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# Investigation of Carbonate Sand Shear Behavior Based on Manzari anid Dafalias Behavioral Model

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**ABSTRACT:** Investigating soil characteristics and models for better design and performance of construction projects is very important. In this paper, the ability of the behavioral model of Manzari and dafaliais, which is an advanced model in the field of soil behavioral model, was evaluated to predict the shear behavior of carbonate sand with brittle seeds. Soil parameters were examined and their effects on soil behavior display were studied. By comparing strain stresses obtained from a tri-axial test and a model in loose and dense samples, it was observed that the results of the behavioral model are in good agreement with experimental results. However, by examining the volumetric strain graphs against the axial strain, the outcomes of the Manzari and dafaliais behavioral model were not sufficiently accurate in comparison with the experimental results. The main reason for this was the crushing of soil grains and its effect on soil volume variation in the Dafalias model. There is no perspective on the prediction of the volumetric strain. Nevertheless, the above-mentioned behavioral model predicts the trend of change. This behavioral model in high imbibed tensions had better results in comparison with the immensely low stresses in the study of strain volumes of samples.

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## 1- Introduction

Typically, in drained loads, loose sandy soil shows a contraction and dense sandy soil exhibits dilation. Also, when the sand sample, whether loose or dense, experiences great strains, the shear stress and soil volume remain constant. This final state has been named as the critical state by Roscoe et. al. [1]. Some researchers have been used the state parameter in their behavioral models and tried to provide a better state parameter by studying the behavior of the sand. Hence, other state parameters were introduced so that these parameters can display the behavior of the sand efficiently. The most significant of these parameters are the parameters of Is [2] and RSR [3-4]. In 2004, Dafalias and Manzari [---] provided a simplified model based on their work in 1997, and also continued it to calculate the effect of structural changes during loading. One of the hypotheses of the Dafalias & Manzari model (2004) is the lack of grains crushing, while one of the characteristics of carbonate sand is the particles crushing. Therefore, in this research, the mentioned model and its ability to predict the shear behavior of carbonate sand soil were investigated.

## 2- Properties of the soil

The soil specifications were extracted from Ph.D thesis of M. Hasanlurad [5]. This soil was a carbonate sand soil with 74% carbonate content. Its specifications are presented in Table 1 [5].

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## 3- The research method

As mentioned, in this article, the behavioral models of Manzari & Dafalias (1999) and Dafalias & Manzari (2004) were utilized. In the formulation of this model, parameters such as $\lambda_c$, $n_b$, $n_d$ and $h_0$ have been used. These parameters have been set for the Hormuz soil tested triaxially under 50, 100, 200, 300, 400, 500 and 600 KPa confining pressures. Also, the volume and axial strain values extracted from this model were compared with the values obtained from laboratory tests. The model parameters were calibrated using trial and error method by comparing the model and laboratory values.

## 4- Results and discussions

### 4- 1- Stress-Strain graph of the loose specimen

For instance, Figures 1 shows the modeled and experimental stress-strain diagrams in a loose state under confining stresses from 50 to 600 kPa. As can be seen, the results of the behavioral model were in good agreement with the experimental results. It is worth noting that the results of high confining stresses are more proper than that of low confining stresses. In low confining stresses, data jumping was observed in addition to data concentration, which requires more analysis.

**Table 1. The specification of soil gradation [5]**

| Soil | $D_{10}$ (mm) | $D_{30}$ (mm) | $D_{50}$ (mm) | $D_{60}$ (mm) | $C_u$ | $C_c$ |
|---|---|---|---|---|---|---|
| Hormuz | 0.18 | 0.30 | 0.51 | 0.64 | 3.60 | 0.78 |

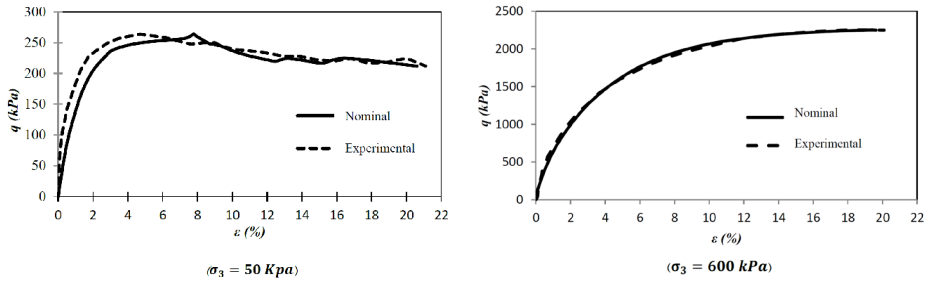


**Figure 1. Comparison of the laboratory and modeled stress-strain diagrams of the loose specimen**

## 4- 2- Volume strain diagrams

The behavioral model and experimental comparative results of volumetric - axial strain diagrams for loose samples between are shown in Figure 2. As shown in this Figure, the volume of soil samples was reduced under high confining stress. This decrease in volume was well predicted with the behavioral model, but in low confining stresses specimens first experience decreasing and then increasing volume, in which, predictions are not suitable using behavioral model; so that the final volume strain of experiments in the low confining stresses is very different with the model results. There is less difference under high confining stresses. Therefore, it can be concluded that this behavioral model in high confining stresses usually leads to better results compared to the low confining stresses. The error percentage of the volume strain results of the model compared to the experimental results in the loose sample is shown in Table 2. According to this Table, it can be seen that the model results are better in high confining stresses.

**Table 1. The specification of soil gradation [5]**

| (Kpa) | 50 | 100 | 300 | 500 | 600 |
|---|---|---|---|---|---|
| Error percentage | 132.32 | 121.49 | 40.32 | 37.25 | 35.75 |

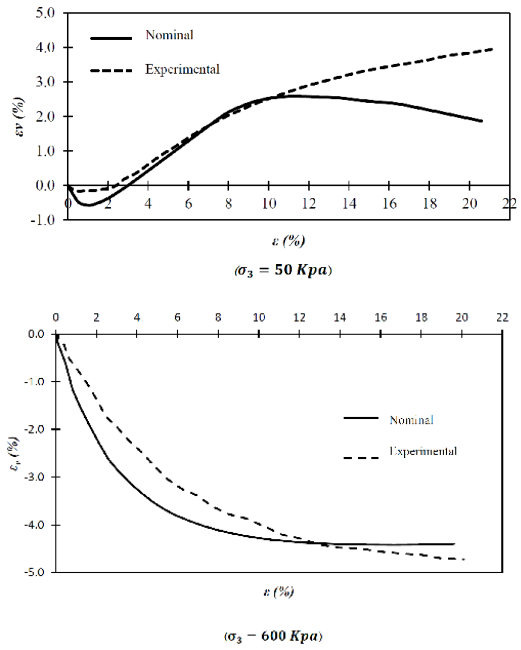


**Figure 2. Comparison of the modeled and laboratory volumetric strain diagram of the loose specimen**

## 5- Conclusion

In this paper, the behavioral model of Manzari and Dafalias (2004) were evaluated for its ability to predict soil shear behavior. For this purpose, the results of triaxial consolidated-drained experiments on the carbonated sand soil were compared with the results of the model. Based on studies and comparisons, the following results were observed:

- Comparison of stress-strain diagrams of the loose and dense soil samples showed good agreement for the laboratory and behavioral model under 50 to 600 kPa confining stresses.
- By examining the volumetric strain versus axial strain graphs, the results of the behavior model of Manzari & Dafalias (2004) were not sufficiently accurate compared to experimental results, although the general trend of behavior was relatively correct. The main reason for this event was the crushing of soil granules and its effect on soil volume variation in which have not been considered in the Manzari & Dafalias model.

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