STANDARD DEVIATION AND ITS RELATION WITH STRENGTH OF CONCRETE

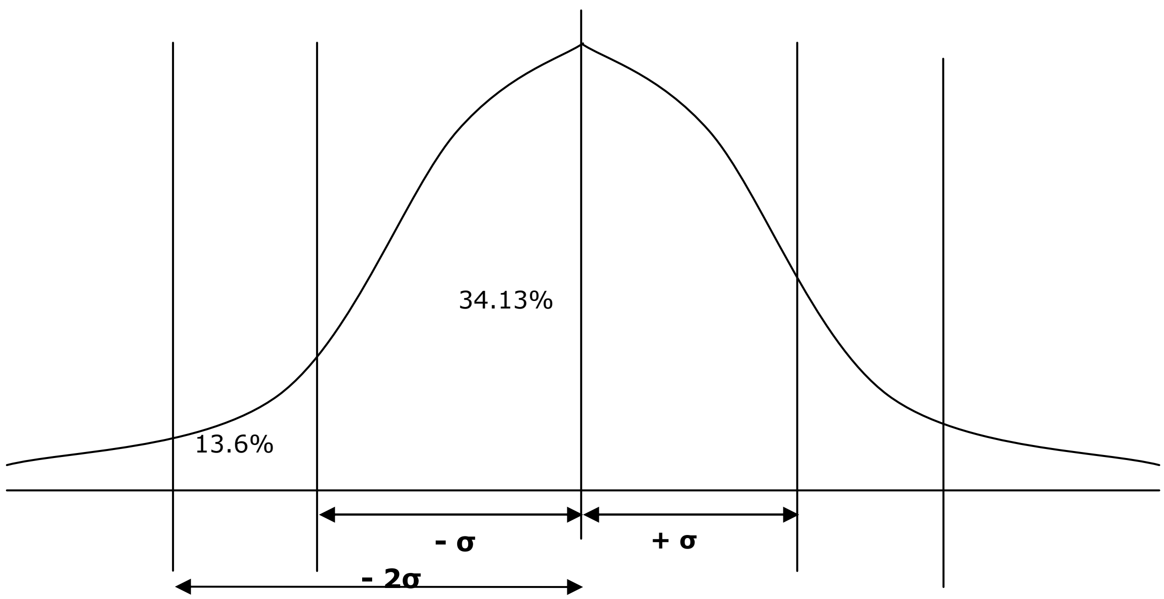
Standard deviation generally indicates the deviation of a set of variables from the mean value. The less the value of standard deviation is, the more the values are close together.

Also, a low value of standard deviation indicates more consistent results. On the other hand, higher values represent inconsistent results.

The standard deviation is represented by a normal distribution curve, which is a bell shaped curve with the mean value at the apex and positive and negative infinities on either side. The area covered by the curve gives the percentage of samples within the range.

We can determine the confidence level of a set of samples using the standard deviation.

See the fig.



We generally represent standard deviation by the notation σ (sigma). In a normal distribution curve, the possibility is that about 68.26% of the values are within –σ and +σ.

For example, if the mean value of a number of samples is 100 and standard deviation is calculated as, say, 6, then 68.26% of all the results fall between 94 and 106.

And 90% of the test results fall between -1.645σ and +1.645σ

Similarly, 95.45% of samples fall between -2σ and +2σ, ie between 88 and 112.

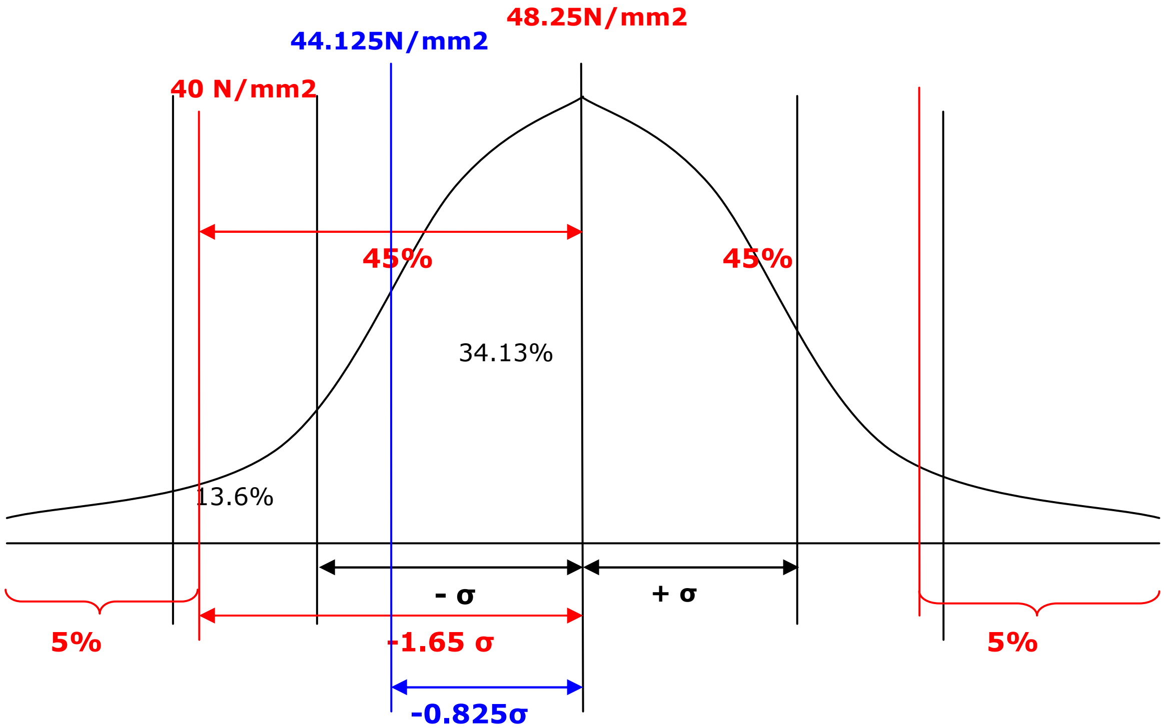
And 99.97% of the test results are likely to fall between 3σ range, ie from 82 to 118.

Ultimately 6σ means the confidence level is 99.99985%.

(Remember the use of sigma as a quality representation by companies now. Quality of six σ means 99.99985% of the products are within the acceptable range or control limits, meantime companies strive to minimise the standard deviation also.)

Now,

Let us consider the case of a concrete mix, say, M40 mix.



M40 mix has a characteristic strength of 40N/mm2. As we know, characteristic strength is the strength of concrete at 28 days, below which not more than 5% of the sample may fall.

As indicated above, 1.645σ gives a confidence level of 90%, and out of the balance 10%, 5% may be below the lower limit and 5% may be above the upper limit.

Since we are only worried about the value falling below the required strength, we conclude that 95% of the test results are ABOVE the lower limit set, ie characteristic strength.

For getting a characteristic strength, the mean strength should be 1.645 σ. That is how the target mean strength for concrete design has become fck + 1.645σ (or fck +1.65σ, rather).

In the absence of proper test data, σ is assumed as 5N/mm2 for M40 concrete.(IS456 table 8).

Since we know fck = 40n/mm2, target mean strength is calculated as fck + 1.65σ = 48.25N/mm2, which is the design parameter.

But as far as acceptance is considered, as per the table 11 of IS 456, mean of the group of 4 non overlapping test samples should be greater than **fck+0.825σ** or **fck+4** whichever is higher.

This clause is to ensure that the average strength is around in the range of fck+4 N/mm2. For instance, if we assume the standard deviation is zero, (ideal condition), our target mean strength will become fck. There we follow the second condition, which is fck+4 N/mm2.

Please follow the following link for more details

http://civiltechnical.blogspot.com/