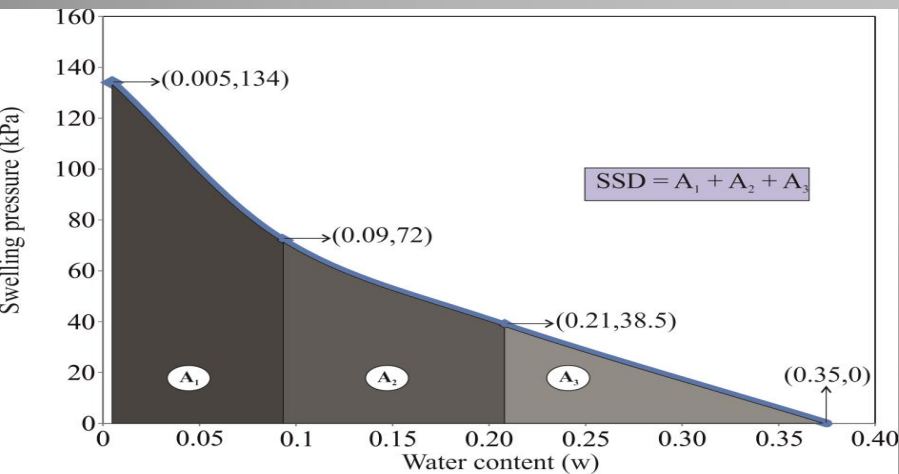
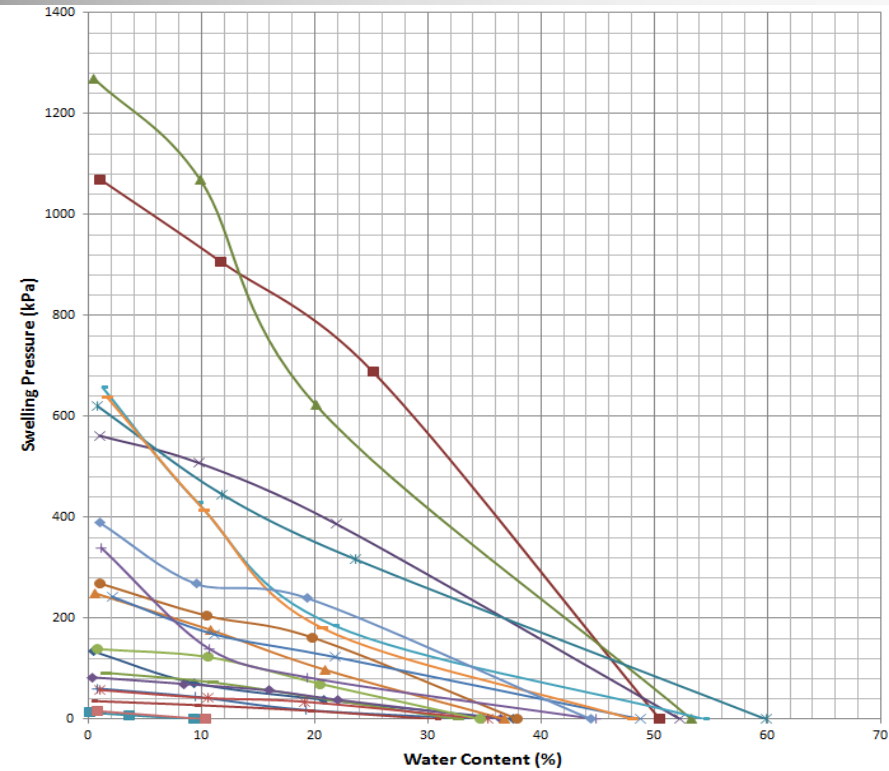


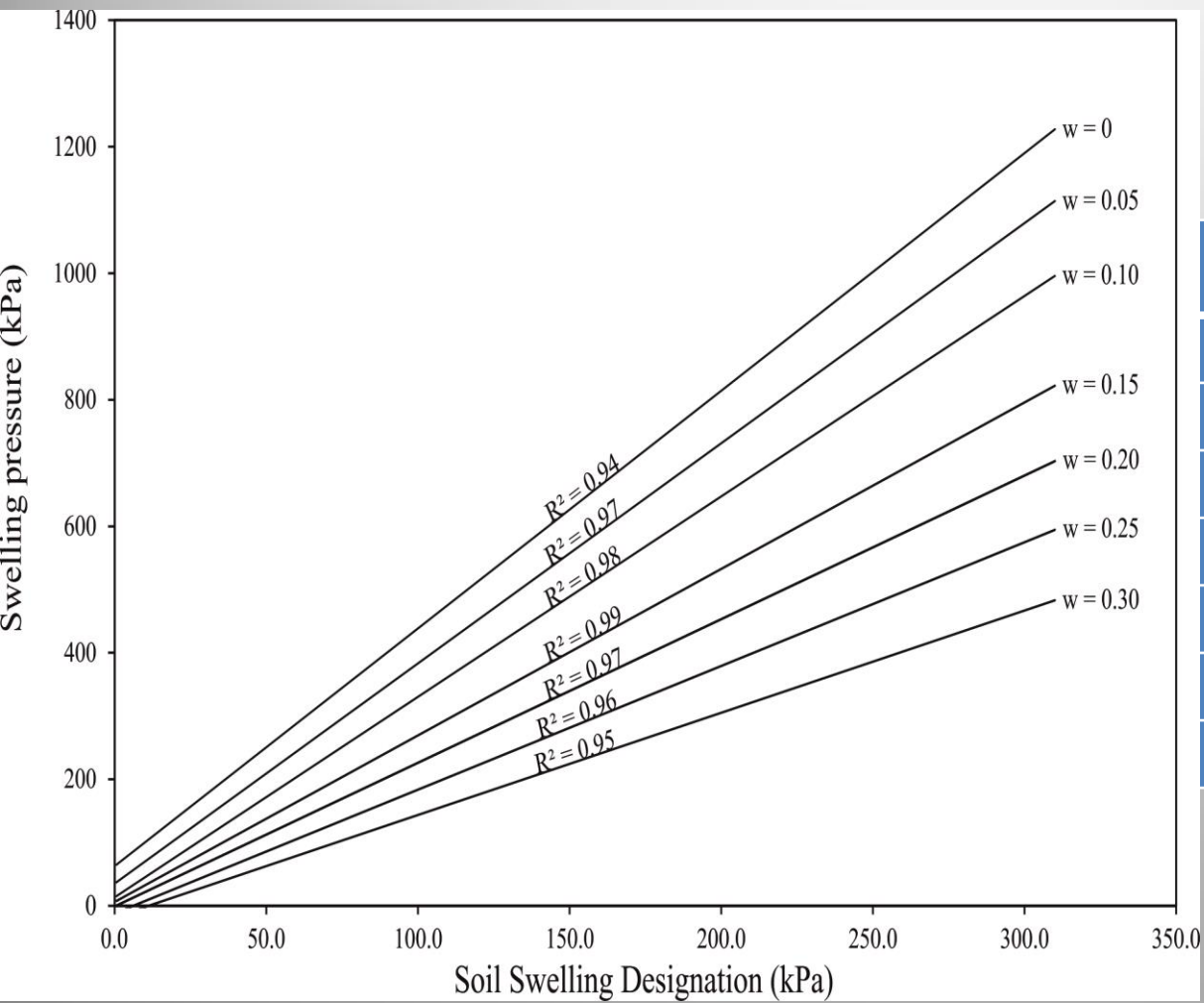


# ➤ Soil Swelling Designation (SSD)

Soil Swelling Designation to predict swelling pressure of samples practically

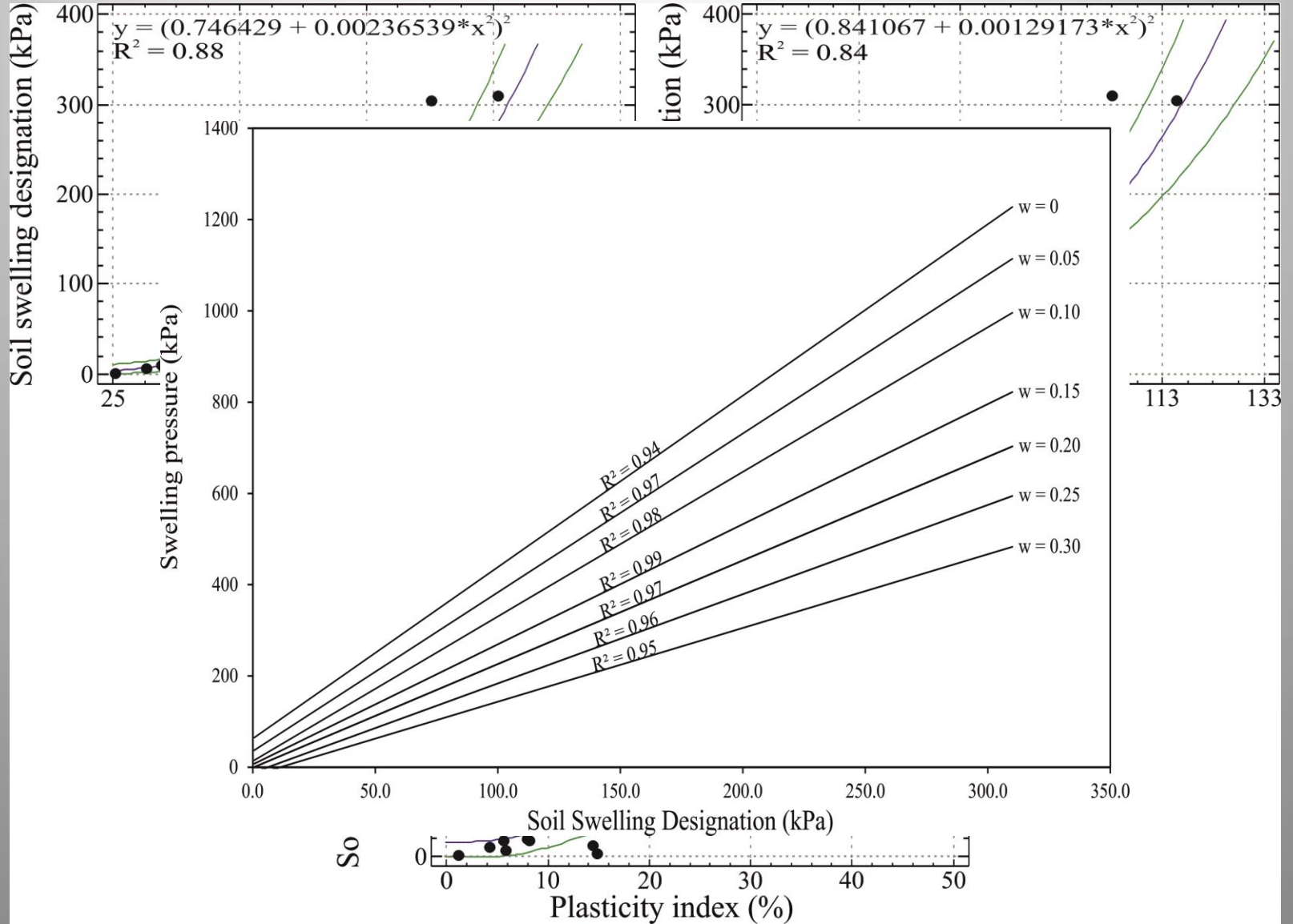


Location	Swelling Pressure in Dry Conditions	Soil Swelling Designation (SSD)
L1	140	19.1
L2	1085	310.1
L3	1275	305.3
L4	570	165.3
L5	638	165.3
L6	280	56.6
L7	62	9.4
L8	36.2	6.2
L9	260	44.7
L10	95	17.0
L11	81	16.9
L12	13.2	0.6
L13	267	55.0
L14	60	11.3
L15	140	28.4
L16	365	45.8
L17	692	119.9
L18	685	109.7
L19	403	86.3
L20	16.2	2.3



Water content (w)	Equation	R <sup>2</sup>
0.00	SP = 62.3098 + 3.75656*SSD	0.94
0.05	SP = 35.0003 + 3.47983* SSD	0.97
0.10	SP = 12.0648 + 3.17359* SSD	0.98
0.15	SP = 6.1056 + 2.63251* SSD	0.99
0.20	SP = -1.20314 + 2.27147* SSD	0.97
0.25	SP = -12.018 + 1.95532* SSD	0.96
0.30	SP = -18.2072 + 1.61639* SSD	0.95

# “SSD-LL” , “SSD-PI” ve “SSD-W<sub>max24</sub>” arasındaki ilişki



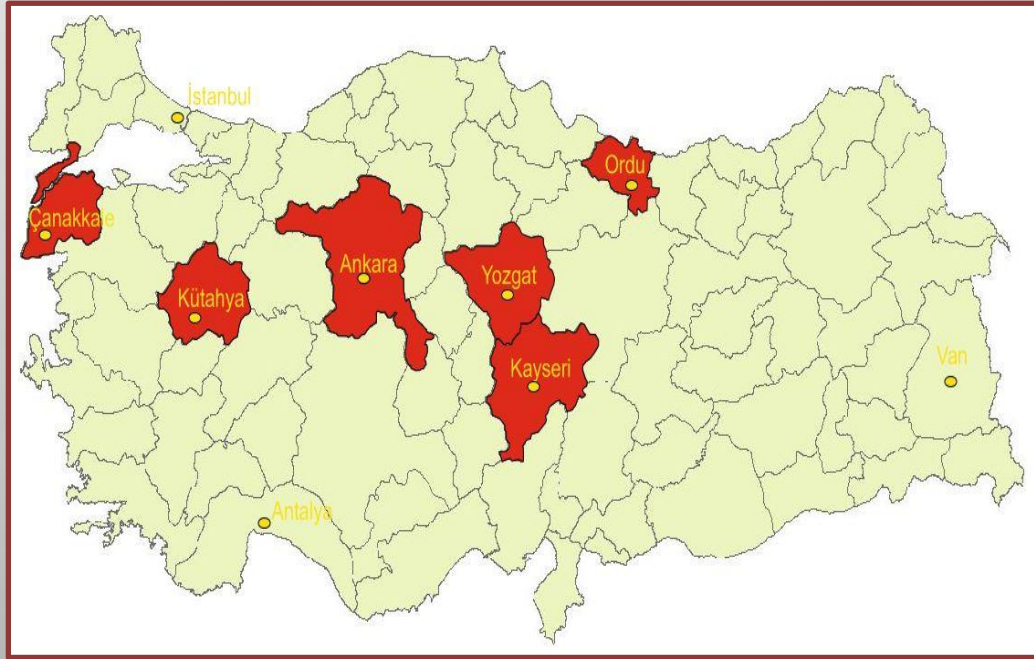
## Main purposes

- Water content has important effect on swelling behavior of soils
- The relationship between swelling parameters and water content is very important to understanding swelling behavior of soils
- We tried to investigate the swelling behavior of soils in different water content conditions

Therefore,

- To see the effect of other properties (physical-index-mineralogical) we have performed some regression analyses between swelling parameters and these properties to predict the swelling parameters practically.

# Sampling Locations



- All of the samples were collected from different cities (Çanakkale, Kütahya, Ankara, Yozgat, Kayseri and Ordu)
- The reason for taking samples from different cities&regions is to investigate the effect of physical-index properties and mineralogical composition in wider range.

# Laboratory Tests

## **A) Physical and Index Analyses**

- Grain Size Distribution Analysis
- Consistency Limits
- Specific Gravity
- Dry Unit Weight
- The maximum water content approaches (denoted as  $W_{max}$ )

## **B) Mineralogical Analyses**

- X-Ray Diffraction (XRD) Analyses

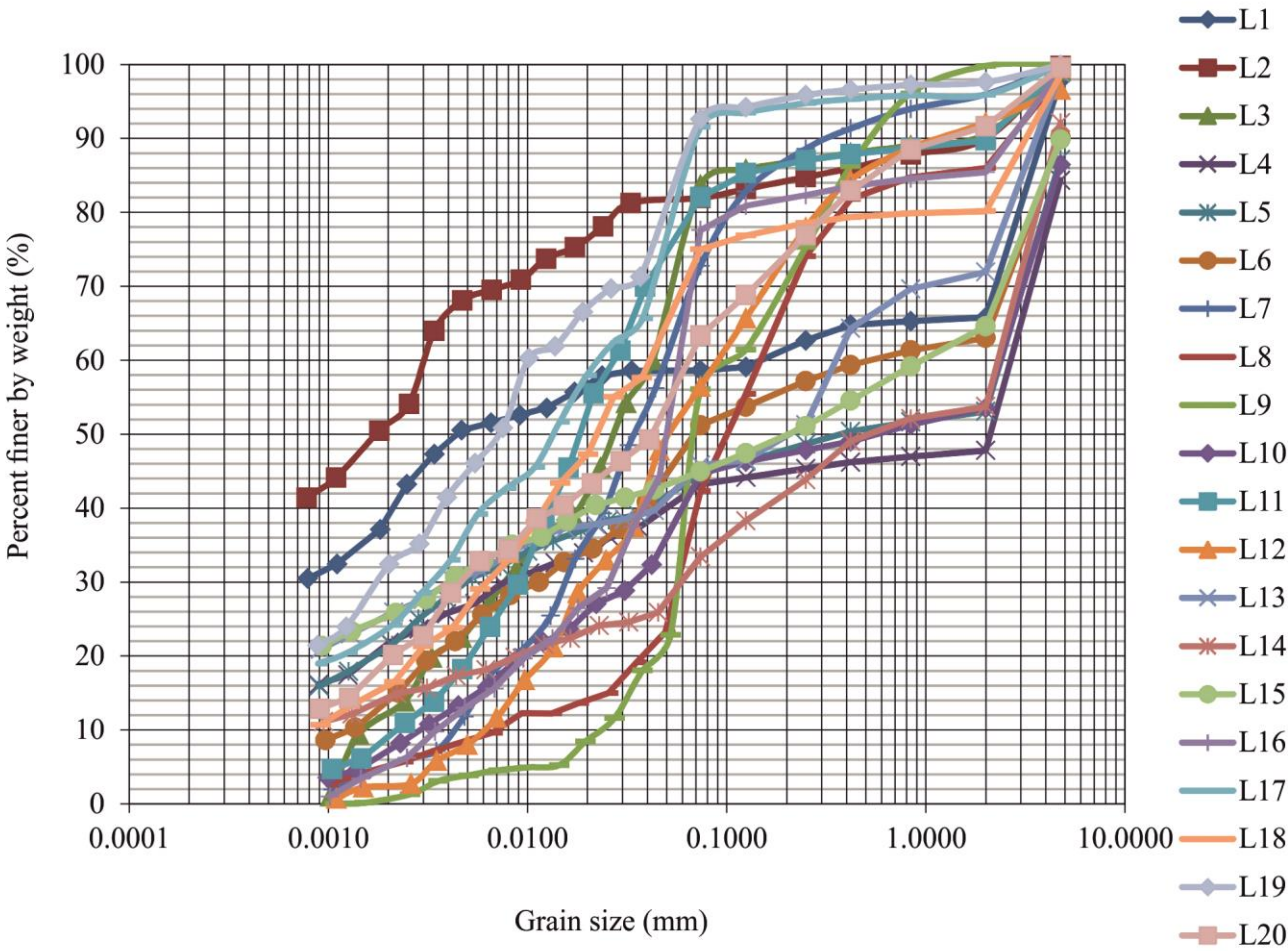
## **C) Swelling Tests**

- Swelling Pressure Dependent on Initial Water Content



# A) Physical and Index Properties

## ➤ Grain Size Distribution



**Gravel (%): 0 - 15.8**  
**Sand (%): 15.54 – 58.70**  
**Silt (%): 15.42 – 71.37**  
**Clay (%): 0.5 – 51.9**



➤ **Consistency Limits**



**LL:** 25.28 – 85.77

**PL:** 18.44 – 44.81

**PI:** 1.08 – 46.68

➤ **Specific Gravity:** 2.60-2.68

➤ **Dry Unit Weight:** 14.6 kN/m<sup>3</sup>

# ➤ Maximum water content approach

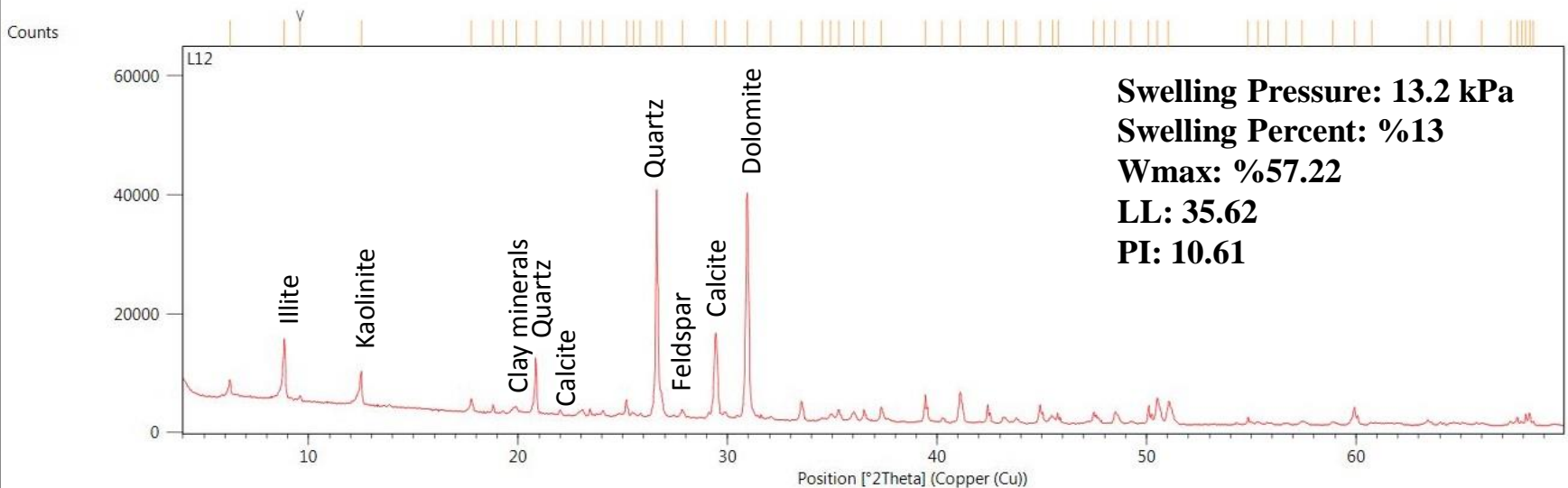
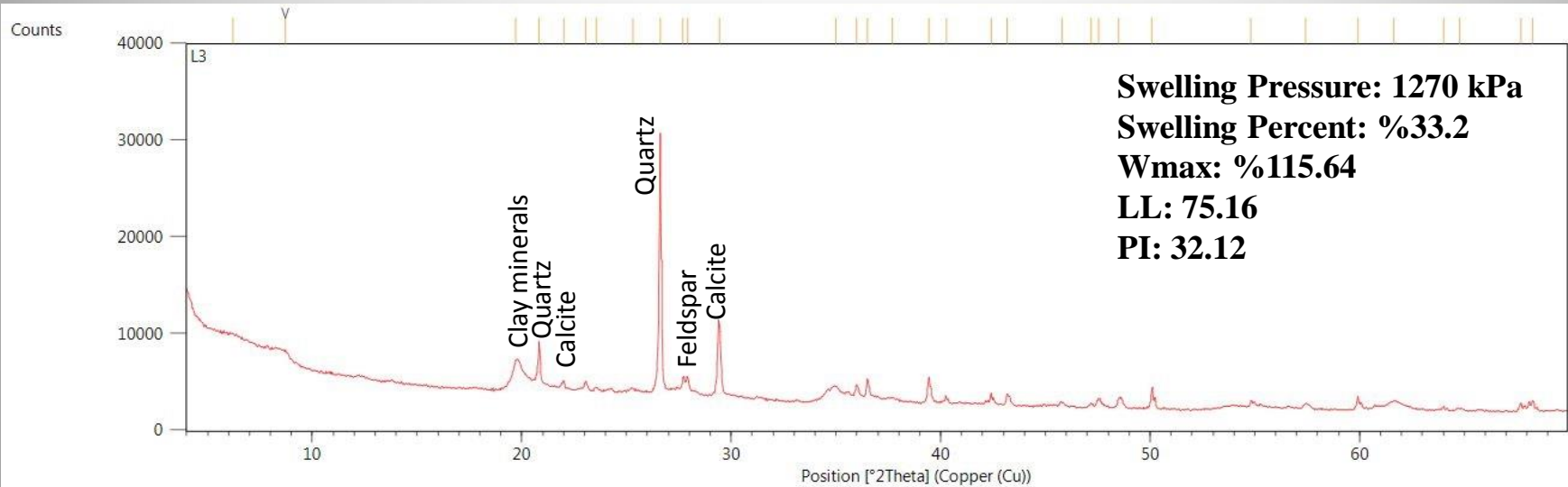
## $W_{max}$ determinations

	Example A	Example B
	The grain and sieve aperture sizes are exaggerated	
Grain sizes before sieving		
	Discard material retained on the 425- $\mu$ m sieve	No discard material retained on the 425- $\mu$ m sieve
Material passed 425- $\mu$ m sieve		
	$Mass_A \ll Mass_B$ $LL_A \approx LL_B$ and $PL_A \approx PL_B$	
	Finer grains (<0.425 mm)	Coarser grains (>0.425 mm)

$$W_{max} (\%) = \frac{W_1 - W_2}{W_2 - W_0} * 100$$



## B) Mineralogical Properties



## C) Swelling tests

- Oedometer devices are used to investigate swelling properties of samples



### Samples preparations for swelling tests

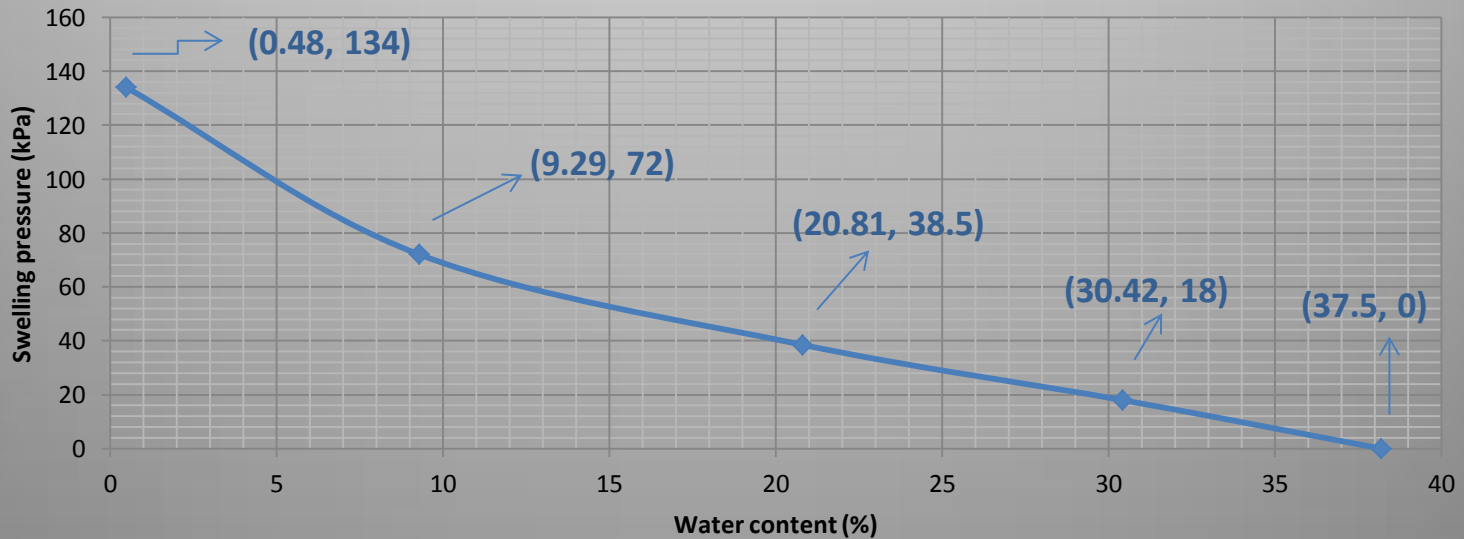
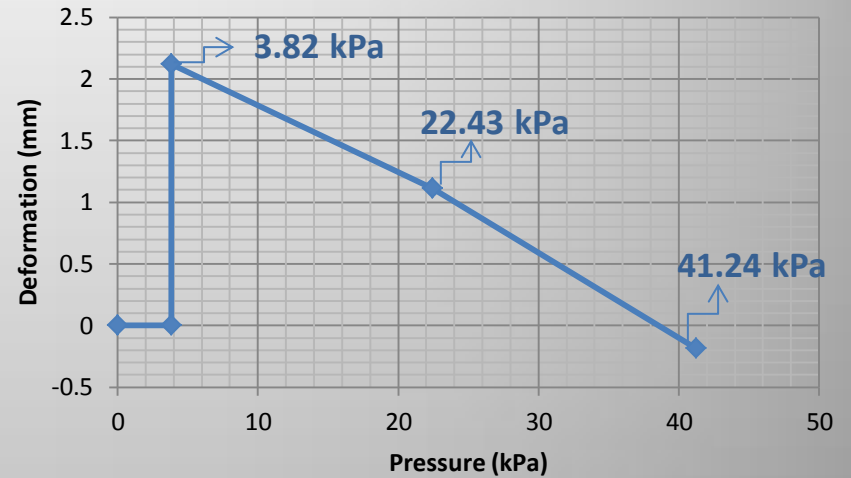
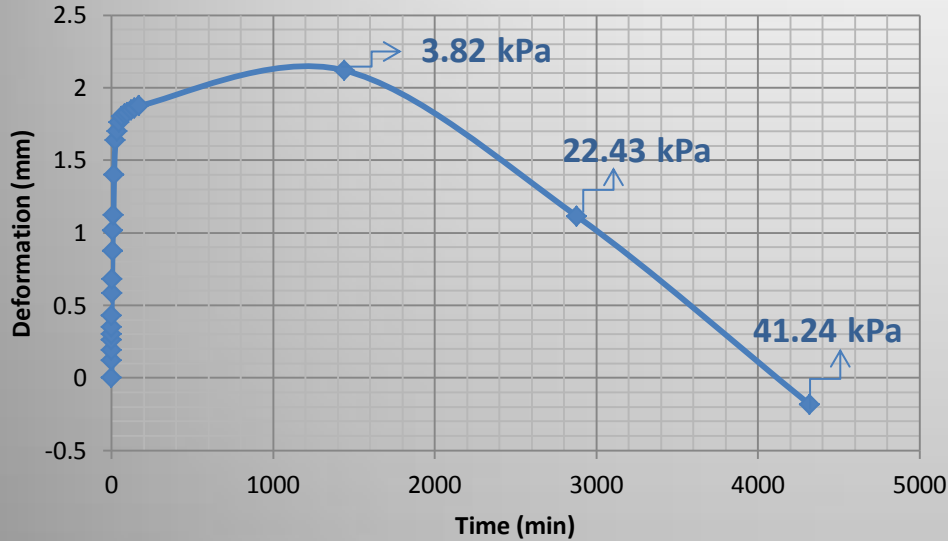
- To minimize the effect of dry unit weight on swelling behavior of soils, samples are prepared at same dry unit weight (14.6 kN/m<sup>3</sup>).



Swelling tests were performed on samples prepared in different water content.

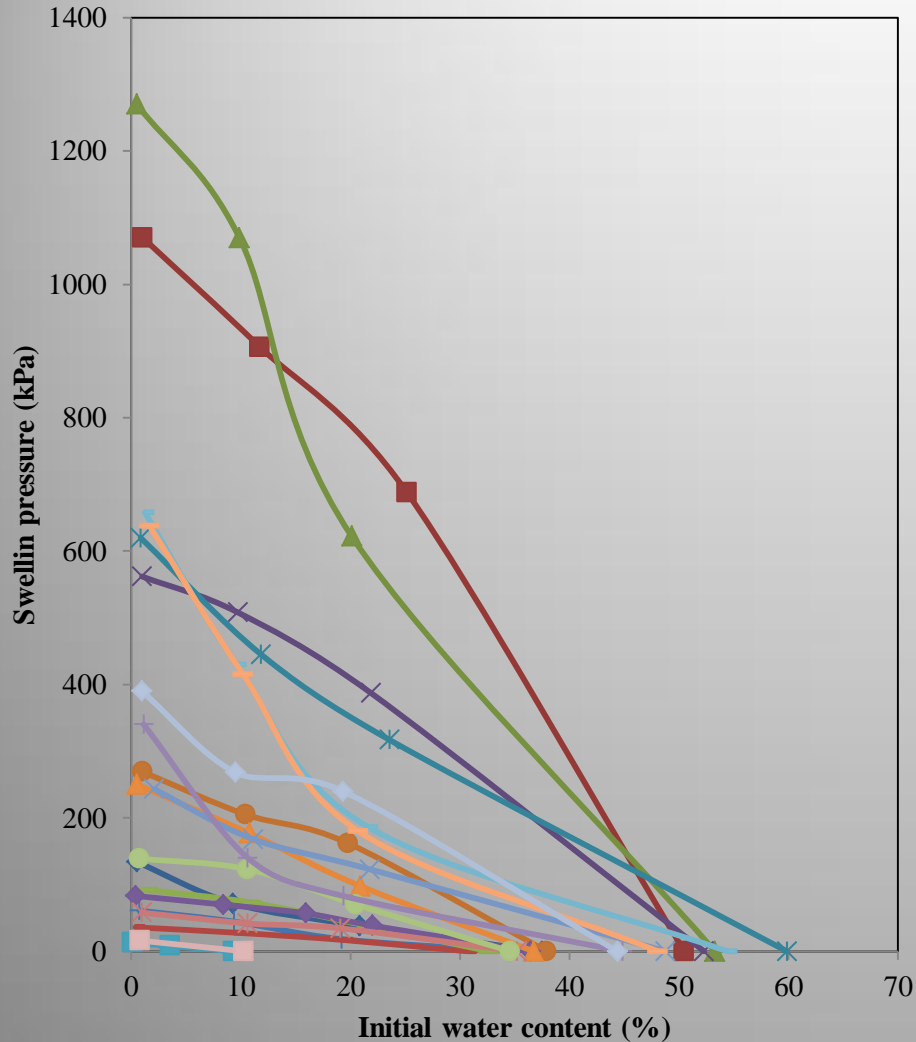
# Analyses

## Determining swelling pressure





# The correlations between swelling pressure and water content

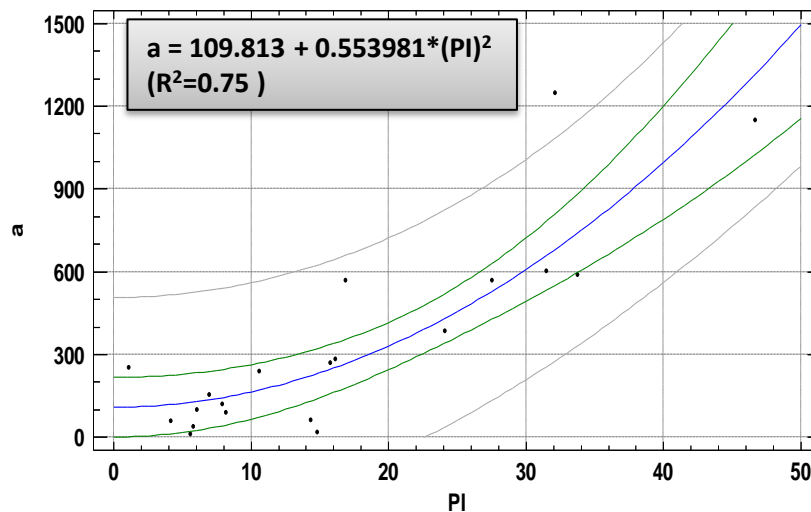
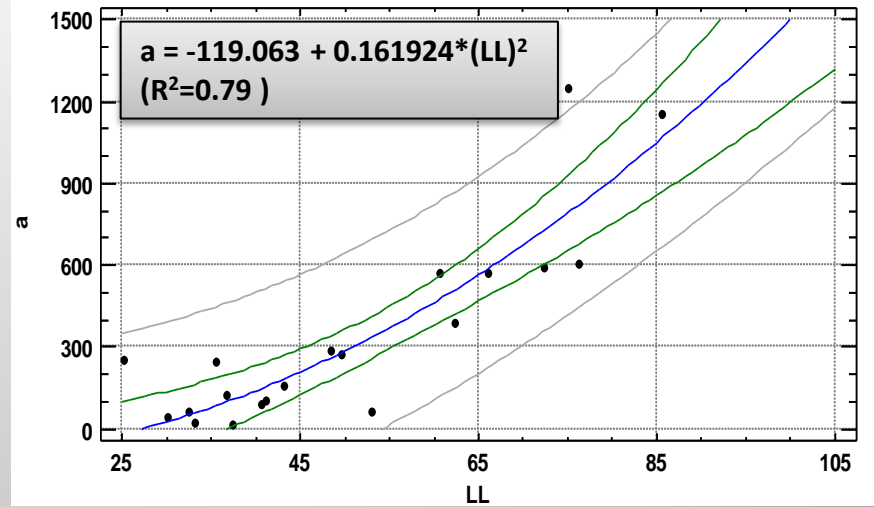
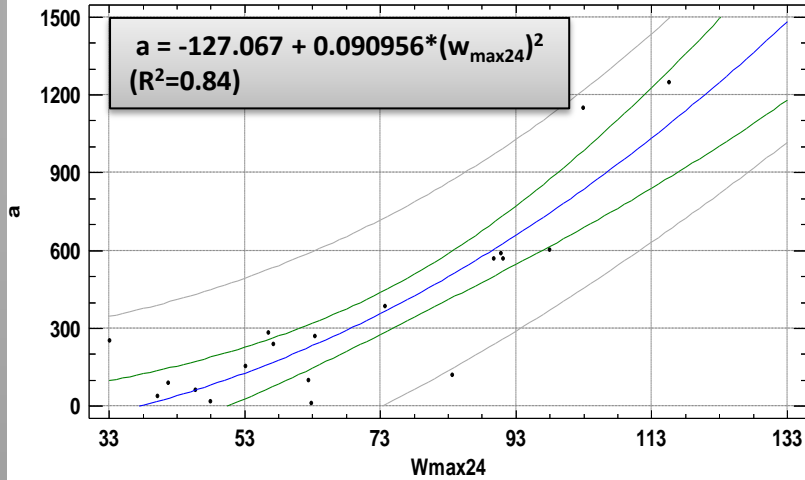


Location	Equations	R <sup>2</sup>
L1	$y = 1119.41 - 3.425 * x$	0.93
L2	$y = 1148.6 - 21.834 * x$	0.98
L3	$y = 1245.9 - 24.136 * x$	0.97
L4	$y = 602.99 - 11.248 * x$	0.99
L5	$y = 588.76 - 10.123 * x$	0.98
L6	$y = 289.78 - 8.01 * x$	0.96
L8	$y = 38.014 - 1.1881 * x$	0.99
L9	$y = 258.59 - 7.9428 * x$	1.00
L10	$y = 100.8 - 3 * x$	0.99
L11	$y = 88.485 - 2.331 * x$	0.98
L12	$y = 13.054 - 1.4025 * x$	1.00
L13	$y = 238.07 - 4.991 * x$	0.98
L14	$y = 60.953 - 1.6633 * x$	0.98
L15	$y = 153.87 - 4.2656 * x$	0.97
L16	$y = 270.25 - 6.8203 * x$	0.78
L17	$y = 567.07 - 11.4375 * x$	0.87
L18	$y = 569.78 - 12.9679 * x$	0.89
L19	$y = 383.72 - 8.58215 * x$	0.98
L20	$y = 16.466 - 0.56838 * x$	1.00

$$\text{Swelling Pressure (kPa)} = a - b * w(\%)$$

$$\text{Swelling Pressure (kPa)} = a - b * w(\%)$$

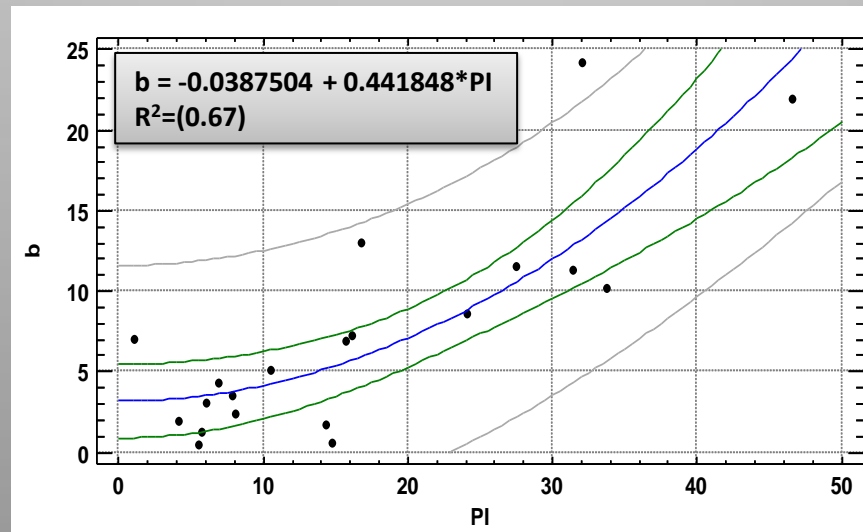
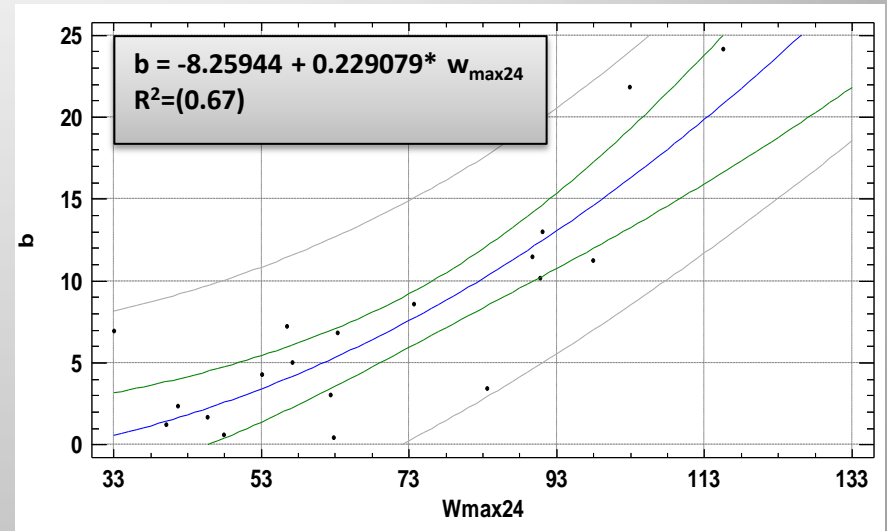
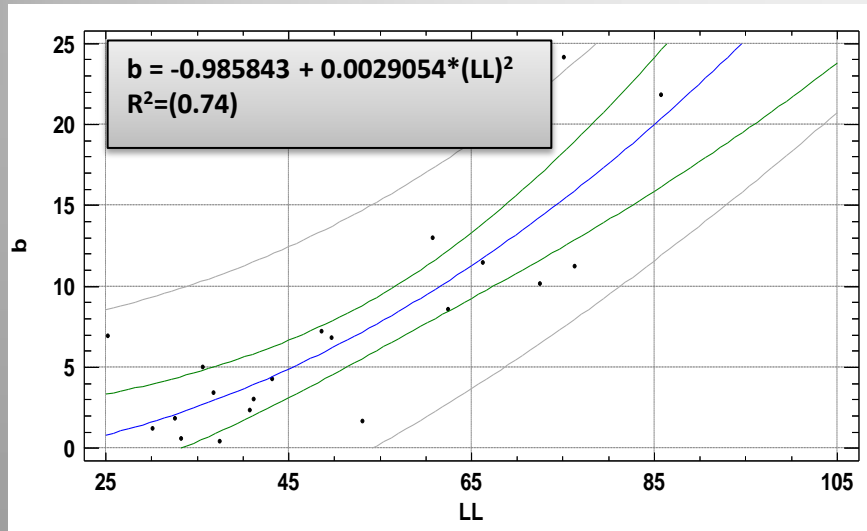
The relationship between “ $a - W_{\max 24}$ ”, “ $a - LL$ ” and “ $a - PI$ ”



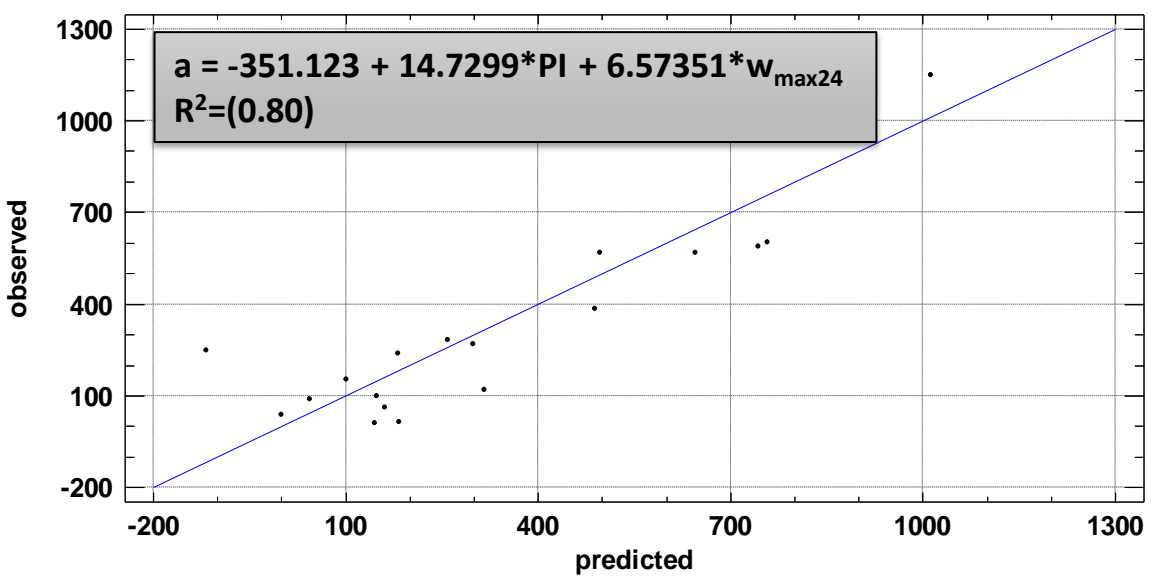


$$\text{Swelling pressure (kPa)} = a - b * w(\%)$$

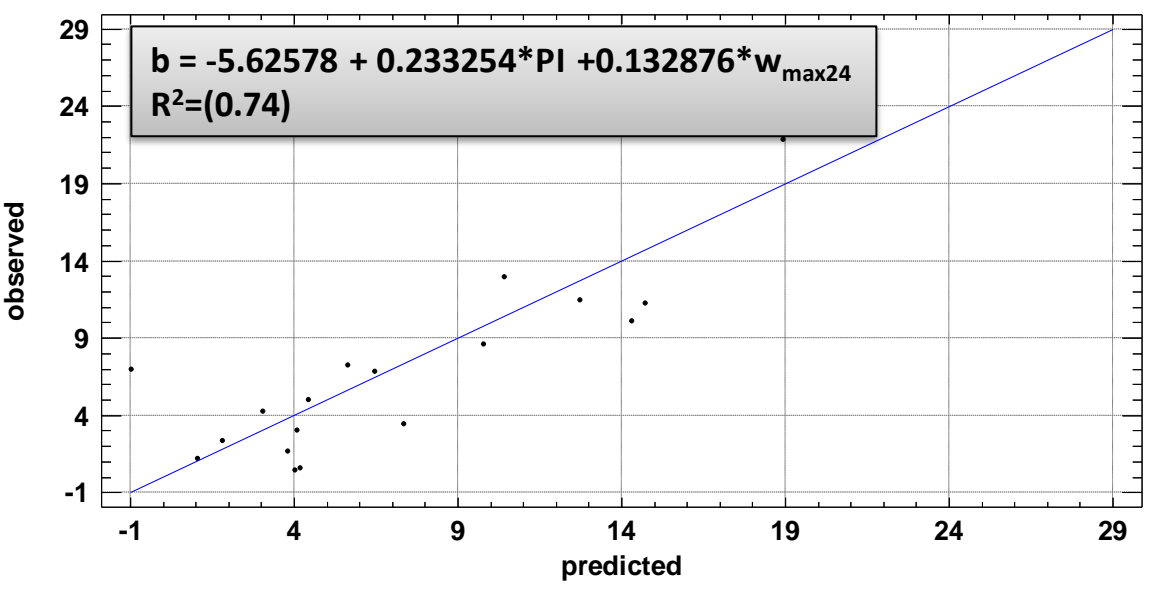
The relationship between “b-LL” , “b-PI” and “b-Wmax”



Multiple regression between "a-PI - W<sub>max24</sub>"

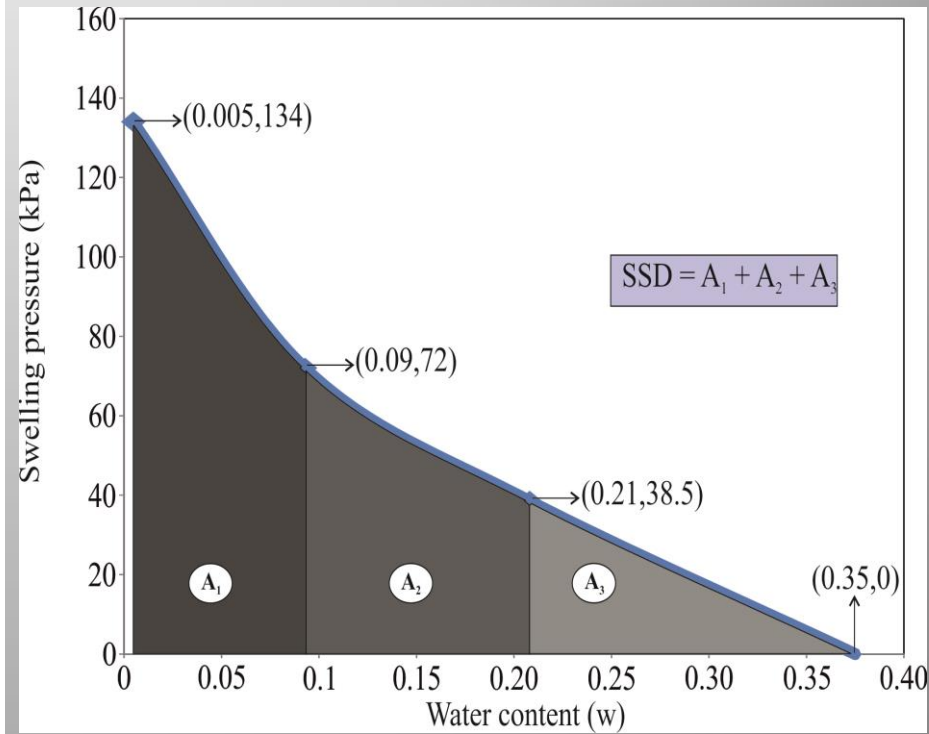
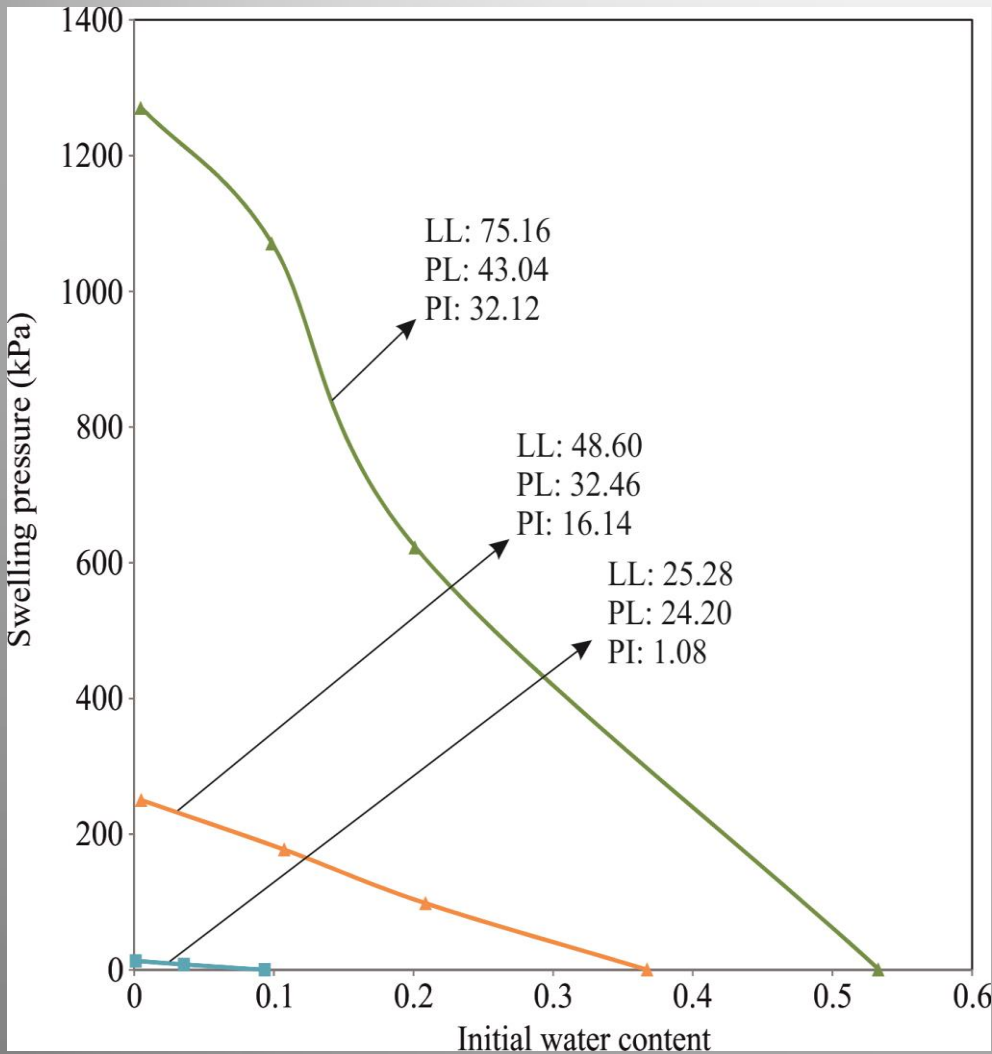


Multiple regression between "b-PI - W<sub>max24</sub>"

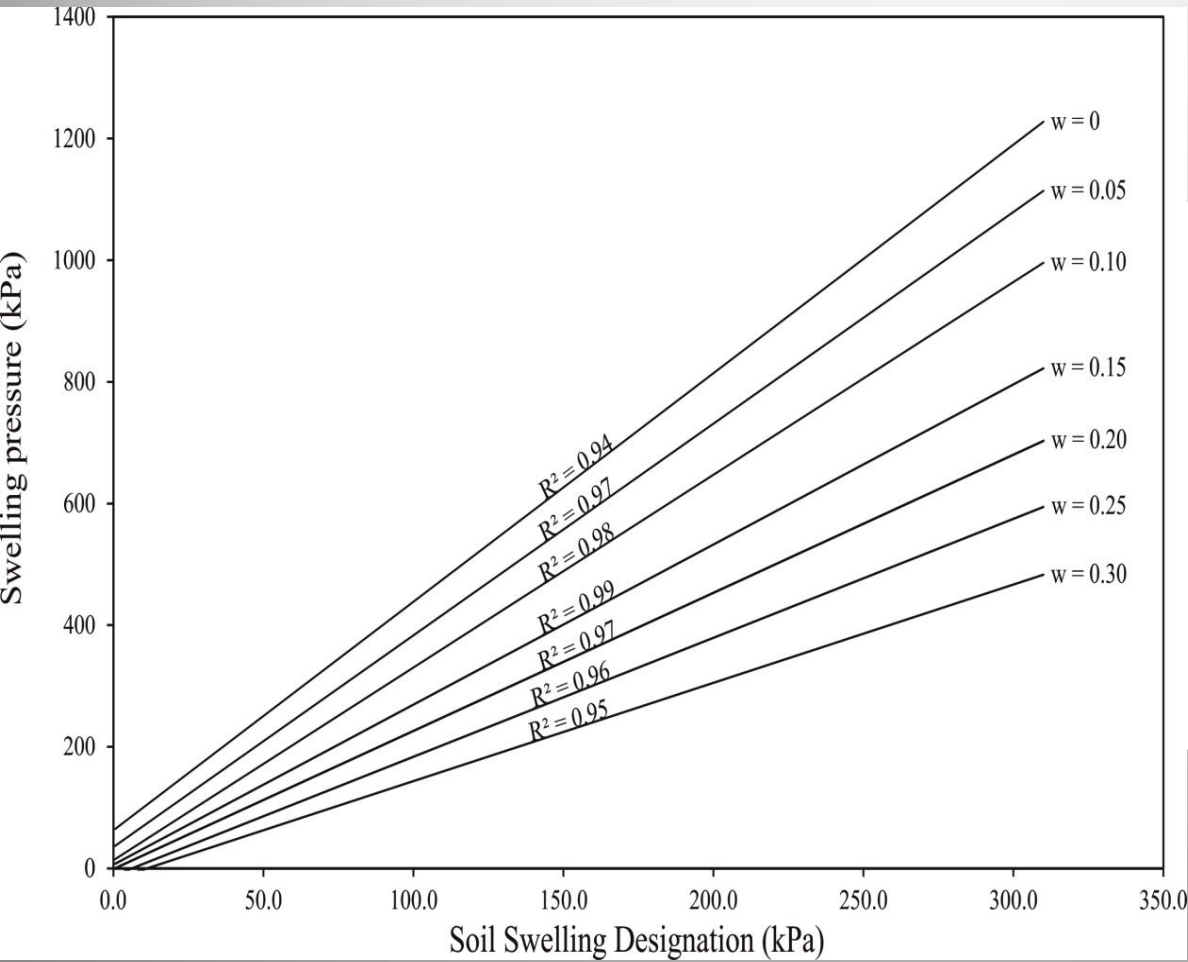


## ➤ Soil Swelling Designation (SSD)

Soil Swelling Designation to predict swelling pressure practically

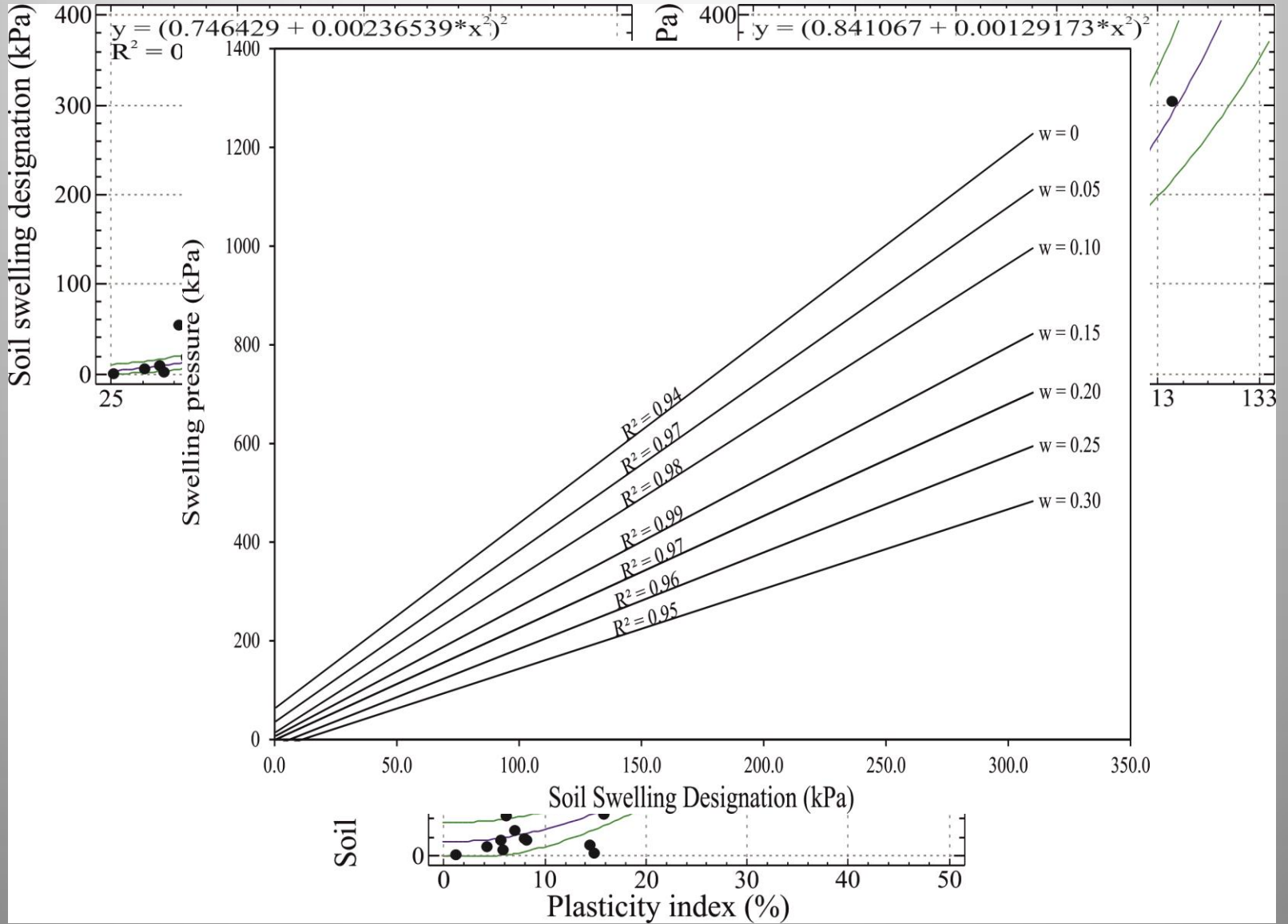


<b>Location</b>	<b>Swelling Pressure at dry conditions (kPa)</b>	<b>Soil Swelling Designation (SSD)</b>
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<b>L3</b>	1275	<b>305.3</b>
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Water content (w)	Eşitlik	R <sup>2</sup>
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0.25	SB = -12.018 + 1.95532* SSD	0.96
0.30	SB = -18.2072 + 1.61639* SSD	0.95

# Relationship between "SSD-LL" , "SSD-PI" and "SSD-W<sub>max24</sub>"





**THANK YOU VERY MUCH FOR YOUR ATTENDANCE!**



Dumlupınar University '16