



Exposed Aggregate finishes

A Guide for exposed aggregate Decorative Concrete

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Exposed aggregate finishes for Decorative Concrete

Guidelines for a successful exposed aggregate finish on fresh concrete. This guide is for use of experienced concrete finishers, architects, owners, and new concrete contractors wanting to expand their work. Decorative Concrete Supply highly recommends that concrete finishers consider both ACI 640 & 601-D certification.



This type of decorative finish has been popular with owner's architects and contractors for decades even though this look has been overtaken by new finishes. The new finishes stamped stenciled, colored and other types of decorative finishes. Exposed aggregate continues to offer a durable and aesthetic pleasing look for concrete. This method has withstood the test of time as concrete such as this has been successfully placed of over a century.

New types of surface retardants allow for new deeper exposures and now even the light sandblast look. Exposed aggregate also offers "because of the quality and amount of coarse aggregates a concrete mix less prone to shrinkage"

For years materials such a redwood and cedar woods have been left in exposed finished for both a look and to provide expansion. If this method is used reinforcement should not be used as this can allow moisture and corrosion over time.

This provides a wide range of colorful looks and will provide a slip resistant surface which is idea for:

- *Driveways*
- *Patios*
- *Walkways*
- *Pool decks*
- *Entryways and courtyards*
- *And tilt-up panels*

Exposure can be achieved in several looks

Sandblast finishes-

Only sand is revealed

Light exposed finish-

The edges and the very top of the aggregate is revealed



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- Medium exposed-** Finish where the exposed rocks and cement are about 50/50 revealed
- Full exposed-** The aggregate is main part of the concrete surface revealed

New types of surface retardants now allow for several in-between looks however depth should never exceed 1/3 of the diameter of the largest size aggregate or 1/2 the size of the smallest ACI 303.

Surface retardants now are more environmentally friendly. In years past surface retardants required 6 mil poly to be applied. This would have to be removed and disposed of though still used and it is an effective method use of the new types can help our environment.

When picking surface retarders it is recommended that you choose one that has a dye that can be well seen to ensure even coverage. When using plastic it is advisable to pre-roll the plastic on PVC pipes of the proper length this will allow the plastic to be both placed and removed much easier and the plastic possible is reused.

Carefully read directions even if you have worked with exposed for years new research now has several types and many perform differently. F/N in years past contractors used a mixture of sugar and water to delay sets this is not advisable with today's concrete mixes.

Both gradation and soundness of aggregates selected cannot be over overstated and sieve sizes, should be checked often. If not there will be variations in the exposed appearance. Avoid flat stones, as they do not bond as well as other round and cube sized aggregates do.

These mixes are more that not called a gap-graded mix, meaning some of intermediate sizes used. Many pours today leave out intermediate aggregate sizes in order to achieve the desired exposed look, but sand grading is still critical. The volume is reduced according to the cement content and the type and size of aggregate chosen. However, too little sand can lead to possible segregation issues or a "honeycombed" look in the course aggregate. Too much sand in an exposed mix might cause early dry shrinkage cracks.



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Exposed mixes should be carefully reviewed on larger projects that have testing procedures in place. These mixes are gap-graded and most will have lower contents of fine aggregate. This can be looked at as a hard to finish product but with the unique aspects of this type of concrete, one should consider the finished product and look, slump tests can also be deceiving because of the over abundance of coarse aggregate. This should be brought to any testing firms in advance, so the concrete won't be rejected on a standard ASTM C 143 slump test.

Most ready mix companies have mix-designs available for their types of exposed aggregates are brought in an outside consulting firm may be needed. Both admixture and sealer suppliers have detailed information on mixes for exposed aggregate mixes.

PLACEMENT METHODS

Three methods of exposed have been successfully used over several decades.

Placement of exposed aggregate requires a low slump concrete so aggregates whether seeded, mixed in a ready mix truck (ready mixed trucks are full depth aggregate supply) or exposed later with mechanical means to wet and the aggregate will settle down, making the task more difficult and harder to achieve the desired look. This can also lead to unwanted expose of the concretes base aggregate when the seeding method is used.

NOTE: Topping may also be done with exposed aggregate concrete. Slump of the concrete can range from 3-5 inches with never exceeding the 5". The mix should contain at least 6 sacks "564 lb of cement per yd." This will not only aid in placement but also provide better consolation water to cement ratios of .42-.47. This will provide the best results when using straight cement mixes. Use of both fly-ash & slag mixes will work for exposed and help in both workability, set times, durability & placement (however it should be noted that these mixes will slightly alter the final appearance of both any colors added and the exposed paste.)

Large sizes may also be added; example adding some specially selected 4" – 8" stones in a 3/8-1/2" to create a different look these can be done with either the seeding or full depth pours. Use proper placement to avoid any segregation. "This is also important when seeding to keep the integrity of the concrete base while finishing." The committee highly recommends that when possible and always on large jobs test panels be poured 2 panels when possible.



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- 1 for approval (in writing)
- 2 for any needed repairs to be 1st demonstrated and approved (in writing) before repairs begin

First the method of seeding the pre-picked aggregate with this method the aggregate is stock piled at the job site and broadcast into the fresh concrete one of the earlier methods was to arrange the stones on large cookie pans and then drop them in the arranged pattern in the concrete. This was popularized by Brad Bowman whom the Bomanite Company was named after. As this look became popular a more full depth exposed look came about by broadcasting more stones.

Seeding can be accomplished by using shovel (square point shovels offer the most even approach) Use of seeding by hand methods can also be used this method is best done along hard to reach areas like walls and some edges. New mechanical methods can also be effective. Experienced concrete finishers should be used to seed the experience of the finisher can avoid propels like aggregate stacked too high.

Coverage can vary depending upon aggregated size smaller sized stones will yield approximately 2½ – 3½ lb / per/sf. Larger sizes may require up to 6 plus lb/per /sf.

It is very important to carefully both weigh and measure forms to have an ample supply on site during the pour; with easy access to the material this is critical when using hand or shovel methods. If mechanical are used the material should be stored where it will be easy to re-load the spreader.

When the seeding method is being used the base course of the concrete mix should have aggregates of 3/8" + to 5/8" dia be careful to not exceed ¾" as this can make it more difficult to seed in the broadcast aggregate.

When seeding it will be critical that the finishers have proper access as well as the experience to provide an even broadcast method can be a simple light casting with larger areas of mortar showing or a broadcast to rejection where a almost 100% of aggregate will be exposed. Care needs to be taken with heavily cast areas as not to "clump" which could result in a birdbath.



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Concrete mix designs for freeze thaw areas should contain 6-8% of an air-entraining admixture these mixes not only help in harsh climates but can improve workability and reduce bleeding of the concrete mix

PLACEMENT METHODS FOR EXPOSED SEEDING METHODS

Check forms and screeds before placement begins be sure subgrade is firm and properly compacted (any lines or sleeves should have a minimum of 2" compacted fill) once aggregated is properly seeded it will need to be worked into the fresh concrete paste "time is of the essence in this critical step"

- **The slab is screened off in the same manner as normal concrete however leaving the concrete 1/8-3/8" low in the seeding is fine as the aggregate will increase the thickness at the surface the concrete is then smoothed with wood Darby's and bullfloats (many experienced finishers use aluminum or magnesium tools. However wood is the recommended choice for the initial finish**
- **NOTE the larger the aggregate size in the seeding method the deeper the concrete level should be below the form (the forms should be set so that the final slab will be both drained and level.**
- **The seeding or broadcasting can usually begin right after the final initial bullfloat application**
- **The aggregate is then uniformly broadcast onto the concrete surface**
- **The aggregate is then worked into the concrete surface this may be done by screeding with a sawing motion, use of tamping tools, or Darby's and bullfloats, some newer type roller screeds are effective but when using this method concrete needs to be 1/8-3/8 inch lower than the forms**
- **When this is accomplished a final pass is made with the bullfloat to ensure 100% paste coverage over the embedded aggregate about 1/16 th of a inch is needed magnesium and aluminum tools work well for the final pass this is one of the biggest reasons to use low slump concrete so the seeded stone does not interact with the base stone**
- **Avoids overworking of the surface as this may work the course aggregate into the concrete too deep.**
- **Small amounts of water may be added during placement however if color is used in the mix all water must be added before placement begins for large pour with or without color consider use of set delays in place of adding water.**
- **Be sure the surface retarders are applied both evenly with a uniform coverage, keep extra sprayer and have spare parts also pick a quality sprayer cheap sprayers can ruin a job. Carefully read directions from the manufacturer on timing for washing and how long the set is delayed temperatures have a great effect on the time.**



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- **Check water source and pressure before placement begins have enough hose to reach the entire area.**
- **Never use jitterbugs when aggregate is to be exposed [however use of a roller bug is recommended when a light sand exposed look is done]**
- **Avoid pours when rain is forecast within 8 hours after placement**

PLACEMENT FOR FULL DEPTH POURS

Many ready mix suppliers now stock aggregate for exposed concrete, although it's not necessary to have aggregate stocked on the job site. It may cost more money as the aggregate is through out the entire pour; these costs may or may not be offset with reduced labor. However the ready mix supplier has the stone and it's delivered with the concrete.

Place the concrete as normal with this method there is no need to adjust the forms or grade as with the seeding method preparation of subgrade and strike off methods are the same however aluminum or magnesium tools will work fine for use after concrete is screened.

Careful screed operations are vital to control any birdbaths or low spots. Be sure that edges are properly leveled it might be necessary to sprinkle extra concrete along edges so that they are level with the forms. This is done after the concrete has been screened and floated.

Avoid excess bullfloat lines and avoid overworking the surface especially on air-entrained mixes. Be sure slumps do not exceed 5 inches and do not use jitterbugs or tamping tools.

Concrete should be placed on a firm compacted subgrade of uniform bearing capacity it should be evenly graded and any lines should have a minimum of 2 inches of compacted fill over these lines. When no damage will be done to the concrete surface apply the concrete surface retardant according to the manufacturer directions (where the retardant was applied with seeding method the full depth pours need a little longer time before application begins) this is especially true in non air-entrained mixes where there is usually more bleed water, also even with air you may see more bleed as for the most part these are harder specially selected aggregates



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Avoid pouring on wet or frozen subgrade and do not pour if rain is forecast within 8 hours of placement

FULL DEPTH POURS WITH SAND FINISHES

New advances in surface retardants allow for placement of concrete and a sand exposed look by applying surface retardants to achieve this look, finishing is different than normal procedures use of a roller bug is done after initial bull floating followed by a light trowel finish and then the retardant is applied and washing as normal only the sand will be exposed when done, toweling will only enough to provide a smooth surface a one pass after the concrete is firm or use of a steel fresno trowel this does not require a hard trowel surface only one smooth and free on any finishing lines will be sufficient.

This method can produce a slip resistant surface and the concrete may be integrally colored at placement, or stained after curing

TOPPING PROCEDURES,

This method can be done at depths from 1" – 3" depth will determine the aggregate size, the topping depth should be at least 3 x/s the size of the largest aggregate in the mix. This method is sometimes done when a smaller aggregate look is wanted in the surface. They may be bonded or unbonded Reference ACI 302 classes of floors and PCA recommends use of finer sand such as masonry sands.

If there are control joints on the base course they will need to be carefully marked and then cut into the topping after placement, topping methods may be difficult in hot weather and placement of the topping may have adjusted to pour in lower temperatures of the day, surface retardants and washing can be done in the same manner as full depth placement pours.

MECHANICAL MEANS OF EXPOSING AGGREGATE

Many mechanical methods will require the use of high voltage equipment and even 3 phase electricity it is a good idea to have a back up generator in place for these

methods. Removal of paste should not be done until concrete has achieved at least 75% of its designed strength, in most cases this will be in 28 days.

Several methods have been used over the years to expose the aggregate in the concrete over the past decade interior concrete floors have had both coarse and fine aggregates exposed by the use of polishing machines these methods can densify the paste at the surface or expose both sand and aggregate interior floors may also have materials such a glass aggregate and ceramics. These methods should be done over floors that are flat and level it is vital that contractor know what F# is along with F/L.

F numbers should be 50 or higher and F/L 30 or higher this method may require as many a 9 steps and application of a liquid densifier may be needed. However this equipment can successfully only expose the concrete aggregate

Other means may be accomplished by

- Sandblasting
- Water-blasting
- Shot-blasting
- Scarifying
- Bush hammering



Sandblasting has been done for years but concerns about the environment and airborne dust issues should be looked at this method has been used successfully for vertical applications for years in revealing aggregates in columns and beams in concrete structures as well as walls templates can be used to create unique designs and logos that are impossible to achieve with other flooring materials custom logos, graphics, works of art and others are all easily accomplished by simply removing the concrete paste and exposing aggregates. Sandblast looks are a popular choice for pool decks as they also provide a slip resistant surface color may be added to the exposed area also many times in the form of acid stains. Over exposed or heavily sand blasted areas can remove the luster from the concrete aggregate and dull its appearance. Workers doing this will need protective eye wear, gloves, and clothing, and boots, surrounding areas with need protected.



Waterblasting is done with high pressure washers with special tips this method requires large amounts of water and there may

be runoff issues with this method. This method should only be done by experienced workers as this method can also produce deep gaps and holes when not properly applied. This method will also require protective clothing and rubber boots as well as face shields PSI should be about 1500 and done by experienced personal.



Shot blasting propels steel balls into the concrete surface when used aggressively can expose aggregates but is best suited for a sand type expose this would be a traction only expose look as the machines leave lines and they are heavy and will not allow you to get close to walls, smaller machines only create light exposed looks while the larger can expose aggregates it will give a uneven look and do some damage to the aggregates



Scarifying is done with a machine with a roller or drum it operates with a number of carbide shafts that chip away at the concrete as these carbide inserts rotate around the drum at high speeds



Bushhammering involves use of air type pneumatic tools equipped with a tool with several points the type of tools will determine the degree of concrete removed this method usually removes about 1/8-1/4 inch of the concretes surface. This method has successfully exposed columns and beans and even walls to provide an architectural effect by exposing the concretes aggregate, this method is more for vertical applications.

Refer to ACI 303 guide to architectural concrete for more information on vertical exposed concrete

With all mechanical methods proper safety procedures should always be in place and any gas powered equipment be properly ventilated.

- ✚ Careful selection of the aggregates is vital to the appearance of this finish, consult ASTM C 127 for detailed information on aggregate absorption
- ✚ River rock
- ✚ Quartz
- ✚ Granite



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- ✚ Trap rock
- ✚ Limestone
- ✚ Marble

Use of the above aggregates can create a rainbow of colors, variations will occur even in the same choice of aggregate according to which part of the country they are from. Quartz comes in several color shades white, yellow, green, pink and rose tones clear quartz can be used in integral colored concrete, and added to give a glimmer look around other aggregates.

Granite long known for its hardness and durability also offer numerous color shades ranging in shades from pink , grey , red , blues and black and white shades.

Limestone offers shades of white, grey, and pink

Trap rocks offer grey, black, and green tones

Many types of gravel offer several shades ranging from reddish browns to yellow, sand, vintage umber these types will need carefully screened and washed

Marble offers the widest range of color looks with red green yellow black white and grey in bright colors

The following chart offer some gradations that will give a good appearance

1/4	To	1/2		
3/8	To	5/8		

1/2	to	3/4
5/8	to	7/8
3/4	to	1”
1”	to	1&1/2 “
1 &1/4”	to	2”

Selection of aggregate should be carefully reviewed by the contractor, ready mix supplier, and aggregates supplier “if said aggregate is to be seeded” architect and owners (example if a sharp edged aggregate is chosen because of a look it could be very hard on ones feet in a pool deck application) all aggregates should be carefully washed and checked for impurities avoid aggregates or sand that may contain deleterious



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materials. When screening keep aggregate within one screen size either up or down but never more in order to achieve the desired look. Use of grading sizes closest to each other will give the best look.

Example ½ - ¾ either size down to ½ - ¾ or up to ¾ - 1"
Use of 1 & ¼" – 2" with ¼ - ½ would not look that good.

This would also lead to more paste shown when the job is washed and exposed and could lead to segregation issues during placement.

Aggregate classifications & colors

The aggregate may be rounded river rock, crushed stone, cubical types, other certain stones such as granite, quartz or trap rock may have slightly different dimensions. Avoid aggregates with high absorption this can lead to popouts especially in hard freeze thaw areas. On large jobs that might be done over time consider stock piling the aggregate chosen for quality results, this is especially important when seeding methods are used. An almost unlimited supply of colored stones can be used however many will dramatically increase the cost of the concrete.

WASHING OF EXPOSED CONCRETE

The washing phase of is of great importance as this determines the look of the concrete the timing needs to be precise with the initial set and the length of time that the retardant works. A good rule of thumb is when the concrete finisher can be on knee boards without making an indentation

The worker or workers can then begin to use a stiff bristle broom and remove some dry paste, when this has been done the concrete can be brushed and light scrubbed with water using a softer broom this will take a few passes keep a light mist to begin and avoid power washers
Some brooms come equipped with water jets to aid in removal, if areas are hard to remove the paste it may be necessary to use a stiffer broom. This procedure should continue until the aggregate has a uniform look and the water is clear and all unwanted paste is removed this will normally take several passes depending on the size of the concrete slab and the degree of expose needed. Be sure that all cement paste is removed.

If aggregates start to become loose and pop out. Stop and wait for the concrete to become more firm. Use low pressure and use of power washers is never recommended



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exposing of aggregate works best with 2-3 man crews so that both washing and scrubbing are the same, to ensure an even look.

ACID WASHING WHEN CLEANING

It has often been a practice to use a mild solution of acid to aid in the breakdown of the paste, this method if used should be done before the sealing application which is usually 14-28 days a solution of 10-15 parts water to 1 part acid, " always apply acid to water first to avoid splashing of any acid" apply while the concrete is damp (pre-wet) never dry use of a plastic type watering can has been a successful method "never use metal cans" work the solution in with a acid resistant broom and rise completely clean. Care needs to be taken not to over dose the acid this can have adverse effects on the alkalinity of the concrete

If this method is used always wear protective boots, gloves, and protect exposed skin and eyes from the acid.

SAW CUTTING OF CONCRETE

Follow normal rules of thumbs spacing 24 to 36 times the slab thickness and ¼ of the slabs depth on smaller jobs joints may be tooled however on larger jobs a saw cut may be the more effective means you would not want to delay application of surface retarders. Whenever possible saw cut while water sources are out and ready this can cut down on time while aiding in the conservation of water.

FN tooled joints just by the nature of the way they are installed may depress aggregate along the joints sides also creating a look not uniform with the rest of the job, because of the hardness and amount of course aggregate sawing make take longer than on a normal pour.

CURING AND SEALING

This can be difficult on exposed aggregate as the paste is removed usually within 4-12 hours after initial finishing, because of the large amounts of water used in removing paste along with excess water accumulation in the joints membrane cures both water or solvent should not be applied, the same day. One day after washing they



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may be as a sealing compound. However it should be noted that a 28 day cure time should be observed

An older method has been when washing is completed to recover with poly; however this method could leave an uneven look on some of the less exposed finishes if this method is use keep the poly as wrinkle free as possible. Or use non-wrinkling paper.

Because of the paste being removed, large amount of water used to wash paste off, and the abundance of coarse aggregate, along with low W/C ratios and slumps curing is not as critical as it would be with a concrete floor or pavement.

Hot and cold weather considerations should be taken. Hot weather consider a soaker hose for curing or white poly to reflect the heat if the poly method is used. Cold weather do not pour if temperatures are expected to drop below 36/F for the 1st 48 hours after placement.

It is recommended that architectural concrete such as this also be sealed after proper cure and dry time this can preserve the aesthetic look and increase the longevity of the surface.

F/N there is special made sealers with a light tint added that highlights the stone and mortar also. Consult manufacturer for coverage rates and application methods on sealers for exposed aggregate concrete.