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Apparent Preconsolidation Pressure Created by Remolding

The relationship of confining stress and overburden pressure used for strength testing is well known, but the apparent preconsolidation pressure created by the remolding process may not be as well understood. When introducing partially saturated testing it adds complication. The relationship of confining stresses and the apparent preconsolidation pressure created by the remolding process is the focus of this article.

Several sets of samples were remolded for partially saturated triaxial unconsolidated undrained compression tests. To be more accurate *Partially Unconsolidated Partially Undrained* testing. When the sample is not 100% saturated none of the aforementioned conditions can be fully attained with the TX-UU test.

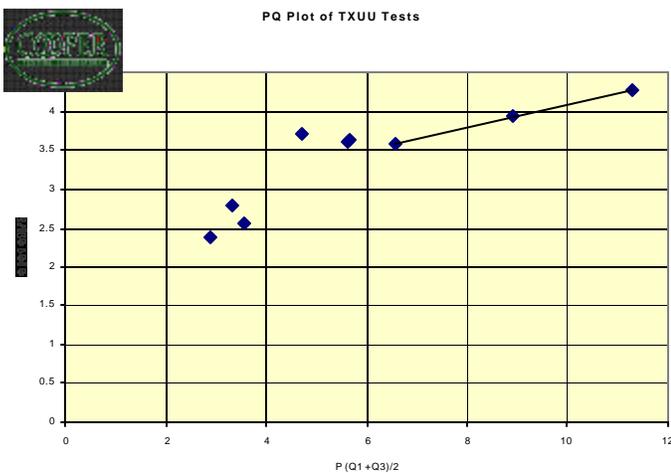
Each report had a set of three envelopes. The confining stresses were 500, 1000 & 2000 psf. The samples were remolded to 97% of ASTM D 698 at 2% over optimum. The degree of saturation at testing was approximately 78%. The material tested was a Dark Gray CLAY with about 14% Sand; a maximum density of 100.7 pcf and optimum moisture content of 20.8%, (see figure 6 for additional data). The samples were remolded to a height to diameter ratio of 2, ($h=5"$ $d=2.38"$). The samples were remolded in 1.0" lifts, scarifying between each lift. A kneading action was created by hand using a rod with a flat circular tamping head, (about 25% of the sample area), the last lift is completed in a press to insure square smooth ends.

Three composite samples

were tested. Two of the three sets showed a reasonable trend in strength increase with an increase in confining pressure, (see figures 1 & 2). There was one problematic composite sample. No matter how many times we reran the tests there was no apparent trend in strength vs. confining stress, (see figure 3 & 4).

We have noticed over the years that the confining stresses used when trying to develop a strength envelope can have a profound effect on the results. Low confining stresses with a small range in pressure will tend to show much more scatter than using higher confining stresses over a larger stress range. There are a couple reasons for this. 1) The limitations of the equipment, such as regulator drift, which affects the confining stress. Electronic noise, which will affect the accuracy of the sensors, which will have a more detrimental effect when using low confining stress (250-500psf) for example. This problem becomes less significant as the

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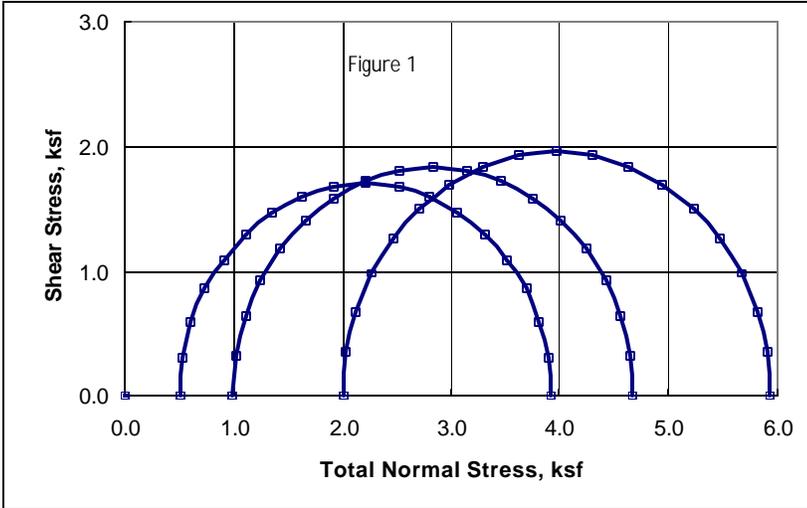
The chart to the left is a PQ plot of all the TXUU tests that were run on sample comp-1. Once the preconsolidation pressure that was created during remolding was exceeded, the trend of strength vs. confining stress was established.



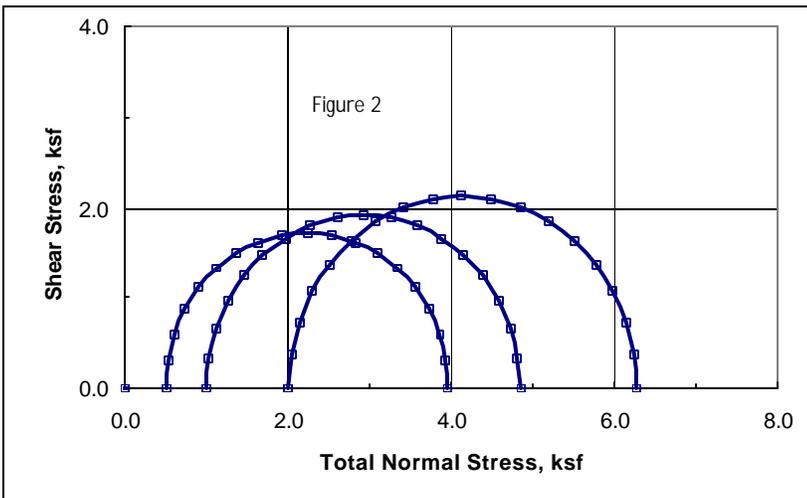
Remolding of gravel by vibratory table. 6"d x 12"h; six 2" lifts; batched to required gradation



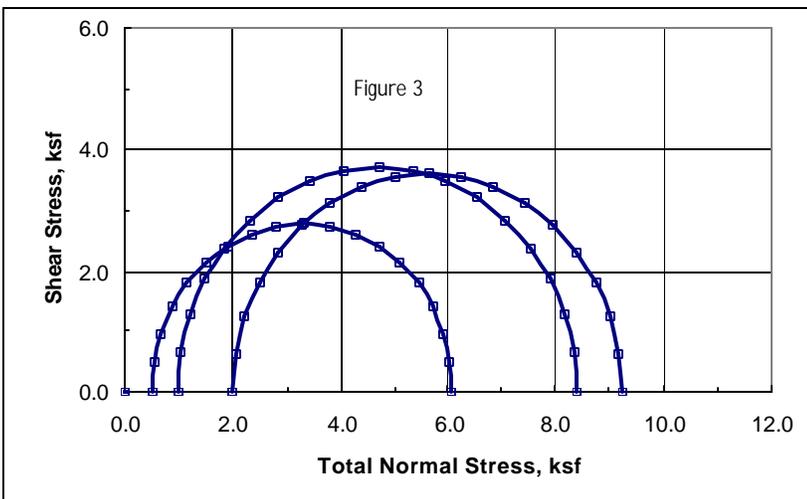
Remolded Triax Sample by compaction.; 6"d x 12"h; six 2" lifts; each lift batched to required gradation



Composite 3



Composite 2



Composite 1

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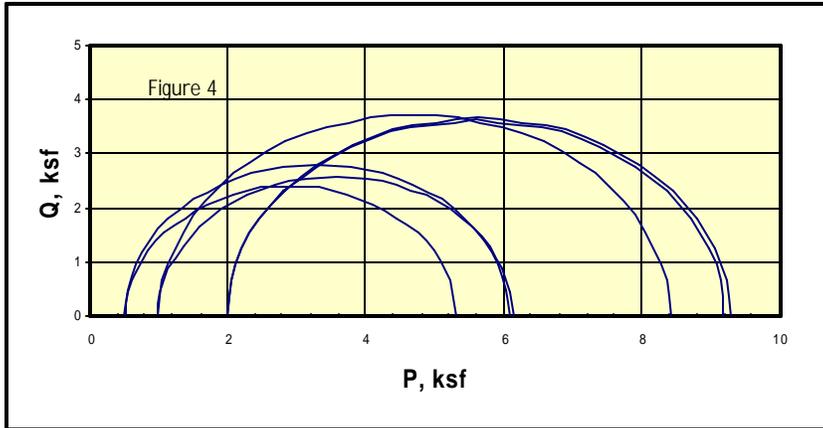
confining stress and resulting strength of the sample increase. 2) If the confining stress is less than the existing or past overburden stress (preconsolidation pressure) the confining stress will not have the desired affect, the result possibly being scatter.

With this in mind we wondered if the remolding process creates an apparent preconsolidation pressure and if so were the confining stresses that were being used, below that pressure. A sample was remolded to the same moisture and density as the TX-UU samples. A consolidation test was run and the preconsolidation pressure of about 4800 psf was determined (see figure 7). Please note that the confining stresses used for the strength testing did not exceed 2000 psf. Another set of three samples were remolded and TX-UU tests run at 3000, 5000 and 7000 psf, putting the middle confining stress at the apparent preconsolidation pressure. Once the confining stresses were in the range of the apparent preconsolidation pressure, created by the remolding process, the trend of strength vs. confining stress became linear, (see figure 5).

Unconsolidated testing, as with the TXUU test, (which in a partially saturated condition becomes a partially-unconsolidated partially-saturated test) is more or less sensitive to the confining stress depending upon the degree of saturation. For example: if the sample has a low degree of saturation the air filled voids have the potential to compress, (if the confining stress is high enough). The void ratio will be reduced, which will increase the strength of the sample. If the sample has a higher degree of saturation there will be less air filled voids to compress when the confining stress is applied, so it becomes less sensitive to the confining stress being applied and there will be less increase in strength. The more saturated the sample is the less change in void ratio when the confining stress is applied. If the sample is fully saturated there should be no change in void ratio and therefore no change in strength, in which case the preconsolidation pressure created by the remolding process should not be an issue. With partially saturated samples the relationship of confining stress and the apparent preconsolidation pressure created by the remolding process can become an issue.

Consolidated fully saturated samples are still

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Above: Composite 1 with initial reruns. Below the apparent preconsolidation stress created by the remolding process

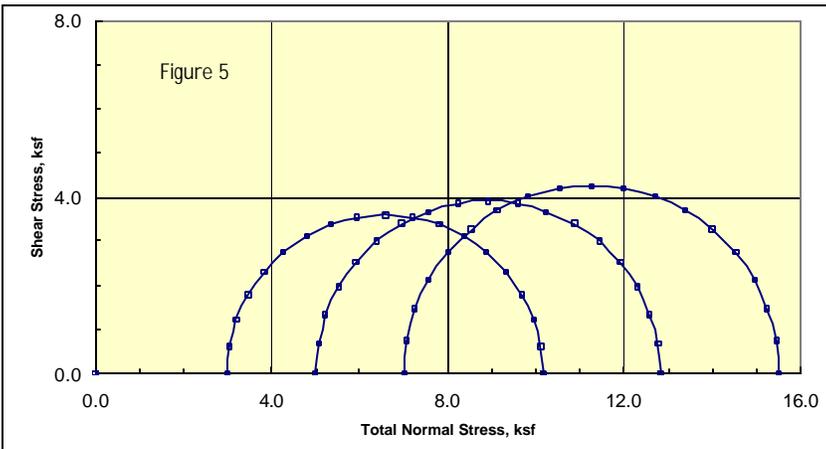
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susceptible to scatter if tested at confining stresses less than the apparent preconsolidation pressure created by the remolding process. There may be less scatter due to the change in void ratio during consolidation but scatter is not uncommon with consolidated strength testing. If the samples are tested below the apparent preconsolidation pressure there will be less change in void ratio than if they were consolidated at or above the apparent preconsolidation pressure, hence having less effect on the strength. What we have found is the further below the apparent preconsolidation pressure created by the remolding process the more scatter will occur.

It is unknown why one out of three materials had this problem. There may be something else occurring or it may be that some materials are more susceptible to this problem than others.

It appears that the relationship of confining stress to the apparent preconsolidation pressure created by the remolding process is most apparent with partially saturated testing. The most critical range being between 70 to 90% saturation. Although more research is needed to verify this.

Your comments are always appreciated!



Composite 1: final reruns at apparent overburden stress created by the remolding process.



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Sample:		1	2	3	4	5	6
Sample No.:		Comp-1	Comp-1	Comp-1	Comp-1	Comp-1	Comp-1
		Initial Moisture Density					
MC,	%	21.1	20.6	20.2	20.0	20.1	20.2
DD,	pcf	98.4	98.7	99.2	99.8	99.8	99.6
Sat.	%	79.8	78.8	78.1	78.5	78.8	79.0
Void Ratio		0.713	0.707	0.699	0.690	0.689	0.692
Diameter,	in	2.38	2.38	2.38	2.38	2.38	2.38
Height,	in	5.00	5.00	5.00	5.00	5.00	5.00

Figure 6 shows the sample Parameters of Sample 1 original three envelopes and three reruns.



Triaxial Sample with Membrane



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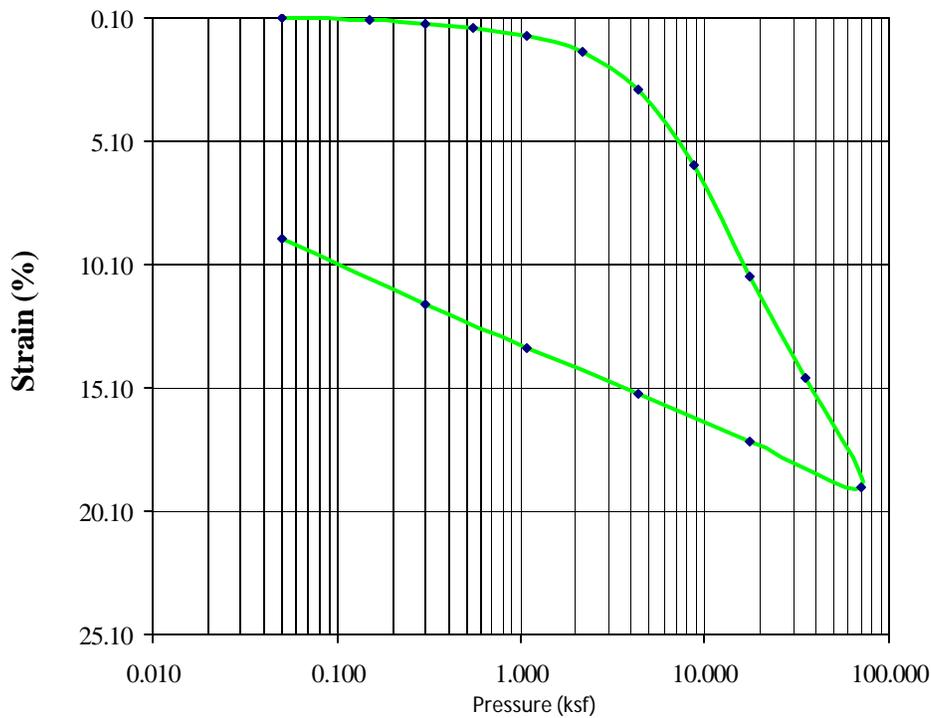
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Fig 7 shows the apparent pre-consolidation pressure created by the sample remolding process.



Triaxial System with Flow Pumps