Review of PennDOT Data

Introduction

Results were provided from 50 different combinations of Super Air Meter (AASHTO TP118) measurements and hardened air void analysis (ASTM C457). All measurements were completed by Penn DOT personnel.

Three of these results were removed from the analysis because the SAM number was either negative or greater than 0.7. These values are not possible and are likely due to leaks in the meter or the meter not being run accurately. The majority of the measurements were from highly flowable concrete. This is very helpful to the research team because we do not have a lot of this type of concrete in our datasets.

Air Content Versus the Spacing Factor

Most specifications only require a fresh air content to be measured during construction to investigate concrete for freeze thaw durability. These specifications typically require between 4% and 8% air by volume. By comparing the air content and the spacing factor for 47 of the mixtures in Figure 1, it is clear that there are a number of mixtures with air contents within the range of typical air volume specifications but the spacing factors are greater than the recommended limits. This highlights the challenge of only using the air content to evaluate the quality of the air void system in concrete.

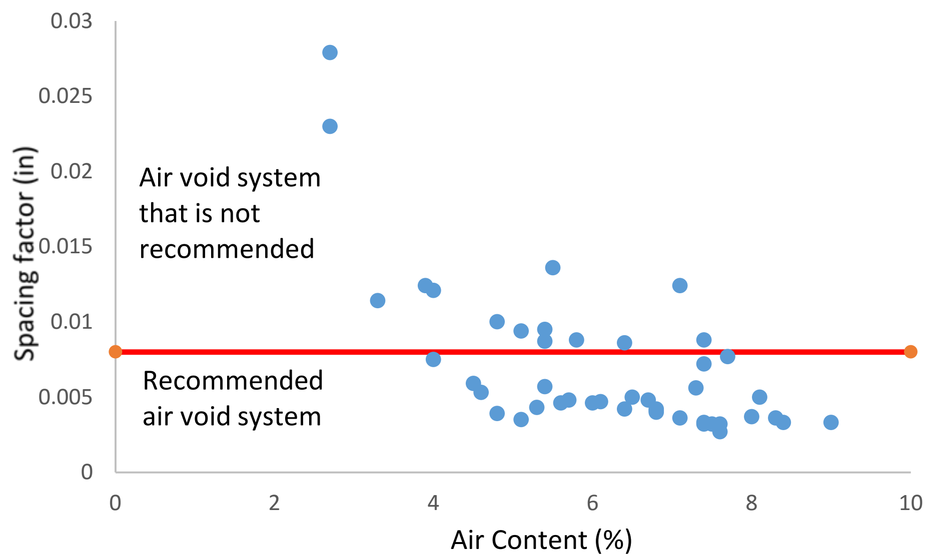

Figure 1 – A comparison of the air content versus the spacing factor.

Spacing Factor vs SAM Number

There was good agreement found between the measured spacing factor and the SAM number. By using a SAM limit of 0.20 and comparing it to a spacing factor limit of 0.008", the SAM number was able to correctly predict if the spacing factor was greater than 0.008" over 81% of the time. An alternate SAM limit of 0.25 has been suggested based on the accelerated freeze thaw testing (ASTM C666). If the 0.25 limit is used then the agreement increases to 89%. Both of these limits show that there is good agreement between the SAM number and the measured spacing factor for these samples. The data is shown in Figure 2.

In addition, all of these incorrect predictions were conservative. This means that by using the SAM number no mixture with a spacing factor greater than 0.008" would have been allowed. This shows the benefits of using the SAM number over the usage of the total volume of air.

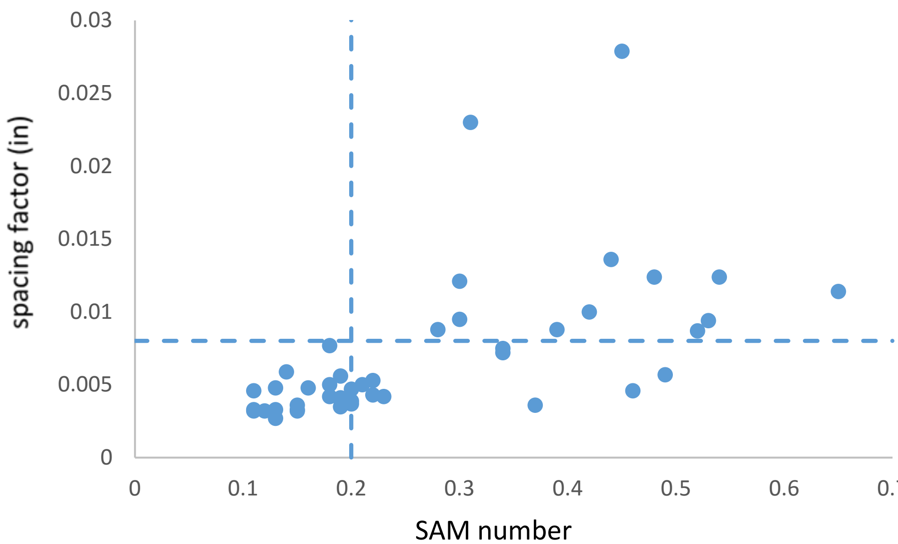

Figure 2 – Comparison of SAM number and spacing factor for 47 samples from Pennsylvania DOT. A SAM limit of 0.20 and a spacing factor limit of 0.008" is shown.

Average Bubble Size

Sometimes when complicated admixture combinations are used then the air void system can be made up of larger bubbles. When this occurs the mixtures require a higher amount of air in order to obtain a satisfactory spacing factor. Also, when the air voids are made of larger bubbles they are more buoyant and try to escape from the mixture and so the air void system is not as stable. While investigating the data it was noticed that several of these mixtures seemed to have air voids made of larger bubbles. To investigate this further, a plot was made that compared the air content and the SAM number. The results are shown in Figure 3.

This data shows the user the overall size of the air voids in the sample from just using the results of the SAM. The upper line shows the air void systems with larger voids and the lower shows mixtures with smaller voids. This data is all obtained from the measurements made by the Super Air Meter and so they can be obtained before the concrete has hardened. This data shows that there are a number of concretes whose air void system is made of large voids. As stated previously, these mixtures will need higher air contents and will have air-void systems that are not as stable.

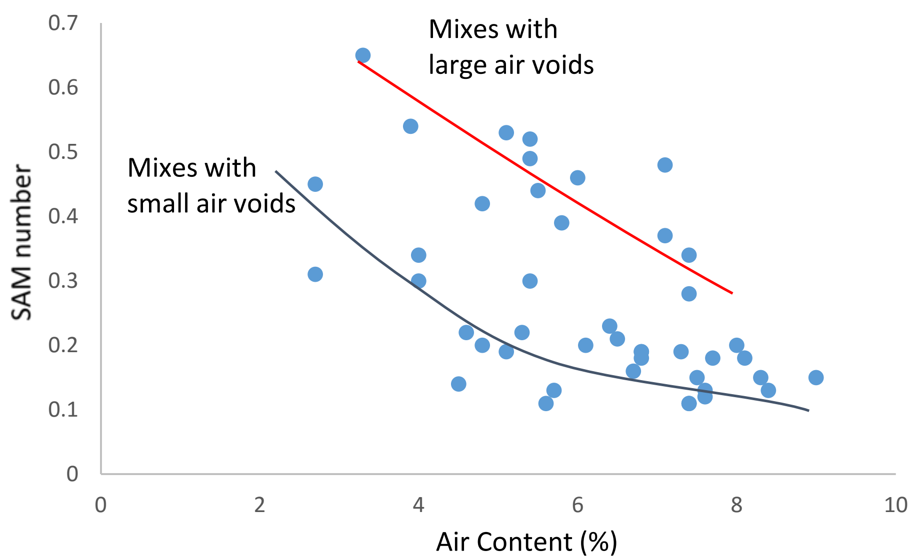

Figure 3 – A comparison of the air content and SAM number. These results will tell the operator quickly if the overall size of the air voids are large or small.

Differences Between Hardened and Fresh Air Content

A comparison was made between the air content as measured by the Super Air Meter and the hardened air void analysis. In a number of cases it was noticed that there was often larger volumes of air in the hardened air void analysis when compared to the Super Air Meter measurements. This same trend was not noticed in the field concretes provided by other states.

One possible explanation for this difference is the unstable air void systems from the larger air voids. These samples may have lost air between creating the hardened air void samples and running the Super Air Meter. More details would be needed to learn more.

Overall comments

This was a very important data set for the Pooled Fund Research. This data clearly shows the inability of using the total air volume to determine the quality of the air void system and the usefulness of the SAM number. All measurements were completed by Penn DOT and the data was just analyzed by the Pooled Fund Research Team.

It would be helpful if more detailed information about the mixture designs could be reported. Including the admixture combinations and mixture proportions. Also, if the other parameters in the hardened air void analysis besides the air content and spacing factor are available then that would also be very useful.