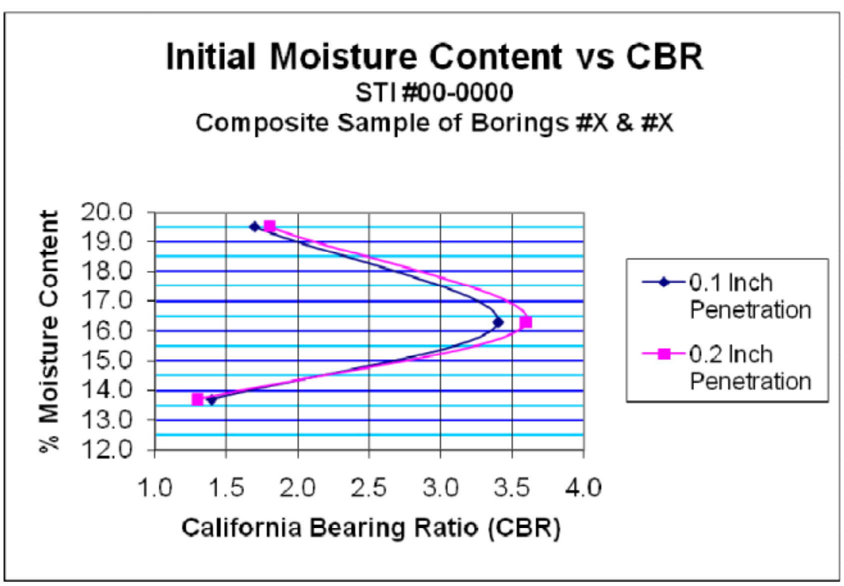
Choose Your CBR Values Carefully

Sometimes We Ignore How Moisture Affects CBR Values: Over the years, we (STI) have received many requests to provide pavement section designs using the typical "one-point" CBR value. The one-point CBR value is normally obtained by performing the CBR test at "95% of the "Standard Proctor Density" and at the "optimum moisture content." The CBR value is then used to design a road or street or airport pavement section costing 100's of thousands of dollars… WOW! It is amazing that we put that much confidence in one test value. So, if we are giving that much weight to one test value, it seems to beg the question, ***"Are we using the correct CBR value?"***

Determining the CBR value for use in design is simple, right? Just run the test, get the CBR value, maybe add a little safety factor and presto, there it is. Well, maybe not so fast…? For many soils, it's just not that simple. In fact, there is one factor that affects the CBR test value more than almost anything else, and that's the moisture content. An example of this is demonstrated in the graph below. The graph shows three actual CBR values of the same soil sample, compacted to the same density (95%), but at three different moisture contents. The moisture contents are 3% below optimum, at optimum, and 3% above optimum.



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As can be seen, the CBR value changes dramatically with a change in moisture content. The CBR value drops from about 3.5 at the optimum moisture content to about 1.7 at a moisture content 3% above optimum. The CBR drops even more to about 1.3 at a moisture content 3% below optimum.

Again, WOW! What a surprise! But, maybe it shouldn't be a surprise. If we think about it, "load limits" are placed on highways in the spring to help compensate for the very phenomenon, i.e. in the spring, the subgrade moisture contents go way up and the CBR values go way down. The pavement sections simply can't handle the normal traffic loads with increases in the subgrade moisture contents that occur in the spring.

So, why do we engineers sometimes design pavement sections using the best CBR value that generally comes from performing one CBR test at the optimum moisture content?   Who knows? Probably, because that is the way we have always done it. If using this one-point CBR value is not correct, then what has been saving us from having pavement failures coming out our ears? Not sure. One reason might be because highway departments compensate for high moisture during spring by using "load limits." However, do cities put on spring load limits…? Not generally. Do airports put on spring load limits…? Haven't heard of any.

Another saving grace may be that many of the street and airports subgrade soils actually get compacted to a higher density than what is called for in the project specifications. For example, if the project specified density of the subgrade soils is 95%, the actual average density for the project might end up being 97% or ever 100% plus. Since a higher density results in a higher CBR value even if the moisture content is not at optimum, the project ends up with fairly decent CBR values. Thus, the pavement's life span actually gets close to what we designed it for, and that is good. But, it seems that this is based more on good luck than good engineering.

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Going back to the graph above, the moisture conditions on that particular project were so high during construction that the contractor had difficulty putting equipment on it to get it paved. Even worse, the site is in an area that typically has high moisture contents most of the year, year after year. So, undoubtedly, the CBR value during construction was well below the 3.5 at optimum moisture and has probably stayed that low ever since. Fortunately, because of the 3-point moisture CBR tests shown in the graph above, the high moisture conditions were taken into account during the design and thus, a lower CBR value was used.

What is the take away on this…? Well, one thing may be that choosing to design a pavement section based on only a one-point moisture CBR test is probably not great engineering. Should a “3-point” moisture CBR be run on subgrade soils in order to determine a more realistic CBR value like the one shown in the graph above? Probably. And then there are the other factors that enter into choosing the CBR value such as: the use of load limits, the subgrade moisture conditions after construction, the depth that the subgrade soils are moisture conditioned and re-compacted, the number of subgrade soil types, and even unusual things like how standing water in a road ditch will affect the subgrade CBR value.

Whatever the case, it seems that designing a pavement system should entail careful consideration, especially on **<u>how moisture affects CBR values.</u>** This one decision in choosing a CBR value is critical to giving the client their dollars worth of engineering and even more, their dollars worth of construction costs. So, **<u>Choose Your CBR Value Carefully</u>**.

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