# Estimating Dispersibility Potential of Soil and its Stabilization by Nano Cellulose

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## Abstract

Existence of sodium elements in fine-grained of some soils causes dispersive phenomenon in them. Failure to accurately identify dispersive clays leads to damage because dispersive clay soil particles disperse under certain conditions and wash away quickly. This research assesses dispersive degree of outcropped soils in southeast of Yazd. Finally, the modification of soil dispersive potential was investigated by using nanocellulose. After performing a series of physical, chemical and mechanical tests, characterization/ specification of the studied soils were determined. Then dispersive degree was specified by conducting chemical, pin hole, crumb and double hydrometer tests. Finally, soil dispersivity stabilization was performed using sample preparation with 0.5, 1 and 1.5% nanocellulose. The results showed that the studied soils have moderate dispersive in borehole A and extreme to slightly dispersive in borehole B. Therefore, it can be concluded that the closer we get to the center of the plain, the greater the dispersibility. The results of the dispersibility stabilization soil tests indicate that the optimum moisture content and dry specific gravity increases and decreases. Uniaxial strength and CBR increases. Also, it shows that the increase in nanocellulose has a positive effect on the modified samples and improves the soil dispersibility in this area.

**Key words:** Southeast of Yazd, Mechanical characteristic, Dispersibility degrees, Rating system.

## Extended Abstract

### Introduction

In some soils, due to the increase in humidity, certain phenomena occur, which sometimes lead to major damages in construction projects. One of these types of soils are dispersive soils. Dispersive soils are defined as clay soils with high sodium percentage, which are highly susceptible to erosion. The tendency of the clays to disperse or de-flocculate depends on the mineralogy and soil chemistry and also on the dissolved salts in the pore water and the eroding water. In the last decades, holes and ruptures have been occurred on the surface of the Yazd-Ardakan plain which are related to the presence of problematic soils in this region. Serious damages such as creation of cracks in buildings and roads, and even forming holes are visible in this region.

The aim of the current work was to assess soil dispersive potential by using a rating system. The general method in this research includes field checking, preparation of soil samples, field and laboratory experiments to identify soil and use a rating system to determine the degree of soil dispersive. Finally, the effect of adding different amounts of cellulose nano fibers in modifying the dispersive of clay soils in the southeastern region of Yazd were investigated and tested.

### Material and methods

After carrying out preliminary studies and assessing geological condition of the study area, two boreholes with depths of 5 m (borehole A, along the ruptures) and 6 m (borehole B in distance of two kilometers from the ruptures) were drilled to obtain samples for laboratory experiments. Also soil strength assessment was performed using manual SPT test. Samples were collected in both disturbed and undisturbed forms by thin-walled sampling at a distance of one meter from each depth. Then various experiments including physical, chemical and mechanical were performed as given in Table 1. Various laboratory tests are usually conducted to identify dispersive soils, including double hydrometric, crumb, pinhole tests, and various chemical analyses. In most cases, a combination of the

results obtained from the methods for determining soil dispersive is considered.

The Bell and Walker rating system was also used to assess soil dispersive. The system uses the results of Pinhole, Crumb, SAR, PS-TDS and ESP-CEC diagrams. The inclusion of physical and chemical factors in the classification assessment allows several aspects of divergence to be considered.

**Table 1. Details of physical, chemical and mechanical tests performed**

| Standard test number | Test number | Test type | |
|---|---|---|---|
| **ASTM-D2216 [10]** | 11 | Moisture content | |
| **ASTM-D1188 [11]** | 11 | Density | |
| **ASTM-D854 [12]** | 11 | Specific gravity | |
| **ASTM-C117 [13]** | 11 | Gradation | |
| **ASTM- D4318 [14]** | 11 | Atterberg limits | |
| **Philips analytical apparatus and angle of X-Ray B.V. 59.99 [°2Th.] incidence 4.01[°2Th.]-** | 5 experiments in 2 and 4 meter depths of borehole A and 2, 4, 6 meter borehole B. | On complete soil without separating clay | XRD |
| | 2 experiments at depths of 4 meters in both boreholes | Determining the percentage of clay minerals | |
| **S4 EXPLORER / X- Ray Spectrometry – Bruker (WD XRF)** | 2 experiments at depths of 2 meters in both boreholes | XRF | |
| **ASTM-D698 [15]** | 11 | Compaction | |
| **ASTM-D2166 [16]** | 11 | Uniaxial strength | |

Finally, the effect of adding different amounts of nano cellulose in modifying the dispersivity of clay soils in the southeastern region of Yazd has been investigated by using adding different percentages of nano cellulose (0, 0.5, 1, 1.5) and samples in 3 days were made from the depths of 2, 4 (m) both boreholes. The characteristics of nano cellulose are given in Table 2.

**Table 2. Specifications used of Nano cellulose**

| Characteristics | Content | How to prepare fibers |
|---|---|---|
| Formula | | **Physical production with gradual crushing of plant products at the nanoscale** |
| Type of structure of nanomaterials | Nano gel (25.5%) | |
| Color | White | |
| Fiber dimensions | Average 35mm | |
| Purity | 99% | |

## Results

Based on the obtained results, the studied soils have moderate dispersive in borehole A and extreme to somewhat dispersive in borehole B. Therefore, it can be concluded that the closer we get to the center of the plain, the greater the dispersibility. The results of the dispersibility stabilization soil tests showed that the optimum moisture content and dry specific gravity increases and decreases. Uniaxial strength and CBR increases. Also, it shows that the increase in nanocellulose has a positive effect on the modified samples and modifies the soil dispersibility in this area.

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