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(After many requests, CalPortland is bringing back our quarterly newsletter. Each issue will contain information that will be useful for everyone involved with ready mix concrete. Consider saving the issues for future reference.)

CHEMICAL ADMIXTURES

Concrete performance for use in a specific application can be judged by a number of different criteria. The most widely used criteria of concrete performance is compressive strength. It was discovered many years ago that concrete compressive strength is determined by the water/cement ratio of the mix design. That is, the weight of water in pounds as a percentage of the weight of cement in pounds. The lower the number, the higher the compressive strength and conversely, the higher the number, the lower the compressive strength. For example, a concrete mix design requiring 250 pounds of water to produce a 3" slump and 517 pounds of cement would have a water/cement ratio of 0.48 (250 pounds of water divided by 517 pounds of cement = 0.48). There may be times when it is necessary to increase the slump and therefore the workability of a particular concrete mix design. To accomplish this, additional water could be added, but by doing this, strength will be sacrificed because the water/cement ratio will be increased. To maintain the original water/cement ratio and increase the slump and workability of a mix, any increase in water will necessitate a proportional increase in cement. Increasing the cement content will increase the cost of the concrete. Additionally, an increase in the cement content will increase concrete temperatures which can lead to faster set times, increased difficulty in finishing, as well as unsightly thermal cracking and crazing of finished concrete surfaces.

WATER REDUCING ADMIXTURES

A different approach to work within the compressive strength requirements of the project, mix design workability and cost constraints would entail the addition of chemical admixtures. ASTM C-494 designates the following types of chemical admixtures for concrete:

Type A – water reducing

Type B – set retarding

Type C – accelerating

Type D – water reducing, set retarding

Type E – water reducing, set accelerating

Type F – water reducing (high range)

Type G – water reducing (high range), set retarding

Our discussion here will be limited to Type A and Type F chemical admixtures. These products are often referred to as "plasticizers" depending on their usage in the mix design as illustrated in the following two examples.

Example #1: If it is desired to increase the compressive strength without increasing the cement content, a water reducing admixture can be introduced that will allow less water to be used while maintaining the same slump. Reducing the water required to produce a certain slump will lower the water/cement ratio and thereby increase the compressive strength. Although there is a cost associated with adding the water reducer, it may be less

STANDARD WATER REDUCERS, MID-RANGE WATER REDUCERS AND SUPERPLASTICIZERS			
	STANDARD WATER REDUCERS	MID-RANGE WATER REDUCERS	SUPER-PLASTICIZERS
As a Water Reducer (% Water Reduction)	5% to 6%	10% to 12%	15% to 18%
As a Plasticizer (Slump Increase)	Up to 2 "	3" to 5"	5" to Flowing or SCC
ASTM Type	Type A	Type A & F	Type F
Set Time	No Effect	No Effect	Possible Retardation

than the cost of additional cement that would be required to produce the same results.

Example #2: If it is desired to increase the slump and workability while maintaining the compressive strength, this same admixture can be introduced to the mix design as a plasticizer. The original water content is maintained thereby producing the same compressive strength. Slump will be increased, and workability will be improved without the addition of additional water thus maintaining the original water/cement ratio. Costs for the addition of the plasticizer will increase the costs for the concrete but these can often be offset with savings in pumping, placing and sacking expenses where a high-quality finish is required.

STANDARD WATER REDUCERS, MID-RANGE WATER REDUCERS, SUPERPLASTICIZERS

For general concrete production, water reducing admixtures can be grouped into three categories: standard (ASTM C 494, Type A), mid-range (ASTM C 494, Type A) and supers (ASTM C 494, Type F). They all have their place, and each has its own advantages and disadvantages.

Standard water reducers will provide 5% to 6% water reduction as a water reducer and about 2" increase in slump as a plasticizer. When used at a standard dosage rate, standard water reducers have no effect on concrete set times. The concrete producer typically adds these admixtures at the batch plant.

Mid-range water reducers will provide 10% to 12% water reduction as a water reducer and 3" to 5" increase in slump when used as a plasticizer. When used at standard dosage rates, mid-range water reducers have no effect on concrete set times. The concrete producer also adds mid-range water reducers to the concrete at the batch plant.

Superplasticizers will provide 15% to 18% water reduction as a water reducer and 5" to self compacting concrete (SCC) increase in slump when used as a plasticizer. Superplasticizers may retard concrete set times. Some superplasticizers effects on concrete have a short time limit. These products are usually added to the concrete at the job site.

CONCLUSION

A properly designed concrete mix needs to encompass many things. Design criteria is foremost. Compressive strength and durability are key factors that must be considered when designing a concrete mix for a specific use. Chemical water reducing admixtures can assist in achieving these factors in a more economical way. How the concrete is to be placed and the quality of the finished surfaces are also key points to consider. An exposed wall with a lot of detail may require a higher slump to achieve the workability necessary to fully transfer the details from the formwork to the new concrete surface. Chemical admixtures used as a plasticizer are an excellent way to preserve compressive strength and durability requirements while providing the workability necessary to achieve the final required visual results. Contact your CalPortland sales representative to learn how to make chemical admixtures work for you to improve the concrete on all your projects.

JOINT PLACEMENT TO ELIMINATE RANDOM CRACKING

Concrete will shrink in size when transforming from a plastic state at the time of delivery to a solid state and will continue to shrink as moisture is lost internally. Additionally, hardened concrete will contract and expand with changes in moisture and temperature. It will also deflect when loads are excessive or if it is not supported adequately by the subgrade. Cracks can occur because of these factors unless proper provisions are made during design and construction. Random cracks are unsightly and are difficult to maintain. Joints in concrete are simply preplanned cracks and are constructed in such a way as to provide a weakened plane for the cracks to occur and follow a straight line.

Joints must be constructed properly if random cracking of flatwork is to be avoided. Joint spacing in feet should not exceed 2.5 times the slab thickness in inches. It is always best to make the concrete panels as nearly square as possible. When this is not possible, and a rectangle shape is required, the length of the panel should never exceed 1.5 times the width. Joints can be broken down into three classifications: construction joints, control joints and isolation joints.

Construction joints are joints determined in large part by the construction methods used and are commonly those joints created by the forming methods chosen. Proper load transfer at these locations can be achieved by keyways or dowels but horizontal slab movement at these locations must be preserved by not tying the two adjacent sections tightly together. **Control joints** can be either tooled or sawed into the concrete surface. These joints should penetrate the concrete surface a minimum of 25% of the concrete thickness. Sawed joints must be timed by determining how the saw blade cuts through the concrete. If the concrete surface ravels during the sawing, the operation must be delayed for a few hours until the concrete has gained more strength. Waiting too long to begin sawing risks the appearance of random cracking plus adds the difficulty of sawing harder concrete. **Isolation joints** are used around columns and against foundation walls to separate the slab-on-grade from adjacent concrete members that are more firmly tied to the subgrade.

In conclusion, there is no guarantee that by following these procedures you will eliminate all random cracking. If followed, however, the appearance of random cracking can be reduced considerably.

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