



Technical note

Swelling behaviour of expansive shales from the middle region of Saudi Arabia

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Abstract. Severe and widespread damage in residential buildings, sidewalks and pavements in various parts of the middle region of Saudi Arabia is caused by the development of heave and swelling pressure in the expansive shales in the region. This paper presents the problems and the geotechnical and physicochemical properties of the tested shales. The swelling potential was determined using various methods. Swell tests were conducted under different loading conditions and following different procedures to quantify the amount of vertical swell and swelling pressure. The conventional one-dimensional oedometer swell tests were performed using three different procedures, namely, free swell, constant volume swell and swell overburden. In addition, swell tests were performed in the stress path triaxial apparatus. Tests under different vertical stresses and confinements were conducted. Vertical swell and swelling pressure obtained from the various methods were compared. The reliability of the different methods for estimation of swelling potential is discussed.

Key words: oedometer tests, shale, swelling pressure, triaxial tests, vertical swell

Introduction

Damage to structures from the swell of foundation soils due to changes in moisture conditions are common problems that occur frequently in many parts of the world including vast areas of the Kingdom of Saudi Arabia. Damage inflicted on superstructures by expansive soils each year is enormous. Although there has been no precise estimate, annually in Saudi Arabia, expansive soils are responsible for millions of dollars worth of damage to man-made structures (Ruwaih, 1987; Dhowian *et al.*, 1990). Damage ranges from minor cracking of pavements or interior finishes in buildings, which is very common, to irreparable displacement of footings and superstructure elements.

Figure 1 shows the distribution of expansive soils in the Kingdom of Saudi Arabia. Expansive soils are encountered over a large area due to geological history, sedimentation and climatic conditions (Slater, 1983). It is estimated that expansive soils cover an area of approximately 800 000 km² in the kingdom (Ruwaih, 1987). Shale formation prevails in different parts of the country including Al-Ghatt, Tabuk, Tayma and Sharorah. The shale of the town of Al-Ghatt was chosen in this study

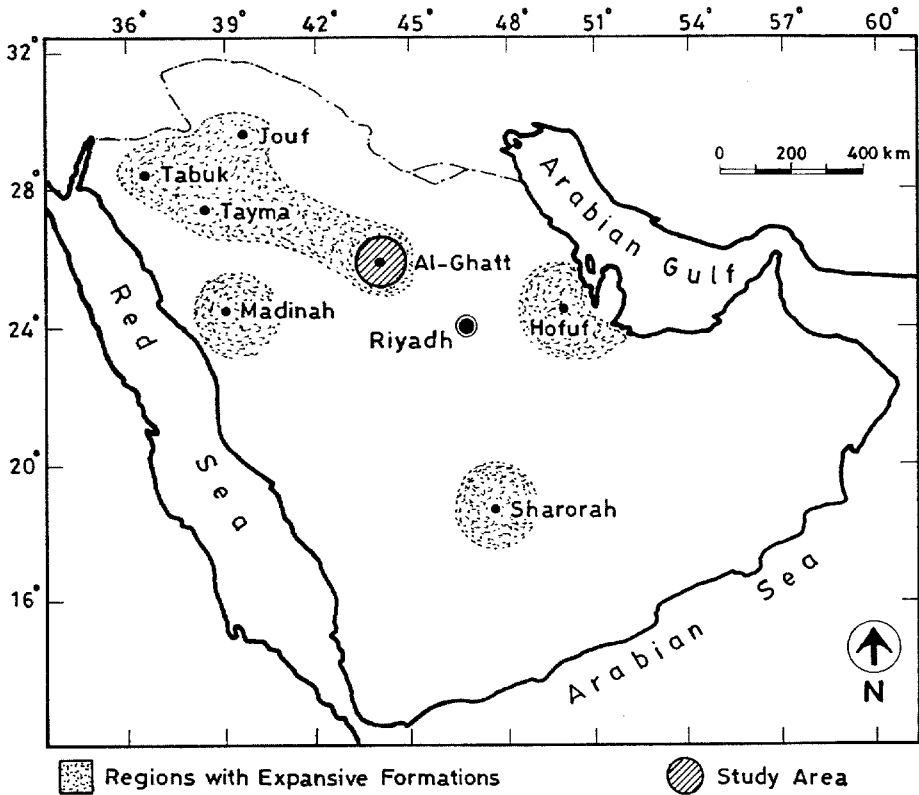


Fig. 1. Map of Saudi Arabia showing the distribution of the expansive formations and the study area (modified after Ruwaih, 1987).

because Al-Ghatt experiences some of the largest differential ground movements in Saudi Arabia (Dhowian, 1990).

This paper presents the results of a laboratory investigation into the swelling behaviour of an expansive shale from the middle region of Saudi Arabia. The investigation included the determination of the geotechnical and physicochemical properties, mineralogical composition and the swelling characteristics of the tested shale. Experiments using various methods to determine the swelling potential of the shale were performed to quantify the amount of vertical swell and swelling pressure. Swell tests were conducted under different loading conditions and following different procedures. The conventional one-dimensional oedometer swell tests were performed using three different procedures: free swell, constant volume swell and swell overburden. In addition, swell tests were performed in the stress path triaxial apparatus. Tests under different vertical stresses and confinements were conducted. A comparison of the results is presented and discussed in terms of the percentage of vertical swell and swelling pressure.