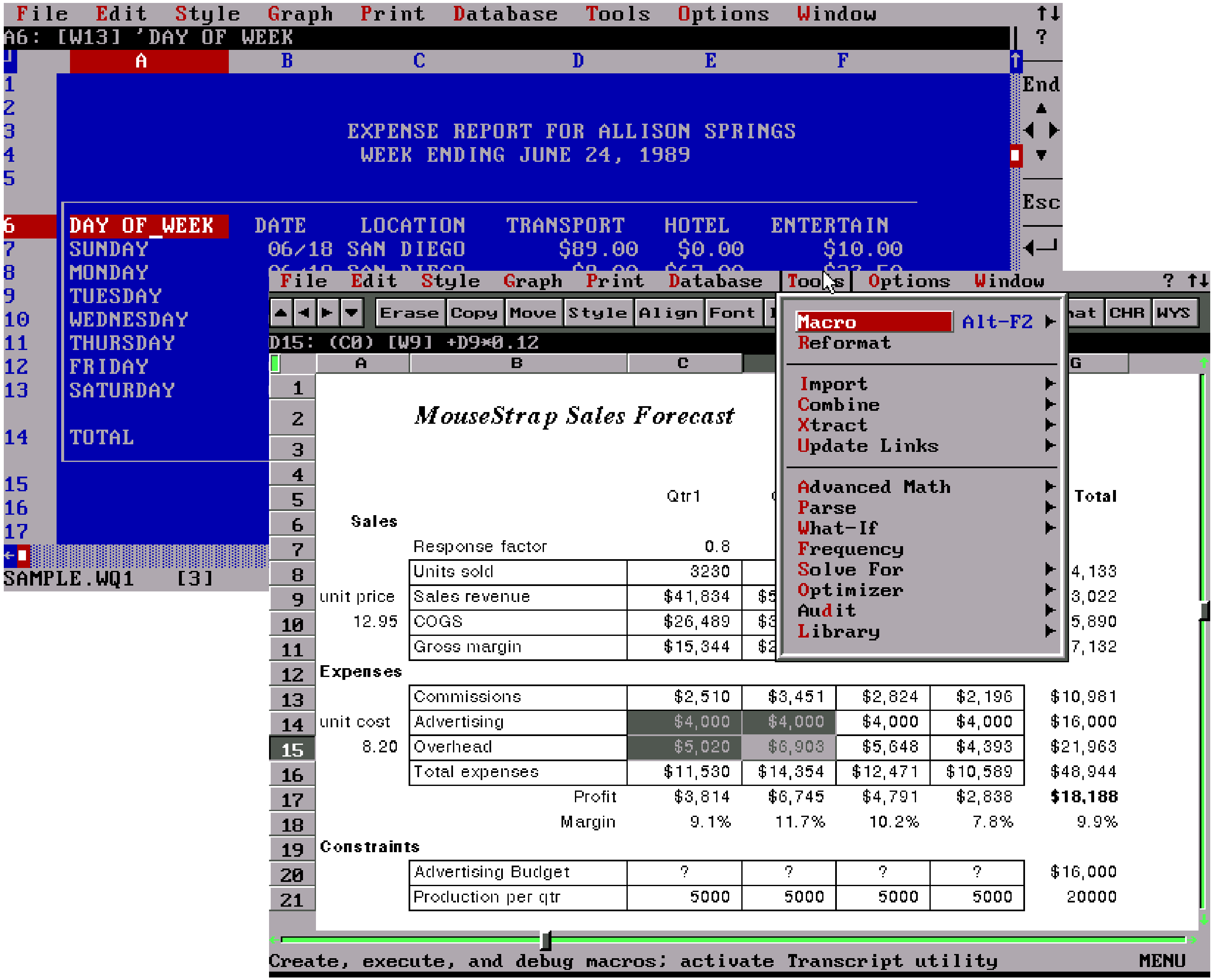


Fig. 4. VARIATION OF RECOVERY WITH THE DURATION OF LOADING IN THE STATIC TEST

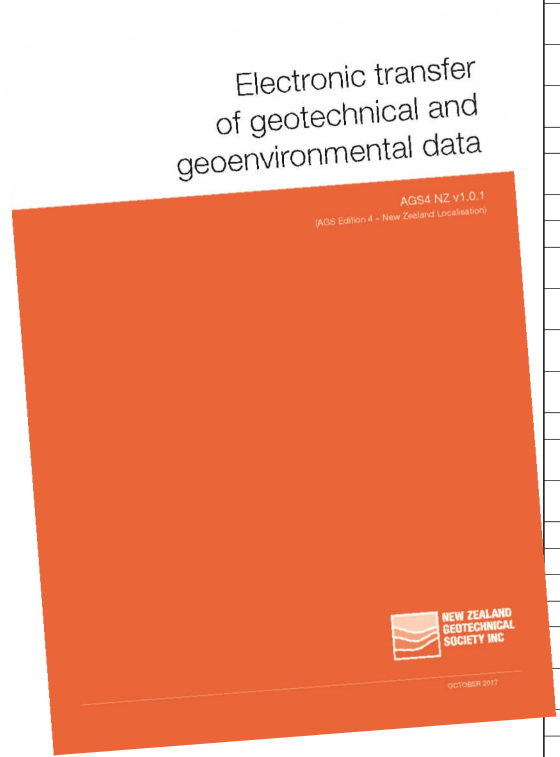
References: UK RRL 1960

DATA


CONSOLIDATION TEST
BOREHOLE 26
SAMPLE 2
DEPTH 1·64 m
SITE TE PUKE CO-OP JOB No. 3344
VOID RATIO
APPLIED PRESSURE kPa (log scale)
CHECKED INITIALS
PRESSURE kPa
VOID RATIO
PRESSURE INCREMENT kPa
COEFFICIENT OF CONSOLIDATION mm²/s
As received
13·4 1·908 13·4 – 26·8 0·367
26·8 1·892 26·8 – 53·6 0·553
53·6 1·882 53·6 – 107 0·622
107 1·862 107 – 215 0·694
215 1·826
429 1·750
858 1·599
1716 1·406
13·4 1·212
1·326
REMARKS SILT, SANDY (Fine to Med, Pumiceous) SC Clayey Firm
Light Brown with yellow mottles, Friable.
TONKIN & TAYLOR CONSULTING CIVIL AND FOUNDATION ENGINEERS
PLATE No. 5


File Edit Style Graph Print Database Tools Options Window
A6: [W13] 'DAY OF WEEK
EXPENSE REPORT FOR ALLISON SPRINGS
WEEK ENDING JUNE 24, 1989
DAY OF WEEK DATE LOCATION TRANSPORT HOTEL ENTERTAIN
SUNDAY 06/18 SAN DIEGO $89.00 $0.00 $10.00
MONDAY
TUESDAY
WEDNESDAY
THURSDAY
FRIDAY
SATURDAY
TOTAL
SAMPLE.WQ1 [3]
End
Esc
File Edit Style Graph Print Database Tools Options Window
Erase Copy Move Style Align Font
D15: (C0) [W9] +D9*0.12
MouseStrap Sales Forecast
Macro Alt-F2
Reformat
Import
Combine
Xtract
Update Links
Advanced Math
Parse
What-If
Frequency
Solve For
Optimizer
Audit
Library
Qtr1
Total
Sales
Response factor 0.8
Units sold 3230
unit price Sales revenue $41,834
12.95 COGS $26,489
Gross margin $15,344
Expenses
Commissions $2,510 $3,451 $2,824 $2,196 $10,981
unit cost Advertising $4,000 $4,000 $4,000 $4,000 $16,000
8.20 Overhead $5,020 $6,903 $5,648 $4,393 $21,963
Total expenses $11,530 $14,354 $12,471 $10,589 $48,944
Profit $3,814 $6,745 $4,791 $2,838 $18,188
Margin 9.1% 11.7% 10.2% 7.8% 9.9%
Constraints
Advertising Budget ? ? ? ? $16,000
Production per qtr 5000 5000 5000 5000 20000
Create, execute, and debug macros; activate Transcript utility
MENU

AGS DATA



This Data Group is modified for NZ use (refer NZ localisation document section 9.4.3)

Group Name: LOCA – Location Details

Status	Heading	Suggested Unit / Type		Description	Example
*	**LOCA_ID**		ID	Location identifier	327-16A
	LOCA_TYPE		PA	Type of activity	CP+RC
	LOCA_STAT		PA	Status of information relating to this position	PRELIM
	LOCA_NATE	m	2DP	National Grid Easting of location or start of traverse	523145.00
	LOCA_NATN	m	2DP	National Grid Northing of location or start of traverse	178456.12
	LOCA_GREF		PA	National grid referencing system used	OSGB
	LOCA_GL	m	2DP	Ground level relative to datum of location or start of traverse	16.23
	LOCA_REM		X	General remarks	
	LOCA_FDEP	m	2DP	Final depth	32.60
	LOCA_STAR	yyyy-mm-dd	DT	Date of start of activity	1991-03-18
	LOCA_PURP		X	Purpose of activity at this location	Groundwater observation well
	LOCA_TERM		X	Reason for activity termination	Abandoned on engineer's instruction
	LOCA_ENDD	yyyy-mm-dd	DT	End date of activity	1991-03-22
	LOCA_LETT		X	OSGB letter grid reference	TQ231784
	LOCA_LOCX	m	2DP	Local grid x co-ordinate or start of traverse	565.23
	LOCA_LOCY	m	2DP	Local grid y co-ordinate or start of traverse	421.12
	LOCA_LOCZ	m	2DP	Level or start of traverse to local datum	106.63
	LOCA_LREF		X	Local grid referencing system used	London grid 1
	LOCA_DATM		X	Local datum referencing system used	Anytown datum
	LOCA_ETRV	m	2DP	National Grid Easting of end of traverse	523195.12
	LOCA_NTRV	m	2DP	National Grid Northing of end of traverse	178486.12
	LOCA_LTRV	m	2DP	Ground level relative to datum of end of traverse	9.67
	LOCA_XTRL	m	2DP	Local grid easting of end of traverse	523195.12
	LOCA_YTRL	m	2DP	Local grid northing of end of traverse	178486.12
	LOCA_ZTRL	m	2DP	Local elevation of end of traverse	9.67
	LOCA_LAT		DMS	Latitude of location or start of traverse	51:28:52.498
	LOCA_LON		DMS	Longitude of location or start of traverse	34:10:34.23
	LOCA_ELAT		DMS	Latitude of end of traverse	51:28:52.550
	LOCA_ELON		DMS	Longitude of end of traverse	34:10:34.23

AGS

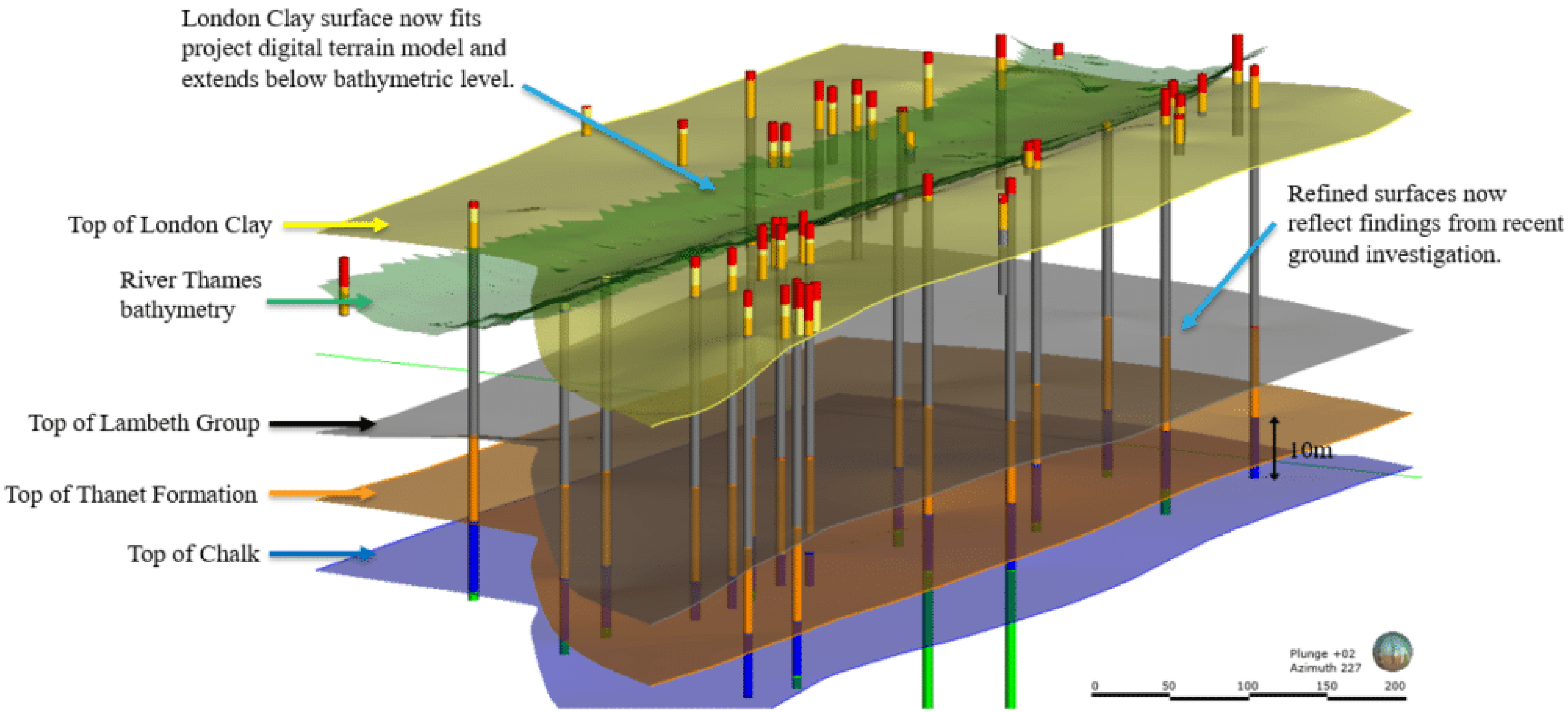
Example AGS Format data file

The following is an example of AGS Format. This demonstrates the basics of the format construct and is not complete.

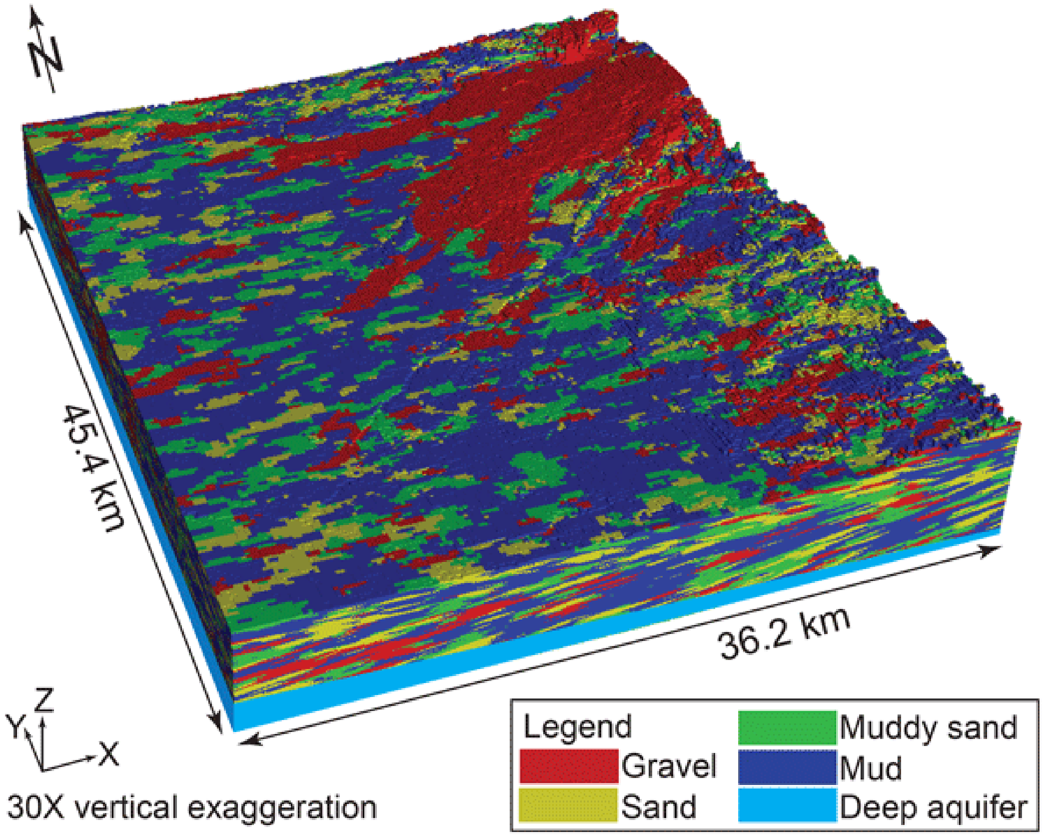
```
“GROUP”,”PROJ”
“HEADING”,”PROJ_ID”,”PROJ_NAME”,”PROJ_LOC”,”PROJ_CLNT”,”PROJ_CONT”,”PROJ_ENG”
“UNIT”,””,””,””,””,””,””
“TYPE”,”ID”,”X”,”X”,”X”,”X”,”X”
“DATA”,”121415”,”ACME Gas Works Redevelopment”,” Anytown”,”ACME Enterprises”,”ACME Drilling Ltd”,”ACME Consulting”

“GROUP”,”TRAN”
“HEADING”,”TRAN_ISNO”,”TRAN_DATE”,”TRAN_PROD”,”TRAN_STAT”,”TRAN_DESC”,”TRAN_AGS”,”TRAN_RECV”,”TRAN_DLIM”,”TRAN_RCON”
“UNIT”,””,”yyyy-mm-dd”,””,””,””,””,””,””,””
“TYPE”,”X”,”DT”,”X”,”X”,”X”,”X”,”X”,”X”,”X”
“DATA”,”1”,”2009-04-01”,”ACME Drilling Ltd”,”DRAFT”,”Draft Logs only”,”4.0”,”ACME Consulting”,”|”,”+”

“GROUP”,”TYPE”
“HEADING”,”TYPE_TYPE”,”TYPE_DESC”
“UNIT”,””,””
“TYPE”,”X”,”X”
“DATA”,”ID”,”Unique Identifier”
“DATA”,”X,”Text”
“DATA”,”PA,”Text listed in ABBR Group”
“DATA”,”DT”,” Date time in international format “
“DATA”,”2DP”,” Value; 2 decimal places”

“GROUP”,”UNIT”
“HEADING”,”UNIT_TYPE”,”UNIT_DESC”
“UNIT”,””,””
“TYPE”,”X”,”X”
“DATA”,”m”,”metres”
“DATA”,”yyyy-mm-dd”,”date”

“GROUP”,”LOCA”
“HEADING”,”LOCA_ID”,”LOCA_NATE”,”LOCA_NATN”
“UNIT”,””,”m”,”m”
“TYPE”,”ID”,”2DP”,”2DP”
“DATA”,”327-16A”,”523145.00”,”178456.12”

“GROUP”,”SAMP”
“HEADING”,”LOCA_ID”,”SAMP_TOP”,”SAMP_REF”,”SAMP_TYPE”,”SAMP_ID”,”SAMP_BASE”,”SAMP_CONT”
“UNIT”,””,”m”,””,””,””,”m”,””
“TYPE”,”ID”,”2DP”,”X”,”PA”,”ID”,”2DP”,”X”
“DATA”,”327-16A”,”24.55”,”24”,”U”,”ABC121415010”,”25.00”,””
```

References: NZGS – AGS Data Transfer

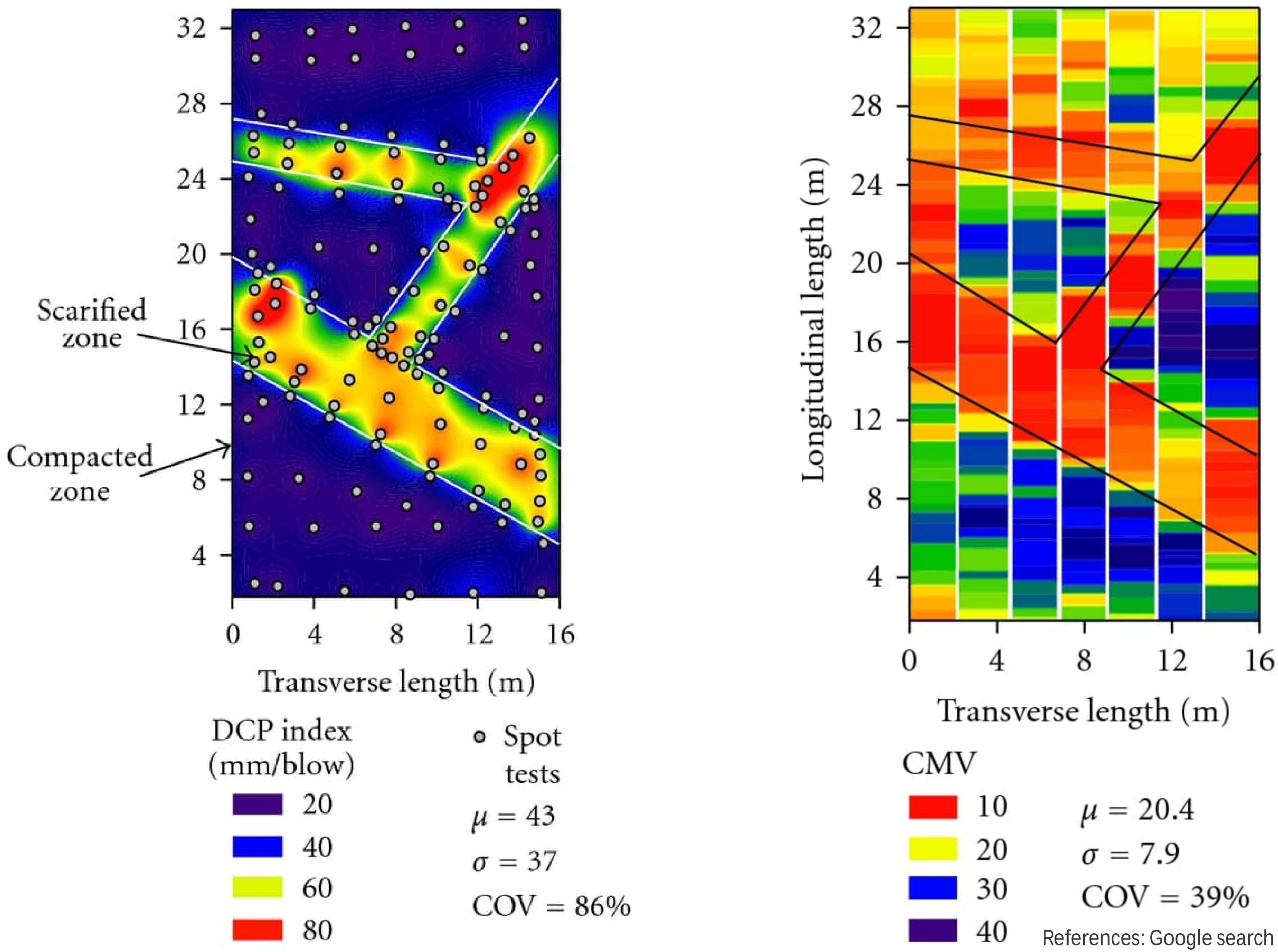
LAB SOFTWARE



References: Google search for an image



References: Google https://hess.copernicus.org/articles/24/2437/2020/



References: Google search for intelligent compaction

GEOTECHNICS