

# Construction on subsidence soils



# ASSESSMENT OF ENGINEERING AND GEOLOGICAL CONDITIONS OF THE CONSTRUCTION SITE

## For clay soils, we determine the following indicators:

- Plasticity index

$$I_p = w_L - w_p$$

where  $w_L$  – Liquid limit:

$w_p$  – Plastic limit.

- Liquidity index:

$$I_L = \frac{w - w_p}{w_L - w_p}$$

*Conclusion: When  $I_L < 0.75$  (fluid plastic and liquid clay soils) cannot serve as a base.*

## For sandy soils, we determine the following indicators:

- Void ratio :

$$e = \frac{\rho_s}{\rho} \cdot (1 + w) - 1$$

$\rho_w$  – water density

Degree of saturation  $S_r$ :

$$S_r = \frac{w \cdot \rho_s}{e \cdot \rho_w}$$

*Conclusion: Loose sand cannot serve as a foundation.*

### Varieties of sandy soils by density

| Kind of sand   | The porosity coefficient $e$ , unit fraction |                      |                      |
|----------------|----------------------------------------------|----------------------|----------------------|
|                | Sands are gravely, large and medium-sized    | Fine sands           | Dusty sands          |
| Dense          | $e \leq 0,55$                                | $e \leq 0,60$        | $e \leq 0,60$        |
| Medium density | $0,55 < e \leq 0,70$                         | $0,60 < e \leq 0,75$ | $0,60 < e \leq 0,80$ |
| Loose          | $e > 0,70$                                   | $e > 0,75$           | $e > 0,80$           |

### Classification of coarse and sandy soils by water saturation coefficient

| Varieties of soils                  | Degree of saturation $S_r$ |
|-------------------------------------|----------------------------|
| Low water saturation (low moisture) | $0 < S_r \leq 0,5$         |
| Moderately saturated (wet)          | $0,5 < S_r \leq 0,8$       |
| Saturated                           | $0,8 < S_r \leq 1,0$       |

Name of dusty clay soil according to plasticity index

| Name of dusty clay soil | plasticity index $I_p$    |
|-------------------------|---------------------------|
| sandy loam              | $0,01 \leq I_p \leq 0,07$ |
| loam                    | $0,07 < I_p \leq 0,17$    |
| Clay                    | $I_p > 0,17$              |

### Flow rate (consistency)

| Varieties of soils                                                                                              | Consistency, $I_L$ , fraction units                                                                                               |
|-----------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------|
| Sandy loam:<br>- solid<br>- plastic<br>- liquid                                                                 | $I_L < 0$<br>$0 \leq I_L \leq 1,00$<br>$I_L > 1,00$                                                                               |
| Loams and clays:<br>- solid<br>- semi-solid<br>- tough plastic<br>- soft plastic<br>- fluid plastic<br>- liquid | $I_L < 0$<br>$0 \leq I_L \leq 0,25$<br>$0,25 < I_L \leq 0,50$<br>$0,50 < I_L \leq 0,75$<br>$0,75 < I_L \leq 1,00$<br>$I_L > 1,00$ |

**Rule: Loose sands, liquid and fluid-plastic clay soils cannot be used as a base.**

Example

Geological structure and hydrogeological conditions of the construction site

| № layer | Soil                           | Well number and the depth of the sole of each soil layer from the surface of the earth, m |     |     |     |   |
|---------|--------------------------------|-------------------------------------------------------------------------------------------|-----|-----|-----|---|
|         |                                | 1                                                                                         | 2   | 3   | 4   | 5 |
| 1.      | plant layer                    | 0,3                                                                                       | 0,3 | 0,3 | 0,3 |   |
| 2.      | Subsidence soil                | 4,8                                                                                       | 4,6 | 4,9 | 4,8 |   |
| 3.      | Sand medium-sized              | 3,4                                                                                       | 3,6 | 3,5 | 3,3 |   |
| 4.      | sandy loam                     | 3,5                                                                                       | 3,6 | 3,7 | 3,6 |   |
| 5.      | Clay gray                      | 8,7                                                                                       | 8,9 | 8,8 | 8,7 |   |
|         | The depth of underground water | 8,2                                                                                       | 8,0 | 8,3 | 8,1 |   |
|         | Well mark, m                   |                                                                                           |     |     |     |   |

Characteristics of soil properties

| Name                                            | Legend                      | Units of measurement | Layer number |       |      |      |      |
|-------------------------------------------------|-----------------------------|----------------------|--------------|-------|------|------|------|
|                                                 |                             |                      | 1            | 2     | 3    | 4    | 5    |
| Density                                         |                             | t/m³                 | 1,39         | 1,72  | 2,01 | 1,98 | 2,06 |
| Solid Particle density                          | $\rho_{II}$                 | t/m³                 |              | 2,73  | 2,68 | 2,69 | 2,70 |
| Water content                                   | $W_s$                       |                      |              | 0,15  | 0,24 | 0,26 | 0,22 |
| Liquid limit                                    |                             |                      |              | 0,35  |      | 0,28 | 0,40 |
| Plastic limit                                   | $W_L$                       |                      |              | 0,19  |      | 0,22 | 0,20 |
| Angle of internal friction                      | $W_p$                       | град                 |              | 21    | 33   | 20   | 15   |
| Specific cohesion                               |                             | кПа                  |              | 25    | 1    | 12   | 80   |
| Modulus of Deformation                          | $E_{II}$                    | МПа                  |              | 20    | 30   | 15   | 50   |
| Relative subsidence under pressure p, МПа       | $C_{II}$<br>$\epsilon_{SL}$ | p=0,1                |              | 0,04  |      |      |      |
|                                                 |                             | p=0,2                |              | 0,073 |      |      |      |
|                                                 |                             | p=0,3                |              | 0,082 |      |      |      |
| Angle of internal friction water-saturated soil |                             | град                 |              | 19    |      |      |      |
| Specific cohesion water-saturated soil          | $\varphi_{II,sat}$          | кПа                  |              | 5     |      |      |      |
| Modulus of Deformation water-saturated soil     | $E_{p,sat}$                 | МПа                  |              | 6     |      |      |      |

Soil classification indicators

| №<br>Layer | e     | $S_r$ | $I_p$ | $I_l$ | Soil properties                                  |
|------------|-------|-------|-------|-------|--------------------------------------------------|
| 1          |       |       |       |       | plant layer                                      |
| 2          | 0.825 |       | 0.16  | -1.25 | Subsidence soil<br>loam solid                    |
| 3          | 0.653 | 0.389 |       |       | Sand medium-sized low moisture<br>Medium density |
| 4          |       |       | 0.06  | 0.667 | sandy loam nplastic                              |
| 5          |       |       | 0.2   | 0.1   | Clay semi-solid                                  |