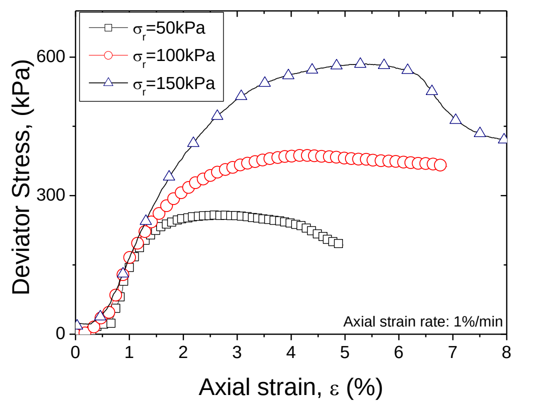
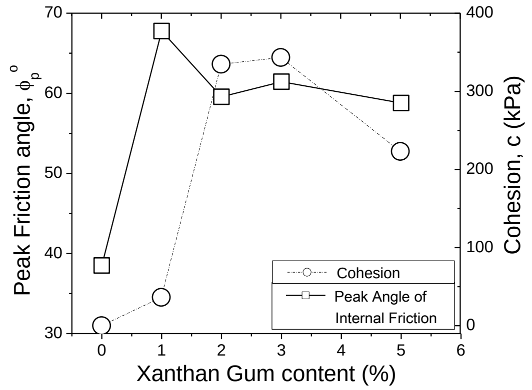


(a) A typical plot of deviator stress and axial strain of Al-Sharqia Sand



(b) Shear strength parameters plotted against xanthan gum content

Fig. 7 Triaxial test results of xanthan gum treated sand specimen in dry state

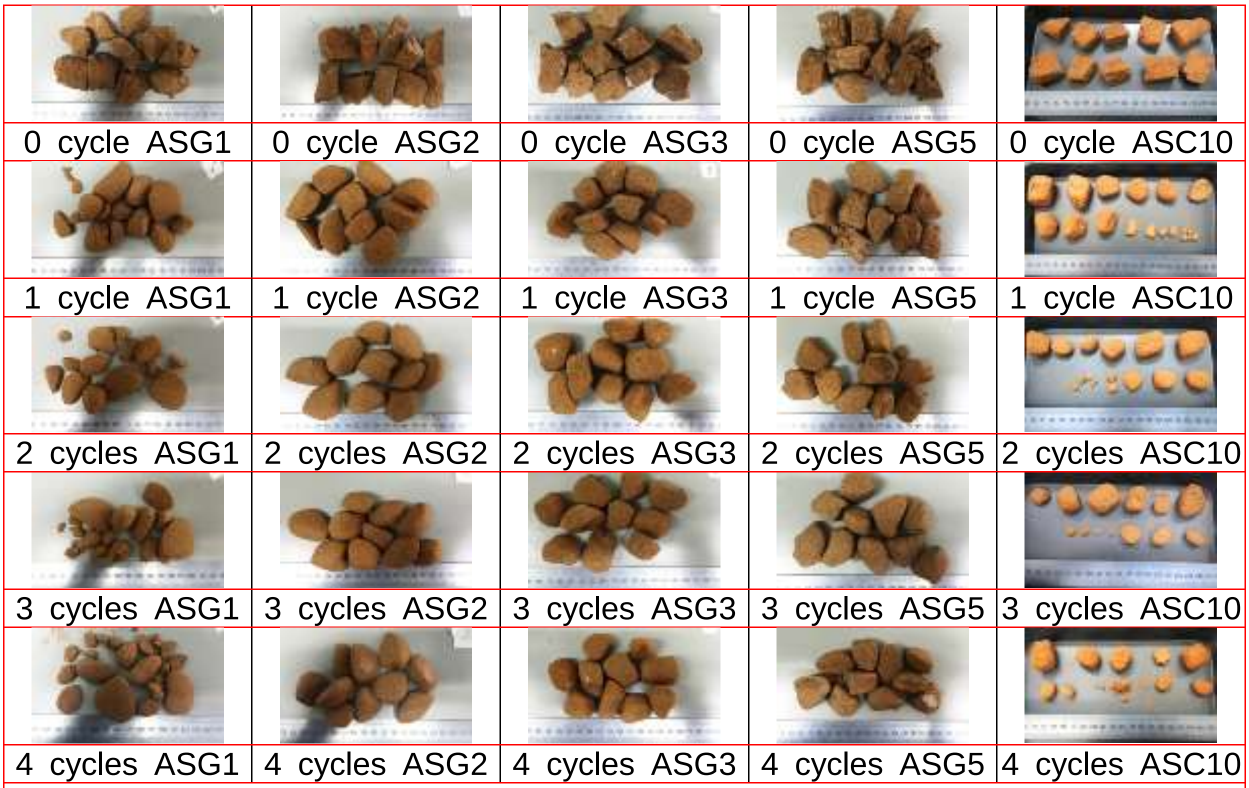
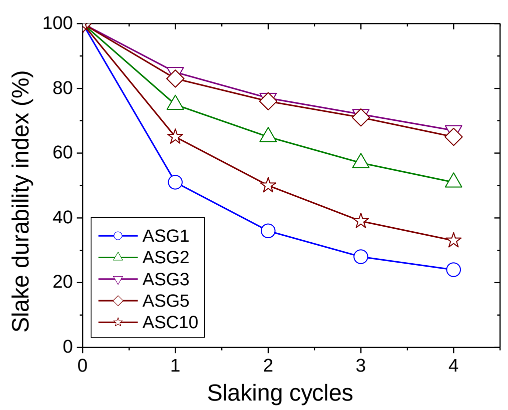


Fig. 8 Changes in xanthan gum treated (ASG) and cement treated (ASC) specimens due to slaking cycles

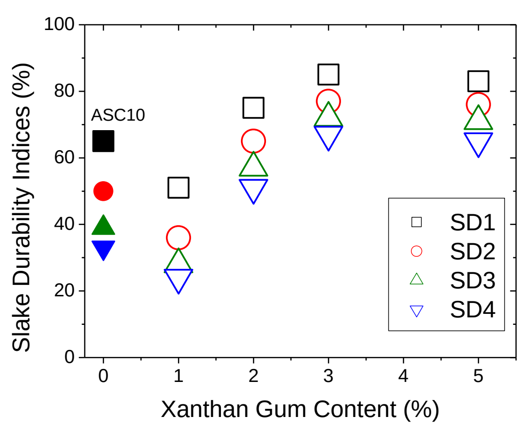
4.5 Slake Durability

The slake durability tests was initially designed to investigate the slaking behavior of clay bearing rocks (Franklin and Chandara 1972). One of main concern in the bio treatment of soil is the water effects on the strengthening behavior. So, the authors performed slake durability tests on xanthan gum treated and cement treated sand specimens. Ten pieces of each treated specimens weighing 40-50gm were oven died at 105^{o}C. Those specimens were then shifter in to the wire mesh drum of slake durability device (Fig. 3(b)). The drum for rotated at 20rpm for 10 minutes half submerged in water. Thereafter, specimens were dried for 24 hours at 105^{o}C in oven to complete one standard slaking cycle. Slake durability index after each slaking cycle is reported as the percentage of initial dried weight to the dried weight at the end of each slaking cycle. The qualitative changes in the specimen at the end of each slaking cycles is presented in Fig. 8. It can be seen that the specimen ASG1 is the least durable as compared to the sand treated with 2, 3 and 5 % xanthan gum. The cement treated specimen (ASC10) also showed a weak response against slaking as compared to sand treated with 3 and 5 % xanthan gum (ASG3 and ASG5).

A decrease in slake durability index is observed after each slaking cycles for all the specimens as shown in Fig. 9(a). The slake durability indices obtained after 1, 2, 3 and 4 slaking cycles (SD1, SD2, SD3 and SD4) are plotted against the xanthan gum content in Fig. 9(b). The slake durability indices of ASC10 are also plotted in the same Fig. 9(b). It can be seen that that durability of treated sand against slaking increases with the increase in xanthan gum content up to 3%. A higher content of xanthan gum gel keeps the sand particles amalgamated during the wetting cycle, however the cement treated specimens loses unrecoverable cementation. During the drying cycle the xanthan gum gel dehydrated but remains available for the next wetting cycle.



(a) Plot of slake durability and slaking cycles



(b) Slake durability indices plotted against xanthan gum content

Fig. 9 Slake durability test results of xanthan gum (ASG) and cement treated (ASC) Al-Sharqia sand

5. Conclusions

The objective of the current research was to investigate the possibility of improving the engineering properties of dune sands by treatment with xanthan gum. Sand was sampled from Al-Sharqia desert of Oman. Al -Sharqia sand characterized as poorly graded fine sand was treated with xanthan gum at 1, 2, 3 and 5% as well as with cement at 10% by weight. A series of compaction, consistency limits, unconfined compression, triaxial and slake durability tests were performed on the treated and untreated sand specimens. Based on the results presented in this paper, the following conclusions can be drawn.

The xanthan gum has substantially increases the unconfined compressive strength of the treated sand. The unconfined compressive strength increases with xanthan gum content up to 2 % and then after that it decreases with the increase in xanthan gum content. The unconfined compressive strength of sand treated with a cement content of 10% was of the same order as of 1% treatment with xanthan gum.

The results of unconsolidated undrained triaxial tests showed that the sand treated with xanthan gum possess both angle of internal friction and cohesion. The dehydrated xanthan gum gel acted as a cementing agent between the sand particles. The angle of internal friction of bio-treated sand increases with the xanthan gum content up to 1 % and then decreases, however remain higher than that of untreated sand. The cohesion of bio-treated sand also increases with xanthan gum content up to 2% and then decreases, however remains higher than that of untreated sand. Thus, the treatment with xanthan gum has effectively improved the strength characteristics of Al-Sharqia sand. To achieve optimal results in terms of bio-strengthening of sand a mix percentage of 2-3% is optimal choice.

The standard proctor tests delineated that the maximum dry density of 1% xanthan gum treatment to sand was the highest. So in the field where compaction is to be practiced along with bio-improvement 1% xanthan gum content is the optimal choice.

The response of bio-treated sand to the slaking also increases with the content of xanthan gum. The slake durability index of bio-treated sand increases up to 3% gum content and remains same thereafter. In comparison, the cement treatment showed a low durability against slaking. The results suggest that the bio-improvement of sand is a sustainable and eco-friendly practice in the desert environment which will not after the biodiversity and it will be very attractive to develop geotechnical systems.

Acknowledgments

The research described in this paper was jointly supported by a Faculty Mentored Undergraduate Research Award Program (FURAP) funded by the Research council Oman and the Final Year project support funded by Sohar University, Oman. The authors are also indebted to their colleagues at sohar University for a continuous support during the experimentation.

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