Technical Bulletin

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Internal Consolidation and Concrete Mix Design

A large number of contractor installers have been internally vibrating their Arxx™ walls with excellent results. Arxx Building Products agrees that this is a positive addition to the installation process. This document demonstrates our position and findings with concrete design and internal vibrators. This guide will help you to better understand the types of internal vibrators available and how to use them, and will also provide you with some insight into appropriate mix design. First, let's look at the basics:

Consolidation

Concrete placed into Arxx formwork needs to be consolidated. That is, it needs to fill every part of the wall to ensure there are no voids and to ensure the rebar is properly embedded in concrete. There are three ways to achieve proper consolidation:

- ❑ External vibration
- ❑ Internal vibration
- ❑ Hand rodding

Although all three methods are acceptable with the appropriate concrete mix, for the purpose of this document we will concentrate on internal vibration.

Proper Concrete Mix Design

The most common problem associated with concrete placement is improper mix design. In general, installers typically look at cost before quality when evaluating mix designs and without the understanding that a small extra cost in mix design can reduce labor on site. Working closely with your concrete supplier will result in a mix design that will work well in the Arxx walls. Arxx cannot provide this mix design because the ingredients in concrete will vary from region to region throughout the country which in turn changes the mix design.

It is not uncommon to see a proper mix design provide time / labor savings, and result in better walls with less concern for consolidation.

What to Look For in Your Mix Design

5" TO 6" SLUMP

Using the ideal slump of concrete is one step on the road to a wall that is free of voids. Concrete is normally designed at a four-inch slump, so when asking for an "Arxx Mix" your concrete supplier will need to increase this in his design. NOTE: Increase slump by adding water on site, will dramatically reduce the strength of the concrete.

PROPER AGGREGATE SIZE

Refer to the following table for recommended aggregate sizes for each of the available Arxx core sizes.

Some aggregate sizes may not be available in all regions. If this is the case in your area and your concrete supplier understands your needs, he may be able to design the mix around the available aggregate sizes.

"FLOWABLE MIX"

A "Flowable Mix" can be achieved in different ways depending on your region. In some parts of the country this is achieved with concrete ad-mixtures (such as a mid range water reducer), while in other parts it may be with more cement content (sometimes it is as easy as ordering slightly stronger concrete), and in yet another area they may add fly ash. In any

A "PUMP" MIX.

Your mix design should take into account whether a pump will be used. Your concrete supplier will know about mix designs for concrete pumps and may work closely with the concrete pump operator's to achieve the best mix design. Using the proper concrete mix with your concrete pump will result in shorter and more successful pump jobs, which in return lowers costs on site.

The bottom line is that your concrete supplier has worked in this area for a long time, and will have the knowledge and wisdom to design the best mix for Arxx that will meet ACI and CSA standards.

Internal Vibrators

Internal vibrators come in different shapes and sizes with the most common being:

LOW FREQUENCY

This type usually has the motor directly in the head of the vibrator and uses lower voltage to run. The advantage of low frequency vibrators then is durability and dependability. This type of vibrator usually depends on a generator to supply it with the proper voltage. A low frequency vibrator is usually easier too handle and will do a better job inside the Arxx forms however due to the cost, we do not see many low frequency vibrators on job sites.

HIGH FREQUENCY

This type usually has the motor at one end of the shaft with the vibrator head at the opposite end. This is a more economical and convenient internal vibrator, and also the most common type of internal vibrator for our application. One thing to note is that high frequency vibrators will wear, and in time do not deliver the expected vibration.

We will concentrate on high frequency vibrators.

The Parts of a High Frequency Vibrator

We need to have an understanding of the different parts of an internal vibrator to be able to exercise proper use.

THE HEAD

Head sizes can be ¾" to over 7" in diameter. As you would not put an oversize head in a conventional wall you should not put an oversize head into an Arxx wall. Due to the slenderness of Arxx walls, we recommend a head size of ¾" to a 1"∅.

THE MOTOR

Motor size is critical for Arxx walls and is measured by horsepower. It has been found that regardless of the head size, motor size will overrule. For an example, a ¾hp motor with a 1" head will work well in a Arxx wall, whereas a 2hp motor with a 1" head will likely cause damage to the Arxx forms. **Arxx Building Products recommends using a ¾ to 1 horsepower motor.**

THE SHAFT

The shaft is the part of the internal vibrator that connects the head to the motor and comes in many different lengths. When you are looking for an internal vibrator keep in mind the different heights of walls you may be building and get a shaft length that will work.

PROPER USE OF YOUR INTERNAL VIBRATOR

There are specific codes that deal with internal vibration. Sentence 5.10.8. of ACI 318-95 states: *"All concrete shall be thoroughly consolidated by suitable means during placement and shall be thoroughly worked around reinforcement and embedded fixtures and into corners of forms."* You can also find more information in the "Guide for Consolidation of Concrete" reported by ACI Committee 309.

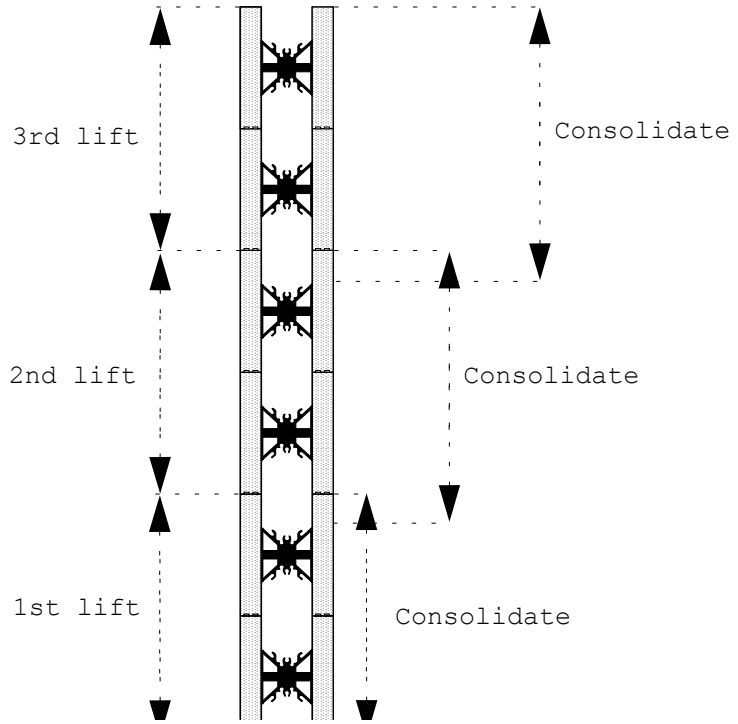
The most effective consolidation will occur when you have an understanding of what you are trying to accomplish. Picture entrapped air inside the wall in your freshly placed concrete. Your objective is to get that entrapped air out of the wall. The only direction that this entrapped air can travel to be released is up. Therefore, when inserting the head of the internal vibrator into the fresh concrete it should be **"fast in – slow out".**

Remember, we want to get the entrapped air up to the surface, so by inserting the head in fast puts the action of the vibrator under the entrapped air. Pulling the head up slowly helps move the entrapped air up to the surface. In ideal conditions, pull out at a rate of 3" per second. This may need to change if concrete is not at the desired slump. In most cases inserting your internal vibrator between every two webs (16" o/c) will do an excellent job, but watch your mix. If the concrete begins to stiffen you may need to internally vibrate every 8" o/c.

Recommended concrete placement & consolidation is as follows:

1. Place first lift of concrete (lifts can be anywhere from 0 to 48")
2. Consolidate first lift of concrete
3. Place second lift of concrete
4. Consolidate second lift of concrete (insert internal vibrator so it breaks into previous lift)
5. Repeat this process until wall is completed

Remember, it is up to the person placing concrete to recognize when concrete is the proper slump and at what height the lifts should be.



Sources

COMPANY	WEBSITE	PHONE
Allen Engineering	www.alleneng.com	870.236.7751
ISKCO	www.iskco.com	501.812.0220
STOW	www.stowmfg.com	607.723.6411
WYCO	www.wycotool.com	800.233.9926

Tips!

The maximum recommended diameter for a vibrator is 1" or less with a maximum horsepower of 1hp.

Consolidation must always be accomplished in lifts and not an entire wall at one time.

Improper consolidated concrete can result in voids, insufficient wall strength and sub-standard work.