SLAKE DURABILITY TEST ON LOWER OLIGOCENE LIMESTONES FROM AL AIN CITY, UNITED ARAB EMIRATES

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Outline of the Presentation

- INTRODUCTION
- GEOLOGICAL SETTING AND CHARACTERIZATION OF LIMESTONE
- SAMPLE PREPARATION AND TESTING
- DISCUSSIONS AND RESULTS
- CONCLUSIONS
- ACKNOWLEDGEMENTS

INTRODUCTION

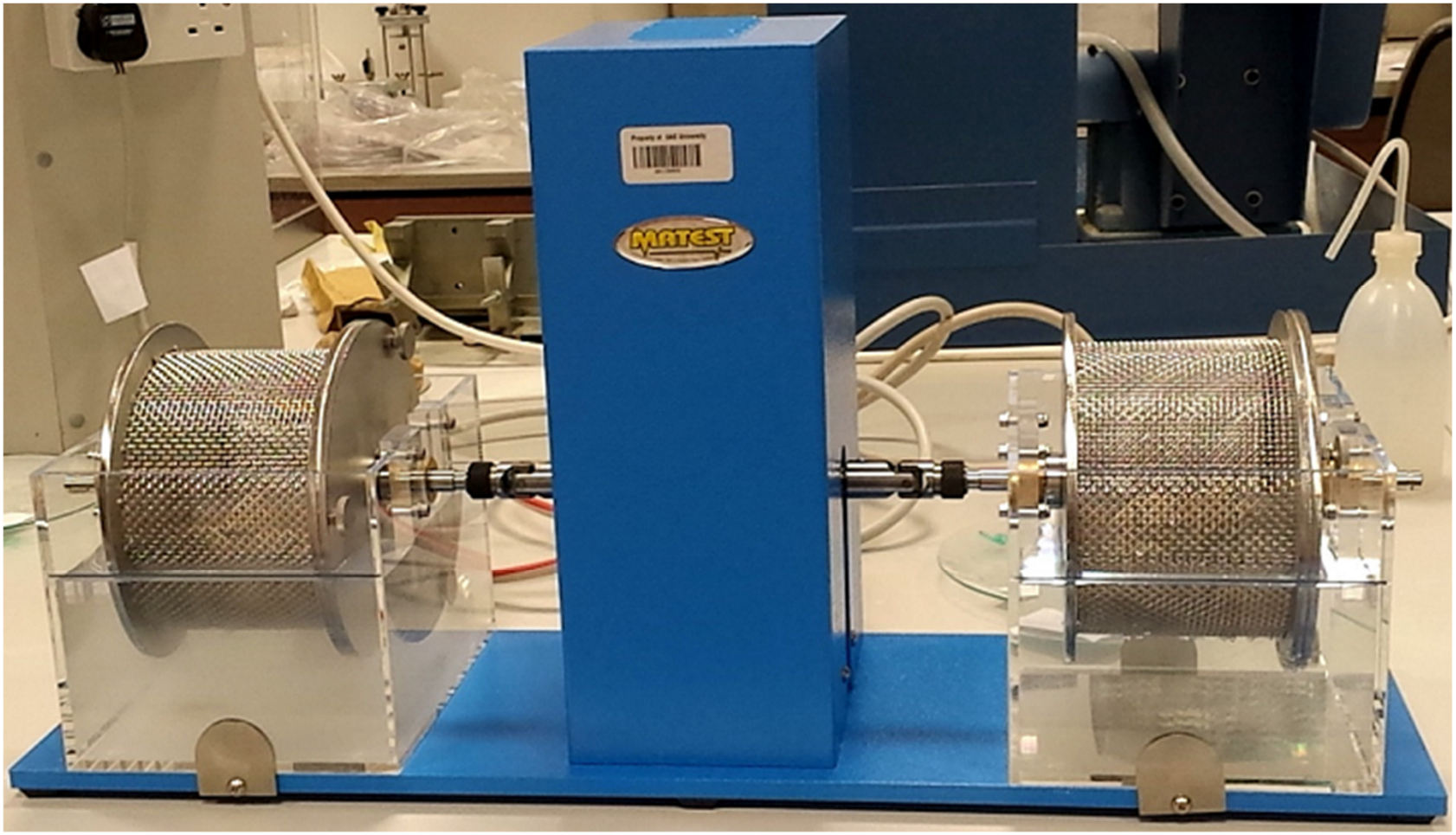
- Different durability test procedures have been suggested to assess the resistance of a rock sample to weakening and disintegration.
- The most important and commonly used one is the slake durability index test by Franklin and Chandra (1972).
- The slake durability test plays an important role in the development of various durability classifications for different types of rocks.

INTRODUCTION

Slake durability index classification (Franklin and Chandra, 1972).

Id_2 (%)	Durability classification
0 – 25	Very low
25 – 50	Low
50 – 75	Medium
75 – 90	High
90 – 95	Very high
95 – 100	Extremely high

INTRODUCTION



Slake durability test apparatus

INTRODUCTION

- The slake durability index is generally calculated at the Id_2, but can be calculated for each cycle, as the percentage ratio of final to initial dry weights of rock in the drum after two drying and wetting cycles.
- All those previous durability classifications were based on the second cycles slake durability index, Id_2.
- However, some researchers emphasized that two cycles slake durability testing did not indicate an acceptable durability of rocks.

INTRODUCTION

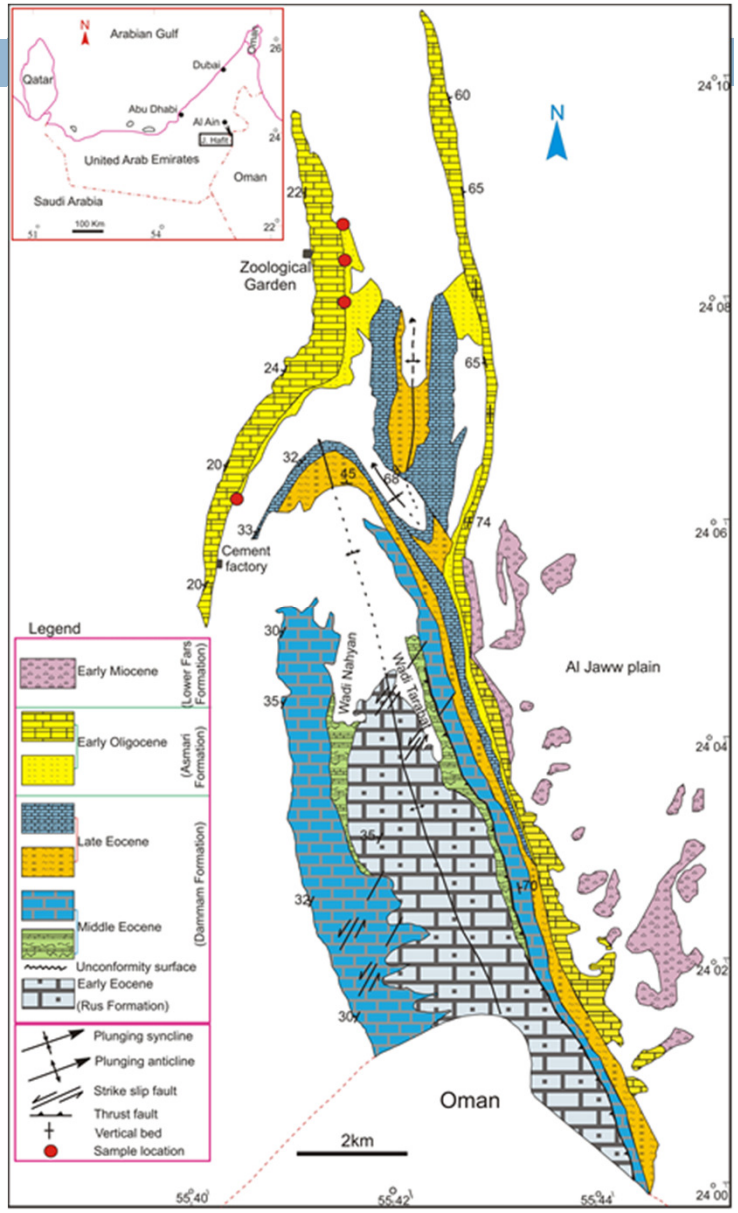
- Some investigators were also shown that the *mineral composition of rocks along with their textures like crystal interlocking, crystal shape and size, surface roughness, crystal area, crystal perimeter length and effective porosity* were greatly related to slake durability of rocks.
- Therefore, it is very important to examine the mineralogical and textural properties of the rocks into account while the slaking property.

INTRODUCTION

- Also, the slake durability can be influenced by the rock alteration associated with weathering, diagenesis and hydrothermal processes on the geological scale
- The objective of this presentation is to have a better understanding of the weatherability of the associated paleokarstic cavernous bedrock, limestones, which have been encountered in the study area.
- In addition, this presentation will provide needed information for engineers in mitigating any possible causalities and reduce lost of property today and/or in the future, too.

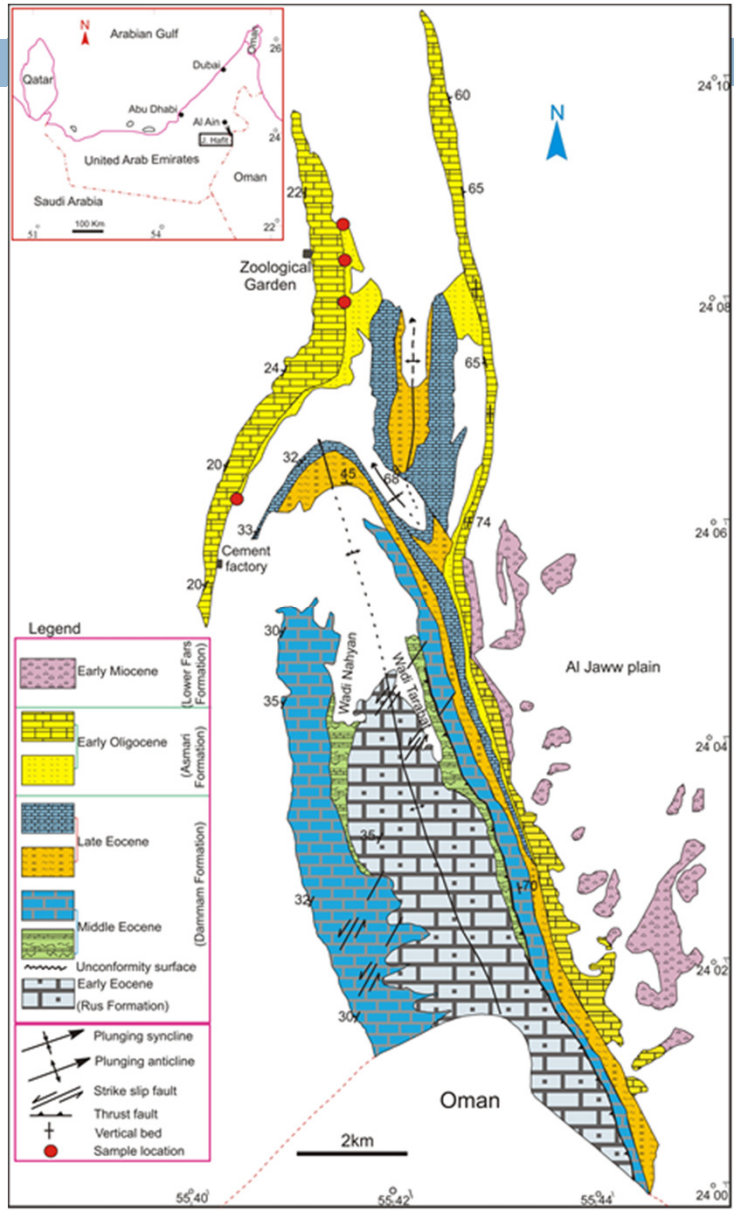
GEOLOGICAL SETTING AND CHARACTERIZATION OF LIMESTONE

- The most complete exposure in the UAE of Oligocene rocks exposed on the limbs of the Jabal Hafit anticline.
- The Asmari Formation of Early Oligocene cover most of the foundational bedrock of Al-Ain city, located in the southeastern part of the UAE.



GEOLOGICAL SETTING AND CHARACTERIZATION OF LIMESTONE

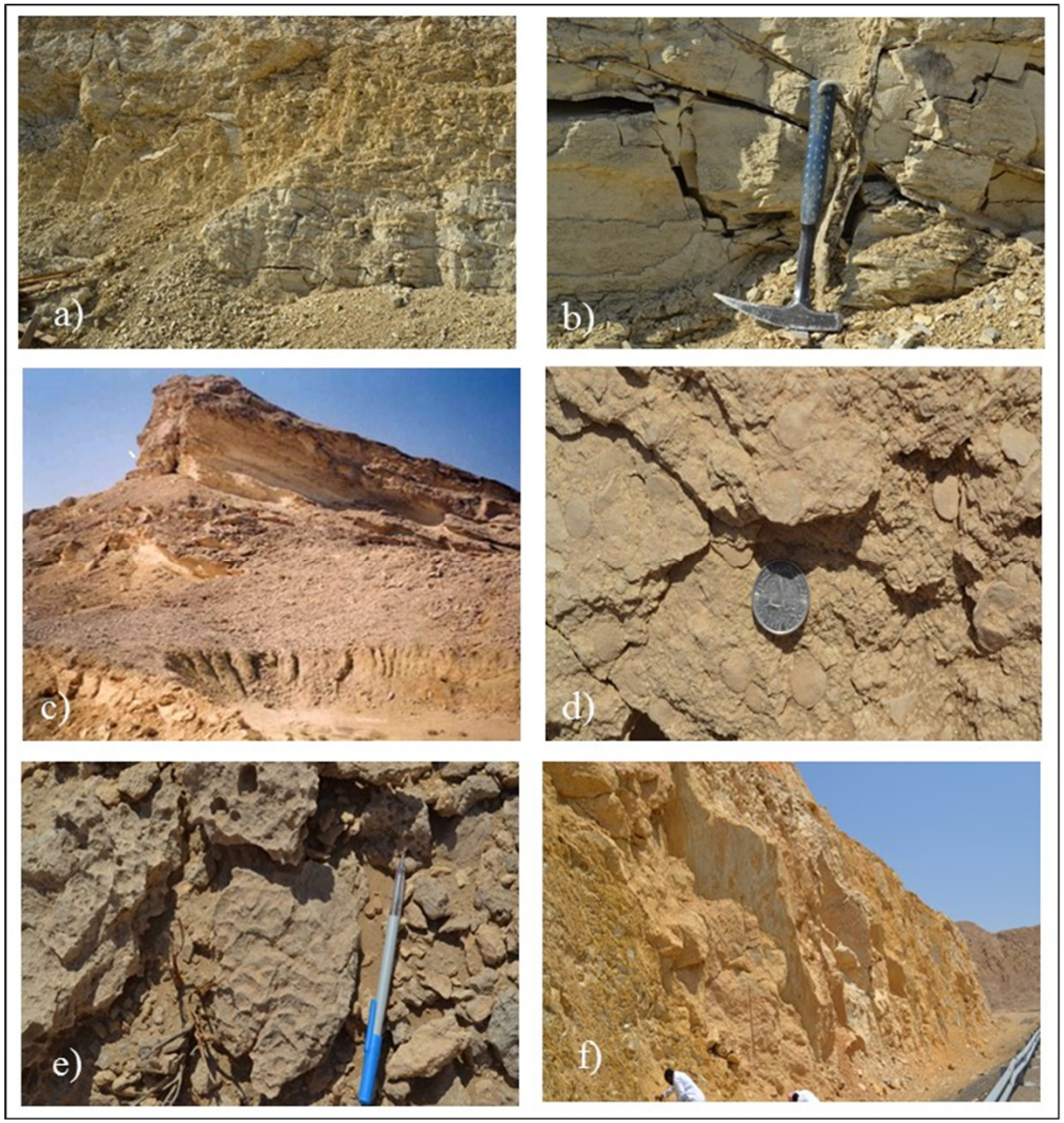
- From the field observation and laboratory investigation of the collected samples from the four sites at the western limb of Jabal Hafit showed that, the Asmari Formation is divided into *three members attains about 295 m thick of carbonate rocks.*



GEOLOGICAL SETTING AND CHARACTERIZATION OF LIMESTONE

- The basal member is 70 m thick composed of *soft green marl, with recrystallized gypsum alternating with argillaceous limestone highly fossiliferous with Nummulites species of larger foraminifera and others macrofossils.*
- The middle member is 140 m thick and composed of *hard nodular limestone, sometimes dolomitic, fossiliferous with reef patches of corals and molluscs shell fragments.*
- Towards the top member, 85 m thick composed of *bioclastic white limestone becomes more chalky rich with microfossils at the topmost part.*

GEOLOGICAL SETTING AND CHARACTERIZATION OF LIMESTONE



Field photographs showing the stratigraphic relations and the characteristic fossils of the Asmari Formation,

a-*Thinly bedded of the lower soft argillaceous limestone,*

b-*Close up view of lower gypsiferous part,*

c-*Coralline limestone of the middle part,*

d- *Nummulitic bank of the middle part,*

e-*Colony corals of the middle part,*

f-*Chalk of the top part.*

GEOLOGICAL SETTING AND CHARACTERIZATION OF LIMESTONE

- The degree of hardness of the carbonate rocks in the sequence depends on the *components of the limestone itself*.
- Therefore, the limestone in the study area classified into; **chalky limestone** (*soft*), **argillaceous limestone** (*intermediate*) and **dolomitic limestone** (*hard*).
- These three members of limestone are dissected by several sets of joints, and host abundant connected paleokarstic cavities of varied sizes.

GEOLOGICAL SETTING AND CHARACTERIZATION OF LIMESTONE

- The diagenetic processes including *dissolution, dolomitization, compaction and cementation* that partially control the mechanical behaviour of the rocks have affected the studied rocks.
- Arman et al., 2014, mentioned that *the dolomitization of limestones increases their strength, in contrary increasing the chalk percent decreases rock's strength.*

GEOLOGICAL SETTING AND CHARACTERIZATION OF LIMESTONE

- *Specific limestone units* may be preferentially resistant or responsive to change and with or without impurities that will affect the character of change.
- *Nodular limestones* are a characteristic product of non-sutured seam solution in silty, clayey limestones. Form and scale of fitted nodules may or may not be influenced by primary structures.
- *Chalk* is principally a soft limestone consisting of the remains of marine microorganisms, deposited in shallow to deeper water environment.

SAMPLE PREPARATION AND TESTING

- Representative rock samples were collected from selected rock outcrops.

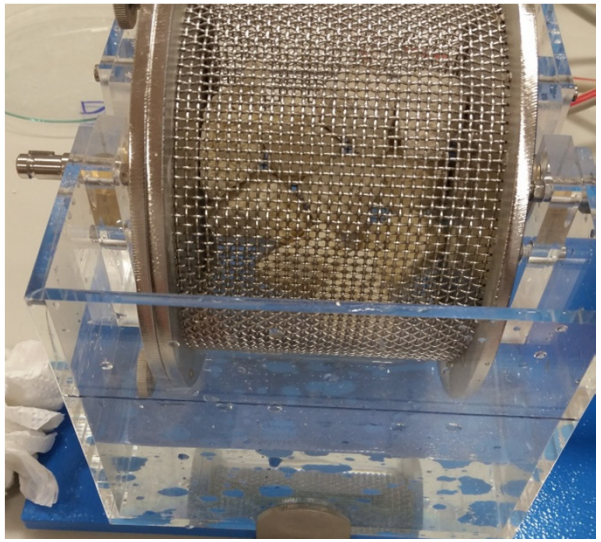





SAMPLE PREPARATION AND TESTING

- Laboratory slake durability index tests performed on rock pieces, about 40 g to 60 g each, prepared in laboratory condition using a geologist's hammer or chisel.
- Before testing, rock pieces were freed from any sharp corners with hammer and dust on rock pieces also removed with brush.
- The slake durability index test accomplished according to standards ASTM D4644-08.
- Tap water were used as a slaking fluid and each sample was subjected three cycles.

SAMPLE PREPARATION AND TESTING



DISCUSSIONS AND RESULTS

- The slake durability index test has been used as a simple laboratory test for assessing the influence of weathering on rock and its disintegration due to its fastness and easiness in application, simplicity and low cost.
- The related standards suggest using the second cycle slake durability index (Id_2) in the assessment of slaking properties of rocks.

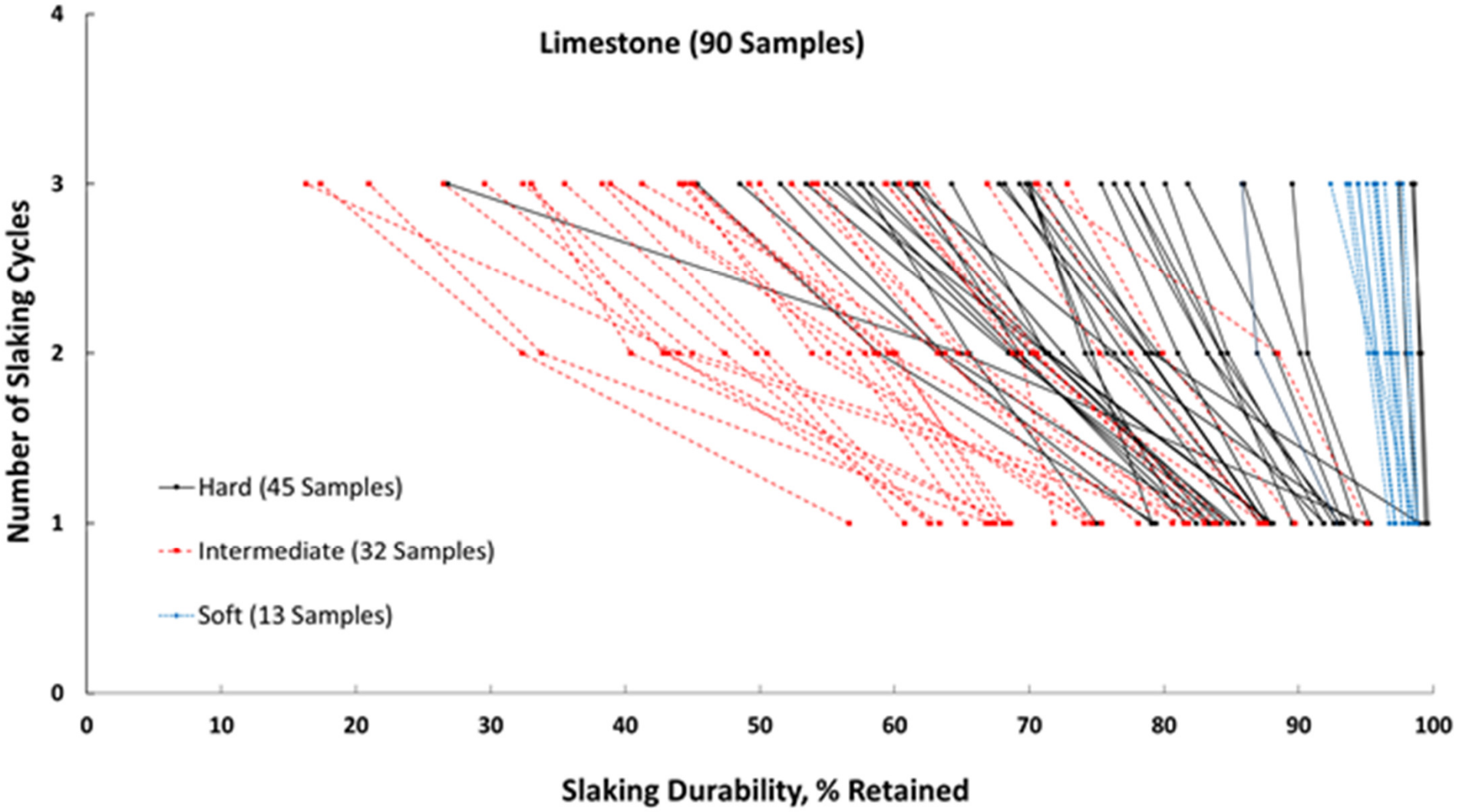
DISCUSSIONS AND RESULTS

- On the other hand, number of recent studies reported that multiple-cycle slake durability testing such as three and four cycle provides a better indication for deterioration of rocks against wetting and drying cycles.
- Nevertheless, in this study all samples were subjected to three cycles slake durability test.
- However, increasing the number of cycles in the slake durability test adds substantial extra time to perform the test.

DISCUSSIONS AND RESULTS

- Total of 90 limestone samples were tested by the slake durability apparatus.
- Of these samples, *45 were classified as hard, 32 as intermediate and last 13 samples as soft.*

DISCUSSIONS AND RESULTS



DISCUSSIONS AND RESULTS

- Even though data designate scattering behaviour, suprisily and in general sense, the slake durability of soft limestone (chalky) is high compared to intermediate and hard limestone.
- This could be due to the low water absorption of the calcareous wall of the microfossils preserved in the chalky limestone and low porosity of chalky limestone itself during the interaction of the slaking fluid, water.

CONCLUSIONS

- The durability behaviour of rock is an important engineering parameter in design; construction and long-term stability of structures build on or in rock material.
- Even though there is no reliable suggested method available in the literatures with a certain standard for in-situ definition of rock durability, it is considered time consuming and may take long term real time observation and recording.

CONCLUSIONS

- On the other hand, rock durability is commonly assessed in the laboratory on rock pieces since it is in a practical and inexpensive way compared to in-situ test.
- Certainly, understanding of rock weatherability problems that can be associated with today and future engineering applications will increase the safety and reduce cost and casualties.

ACKNOWLEDGEMENTS

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Thanks

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