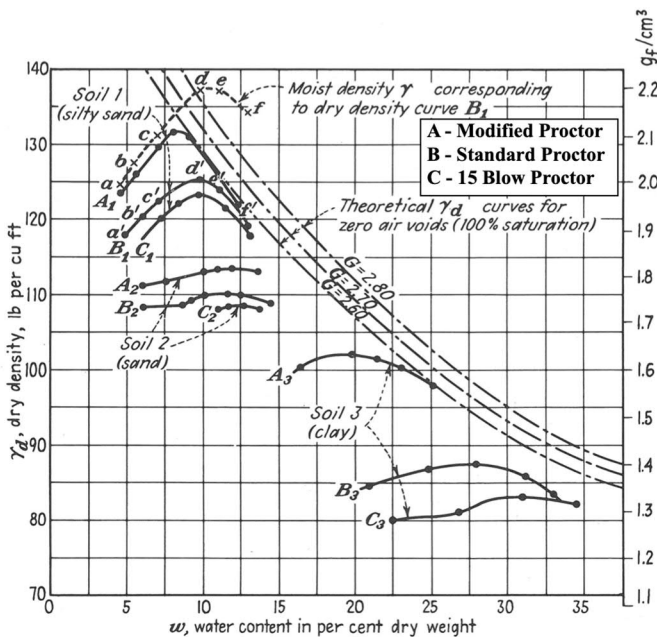


Soil Density - Standard vs. Modified Proctor

Reinforced soil structures routinely specify that all soils be compacted to a minimum of 95% of the maximum density determined by ASTM D698 - *Standard Proctor Density* for conformance with the design. However, *Standard Proctor* density criteria is typically utilized in the Eastern US whereas *Modified Proctor* density criteria is typically utilized in the Western US which can create some conflicting specifications. The goal is always a well compacted structural fill with the appropriate density testing quality control regardless of method.

Research has been done showing the relationship between *Standard* and *Modified Proctor* density testing for different soils types as indicated below:



Moisture-Density Relationships

(Ref. Tschebotarioff - 1973)

It is obvious from this limited data that a simple conclusion can not be drawn but some general guidelines can be established when using *Modified Proctor* density testing vs. *Standard Proctor* testing for quality assurance testing of reinforced soil structures:

- 90% - 93% of *Modified Proctor* density is roughly equivalent to the specified 95% *Standard Proctor* density for granular soils. Finer grained soils (ie: silts & clay) can be very responsive to compactive effort and moisture content thus the relative density difference may be significantly greater.
- *Modified Proctor* testing typically requires a lower optimum moisture content for achieving maximum density (curve shifts to the left) which is desirable for Keystone retaining wall construction and performance especially with silty and clayey soils. It also helps avoid pumping conditions.
- The density difference between *Modified Proctor* and *Standard Proctor* density testing appears to increase with the percentage of fines in the soil matrix while the optimum moisture content decreases. It may be prudent to utilize 92% or 95% of *Modified Proctor* as the minimum density and optimum moisture content when working with finer grained soils such as clays for best results.

Characteristics of Three Soils

Type	Sand	Silt	Clay	LL	PI
Soil 1-Silty Sand	80%	15%	5%	17	1
Soil 2-Sand	92%	5%	3%	NP	NP
Soil 3-Clay	10%	28%	62%	68	47

Summary of Soil Compaction Data

Type	Dry Density, pcf			Opt. Moisture, %		
	A	B	C	A	B	C
Soil 1-Silty Sand	132	125	123	8	10	10
Soil 2-Sand	113	110	108	ind	ind	ind
Soil 3-Clay	102	88	83	20	28	31

95% Standard vs Mod. Proctor Comparison

Type	Standard	95% Standard	% Modified
Soil 1-Silty Sand	125 pcf	119 pcf	90%
Soil 2-Sand	110 pcf	105 pcf	93%
Soil 3-Clay	88 pcf	84 pcf	82%