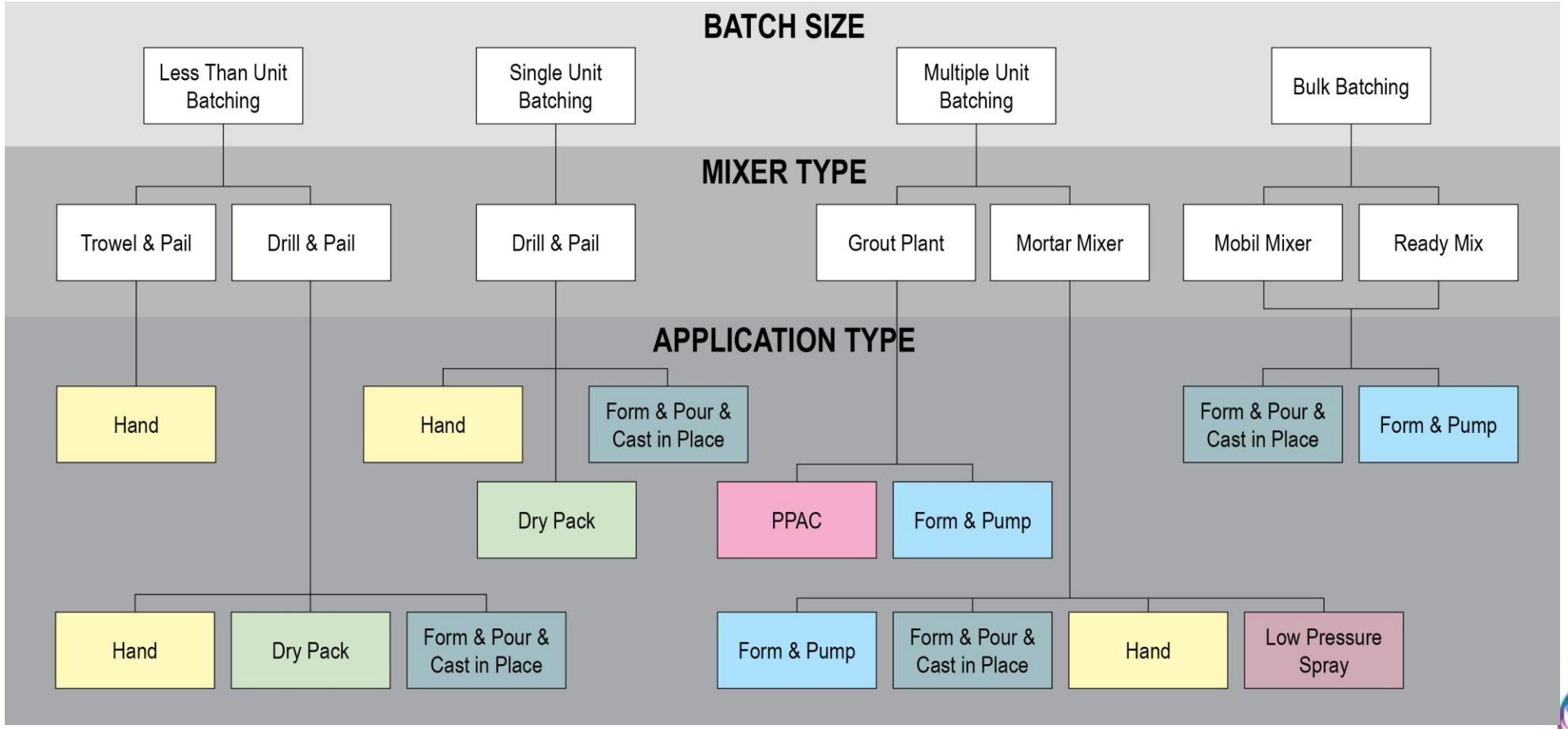
Guide for Selecting Application Methods for the Repair of Concrete Surfaces

- Guideline No. 320.1R–2019

Guide for Selecting Application Methods for the Repair of Concrete Surfaces – Project size decision tree



Guide for Selecting Application Methods for the Repair of Concrete Surfaces

- Guideline covers basic application techniques:
  - Unformed Hand Applied
  - Formed
    - Dry Pack
    - Form and Pour
    - Form and Pump
    - Pre-Placed Aggregate
  - Pneumatically Applied
    - Dry Mix Shotcrete
    - Wet Mix Shotcrete
    - Low Pressure Shotcrete

Guide for Selecting Application Methods for the Repair of Concrete Surfaces – Unformed Hand Applied

- General Description:
  - Unformed hand-applied repairs are best for vertical or overhead applications.
  - Repair material is mixed into a trowelable consistency. Trowels are used to place the repair material onto the prepared substrate.
  - A thin bond coat of the repair mortar is scrubbed into the saturated surface dry (SSD) substrate immediately before repair material placement. The repair material is then pressed into the substrate to develop intimate contact without voids.

Guide for Selecting Application Methods for the Repair of Concrete Surfaces – Unformed Hand Applied

- Best application:
  - Intended for shallow, non-structural, resurfacing of deteriorated vertical and overhead concrete substrates where steel reinforcement is not visible after preparing the repair area.
  - This application method is typically used for smaller size, localized repairs.
- Material Requirements:
  - Fine-grained cementitious repair material, typically packaged, easily finished, with a non-sag, trowel-grade consistency.
  - Can have light weight aggregate, corrosion inhibitor enhanced and/or be polymer modified.

Guide for Selecting Application Methods for the Repair of Concrete Surfaces – Unformed Hand Applied

- Advantages:
  - Can be mixed in small batches, this repair method is useful for isolated, small-scale repairs, potentially in difficult to access areas.
  - Forming not required.
- Cautions and Limitations:
  - Should only be used for non-structural repairs.
  - Repairs are labor intensive resulting in lower productivity.
  - Allowable build thickness in a single lift varies; typical range is 1½” to 3” for vertical and overhead applications.
  - Building material thickness in lifts can lead to inter-layer bond issues and delamination.
  - Steel reinforcement will generally not be present, supplemental repair anchorage may be required.
  - Proper curing is critical based on the low volume-to-surface ratio which can result in rapid drying.

Guide for Selecting Application Methods for the Repair of Concrete Surfaces – Dry Packing

- General Description:
  - Repair material is mixed into a uniform, cohesive, plastic state, then placed in a confined space and compacted with rodding tools to consolidate.
  - Dry pack repair material is typically placed in cavities 1” to 3” high in horizontal “lifts” of approximately 3” to 5”.
  - Each lift is rammed into the cavity using a flat-faced wooden or metal tool. The end of the tool not in contact with the repair material may be struck with a hammer to increase compaction.
- Best Applications:
  - This method is suitable for repair of relatively low-volume cavities with a high degree of confinement and open-sided access.
  - Typical applications include post-tensioning grout pockets, form tie holes, formed repairs at bottom edges of pan joist stems, and dry-pack grouting beneath column and machine base plates.

Guide for Selecting Application Methods for the Repair of Concrete Surfaces – Dry Packing

- Material Requirements:
  - Repair material with a no-slump consistency capable of being molded into a ball without sagging.
  - Material should be sufficiently damp to allow proper consolidation and hydration, yet stiff enough to resist sagging and deformation during the dry packing operation.
  - Avoid overly cement-rich mixes as these may develop cracking due to self-desiccation and drying shrinkage.
  - For repair cavity height/thickness on the order of several inches, the addition of aggregate up to 3/8” nominal maximum size should be considered.
  - Packaged “non-shrink” materials conforming to ASTM C1107/C1107M or Corp of Engineers CRD-C 621 are often specified.

Guide for Selecting Application Methods for the Repair of Concrete Surfaces – Dry Packing

- Advantages:
  - This method provides for intimate contact of repair material with an upper cavity surface without sophisticated placement methods or materials.
  - Relatively low material cost, minimal shrinkage, and high compressive strengths are possible, but depend on mixture proportions and placement techniques.
- Cautions / Limitations:
  - This method should be limited to applications where dry pack material is confined on all sides except the side of placement access.
  - Used for small placements - no more than a few cubic feet. It should not be used for repair of large, open-topped or open-sided cavities where confinement cannot be obtained.
  - The labor for providing sufficiently rigid and confining formwork, mixing of the damp material, and manual consolidation makes dry pack repairs one of the most labor-intensive application methods.
  - For hydraulic cement repair materials, the concrete surface should be continuously saturated with water for at least 24 hours just prior to application. SSD prevents water from being absorbed rapidly from the repair material. Minimal mix water is present for drypack repair materials, the loss of water at the bond surface could result in insufficient hydration. Substrate must be damp to prevent capillary absorption. Once placed, sufficient water for curing must be present to provide proper hydration.

Guide for Selecting Application Methods for the Repair of Concrete Surfaces – Dry Packing

- Cautions and Limitations con't:
  - Requires an almost unobstructed space and must be installed by appropriately trained and experienced applicators. The method is labor intensive and largely dependent on the installer to achieve and maintain proper consistency and consolidation
  - For placement of dry-pack, the forms do not need to be as tight-fitting but should be more rigid. The constant compaction of the dry-pack will loosen forms unless they are well braced. Movement of forms during compaction may cause insufficient compaction.
  - For applications to be dry-packed, the gap/ void should be approximately 1” to 3” in its least dimension. Large gaps/voids make compaction impractical. To aid proper compaction, the width of the area to be dry-packed from any direction should preferably be less than approximately 18”. Shims, jack bolts, and other obstructions have a direct impact on dry packing. Shims and formwork can be displaced during compaction causing movement, and both can prevent proper compaction.

Guide for Selecting Application Methods for the Repair of Concrete Surfaces – Form and Pour

- General Description:
  - The placement of repair material into an enclosed space with formwork and adjacent concrete defining exposed vertical or horizontal boundaries.
  - Repair materials are deposited into the repair cavity and consolidated by rodding, internal vibration or external (form) vibration. Internal vibration is not required for self-consolidating concrete (SCC) but, with some repair configurations, external form vibration may be needed to move the SCC material.

Guide for Selecting Application Methods for the Repair of Concrete Surfaces – Form and Pour

- Best Applications:
  - Use for columns, walls, beams and slabs with a repair thickness/depth of approximately 2” more.
- Material Requirements:
  - The material should be castable concrete/mortar with good workability. Larger top size aggregate generally reduces shrinkage, but maximum aggregate size typically should not exceed 20% of the minimum gap between forms, 75% of the clear distance between individual reinforcing steel bars, or ¼” less than the clear distance between reinforcing bars and the forms or substrate.
  - Concrete is typically either ready mix or packaged but can also be transit mixed or site batched.

Guide for Selecting Application Methods for the Repair of Concrete Surfaces – Form and Pour

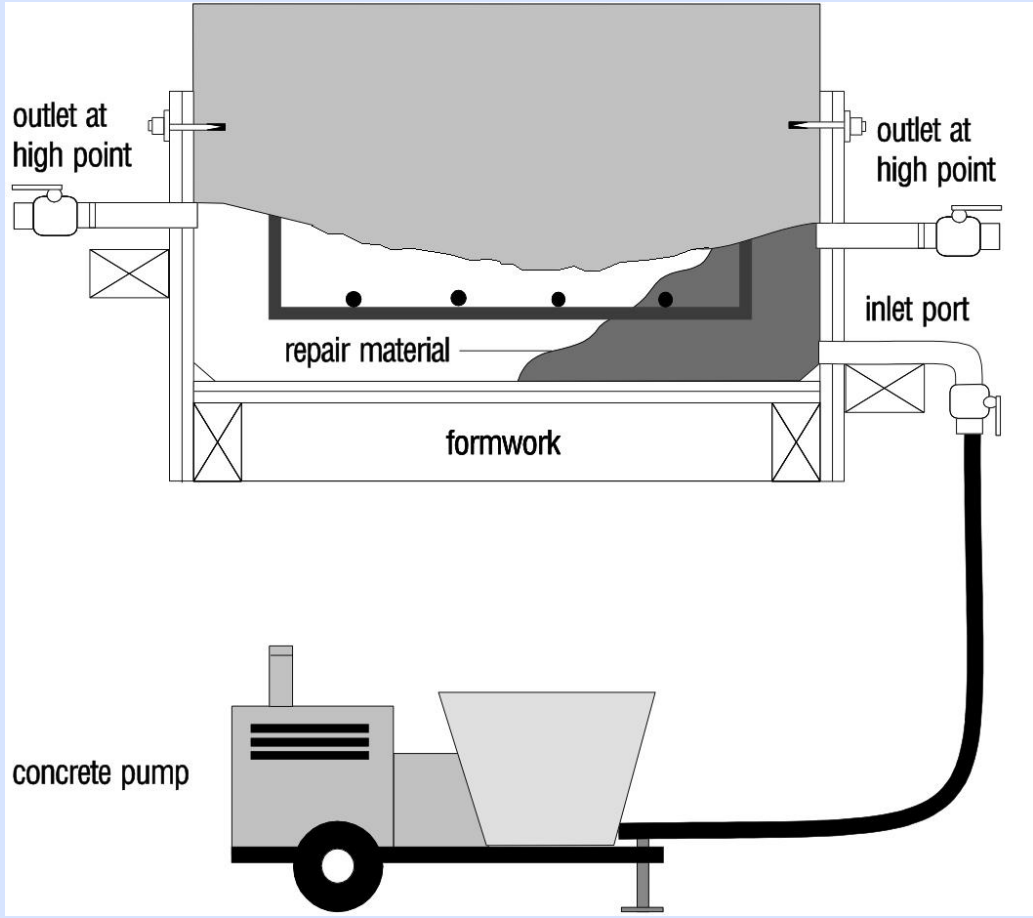
- Advantages:
  - More consistent repair quality and bond than hand-applied repairs.
  - Forms typically provide an excellent curing environment.
  - Allow for significant flexibility in repair material selection.
  - Require limited mobilization effort.
  - Are less sensitive to operator skill than shotcrete repairs.
  - Are less sensitive to achieving consolidation around reinforcing steel than shotcrete repairs.

Guide for Selecting Application Methods for the Repair of Concrete Surfaces – Form and Pour

- Cautions and Limitations:
  - Methods of consolidation are contingent upon repair thickness, repair material flow characteristics, and availability of access for internal or external vibration.
    - If internal vibration is not used, repair thickness must be limited, or material flow characteristics increased to ensure adequate consolidation.
    - Internal vibration is generally not required for self-consolidating concrete (SCC).
    - Minimum thickness of 2” aids flow of repair material and proper consolidation.
    - Enhanced material flow characteristics are necessary for narrow or congested repair cavities.
    - Evacuation of air from the enclosed repair cavity must be vented.
    - Use of a “bird’s mouth” or head box on forms may be necessary to maintain repair material contact with top of repair cavity.
    - Formwork adds costs not applicable to hand applied or shotcrete repair.

Guide for Selecting Application Methods for the Repair of Concrete Surfaces – Form and Pump

- General Description:
  - The placement of repair material using mechanical pumping equipment into an enclosed space with formwork defining exposed boundaries. External form vibration may be necessary to achieve proper flow and consolidation. Vibration is generally not applicable to self-consolidating concrete (SCC).



Guide for Selecting Application Methods for the Repair of Concrete Surfaces – Form and Pump

- Best Applications:
  - This method is suitable for overhead and vertical applications, including where reinforcing steel is exposed. Common applications include beam sides/soffits, and vertical surfaces of columns, walls, piers, etc. It is also commonly used in jacketing repairs. Usually 2” or greater clearance is needed.

Guide for Selecting Application Methods for the Repair of Concrete Surfaces – Form and Pump

- Material Requirements:
  - The material should be pumpable concrete or mortar with good flow characteristics.
  - Larger top size aggregate generally reduces shrinkage, but maximum aggregate size typically should not exceed 20% of the minimum gap between forms, 75% of the clear distance between individual reinforcing steel bars, or ¼” less than the clear distance between reinforcing bars and the forms or substrate.
  - Depending on pump type used, further restrictions on aggregate size may be required, especially for progressive cavity (rotor stator type) pumps, that are usually limited to fine aggregate only. Concrete is typically either ready mix or packaged but can also be transit mixed or site batched.

Guide for Selecting Application Methods for the Repair of Concrete Surfaces – Form and Pump

- Advantages:
  - Repairs generally result in more consistent repair quality and bond than hand-applied repairs.
  - Forms typically provide an excellent curing environment.
  - Repairs are less sensitive to operator skill than hand applied or shotcrete repairs.
  - Repairs are less sensitive to achieving consolidation around reinforcing steel than shotcrete repairs.

Guide for Selecting Application Methods for the Repair of Concrete Surfaces – Form and Pump

- Cautions and Limitations:
  - Formwork must be sufficiently rigid and watertight to withstand pumping pressures.
  - Many contractors are not well experienced in this repair method.
  - Provision must be made for placement of material to proceed from the lowest to the highest point.
  - Air must have a place to escape as the repair material fills the repair cavity. This is done by drilling air vent holes at the high points of the repair area.
  - Forming and pumping into a cavity with a flat soffit should be approached with caution since it is difficult to ensure proper evacuation of air from the repair cavity and establishment of intimate contact of repair material with the substrate.
  - For deep placements where bond to an overhead substrate is required, accumulation of bleed water at the top of the repair cavity may prevent bond of the repair material with the substrate. Limiting placement heights and/or use of a low-bleed repair material should be considered.

Guide for Selecting Application Methods for the Repair of Concrete Surfaces – Form and Pump

- Cautions and Limitations con't:
  - A minimum repair thickness of approximately 2” aids flow of repair material and proper consolidation.
  - Formwork adds costs not applicable to hand-applied or shotcrete repairs and greater access is generally required than for hand-applied or form-and-pour repairs. If access and repair volume are favorable to use concrete pumps, form and pump repairs may have cost advantages over form and pour repairs.
  - Methods of consolidation are contingent upon repair thickness and repair material flow characteristics. Pumped concrete often does not require vibration. In some circumstances, repair thickness may need to be limited to allow effective form vibration; alternatively, material flow characteristics generally can be increased to ensure adequate consolidation without vibration.

Guide for Selecting Application Methods for the Repair of Concrete Surfaces – Pre-Placed Aggregate

- General Description:
  - The preplaced aggregate concrete repair method is produced by placing a selected coarse aggregate size into a form then injecting/pumping a suitable repair grout material from the lowest point in the formwork until the form is filled and pressurized.
- Best Applications:
  - Suitable for vertical and overhead applications where extremely low shrinkage of repair material is required.
  - Column enlargements; or applications in which placement of the repair by conventional methods is difficult such as in certain vertical, overhead or other difficult-access applications.
  - Ideal for remote locations if suitable coarse aggregate can be produced locally or if the repair grout material is required to be pumped long distances.
  - Preplaced aggregate concrete is also commonly used for underwater placement when dewatering is impractical or to minimize washout during placement.

Guide for Selecting Application Methods for the Repair of Concrete Surfaces – Pre-Placed Aggregate

- Material Requirements:
  - Grout consistency must be a balanced blend of water and cement combined with selected additives and admixtures producing a mixture with appropriate bleeding, cohesion, and resistance to pressure filtration (i.e., resistance to water separation under pressure) properties.
  - Material requirements include the use of gap-graded aggregate (40-50% void ratio) and pumpable, high-flow, cementitious or resin-based binder. One inch or larger aggregate is typically used in cementitious applications. A method for proportioning grout mixtures to be used in preplaced aggregate concrete is provided in ASTM C938.

Guide for Selecting Application Methods for the Repair of Concrete Surfaces – Pre-Placed Aggregate

- Advantages:
  - Shrinkage of preplaced aggregate concrete is low because of point-to-point aggregate contact and large volume fraction of aggregate in the repair concrete. Repairs can have high bond strength with shrinkage reduced as much as 50 to 90% compared to cast-in-place concrete repairs.
  - Repairs can be installed either above or below water level.
  - Repairs can be placed in hard-to-get-at locations such as around closely placed reinforcement.
  - There is little need for heavy equipment or concrete batch plants.

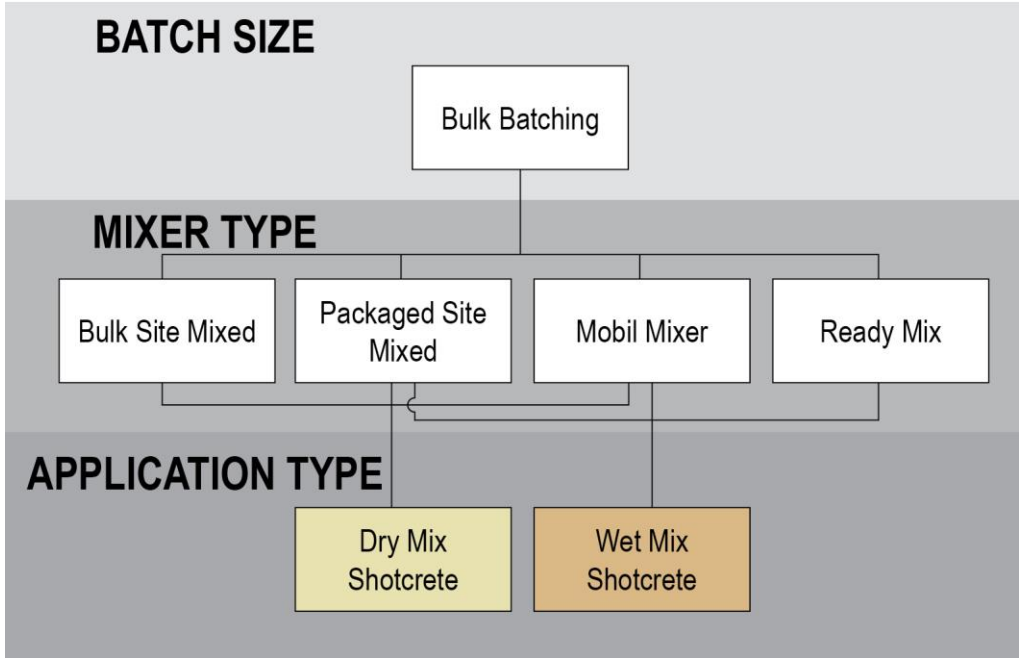
Guide for Selecting Application Methods for the Repair of Concrete Surfaces – Pre-Placed Aggregate

- Cautions and Limitations:
  - Pre-placed aggregate method is limited to repair applications of a thickness or depth greater than 2”.
  - Strict proportioning of the structural repair grout mixture is necessary to produce the required consistency, stability, strength, and durability requirements of preplaced aggregate concrete.
  - Aggregate and concrete substrate must be SSD to prevent absorption of water from the cementitious repair grout.
  - Formwork is similar in configuration to that used for cast-in-place concrete, but the formwork must be watertight and stronger than formwork for conventional concrete repairs. The repair grout must be pumped into the base of the repair until fully vented from the top.

Guide for Selecting Application Methods for the Repair of Concrete Surfaces – Pre-Placed Aggregate

- Cautions and Limitations con't:
  - Air must have a place to escape as the repair material fills the voids. This is typically accomplished by proper repair geometry or by drilling air vent holes at the high points of the repair area.
  - Personnel should be well qualified in concrete repair and experienced in the use of preplaced aggregate concrete.
  - For underwater applications, specially trained diving teams are required with experienced supervision topside to assure proper aggregate placement, structural repair materials mixture proportioning, and mixing and pumping of repair grout.

Guide for Selecting Application Methods for the Repair of Concrete Surfaces – Shotcrete decision tree



Guide for Selecting Application Methods for the Repair of Concrete Surfaces – Pneumatically Applied Dry Mix

- General Description:
  - Material is placed dry or slightly damp into a dry-mix shotcrete machine, commonly referred to as a shotcrete gun, and mixed with compressed air. The dry mixture is transported via the delivery hose to the exit nozzle where water and admixtures, if any, are introduced at a high pressure into the material stream. The ingredients are propelled onto the prepared substrate by the force of the compressed air. The repair material is sprayed at a high velocity (60 to 80 mph) to achieve proper compaction and bond to the substrate.

Guide for Selecting Application Methods for the Repair of Concrete Surfaces – Pneumatically Applied Dry Mix

- Best Application:
  - Best suited for large vertical and overhead areas or curved surfaces with small diameter bars, No. 6 (3/4”) or less, and minimal congestion of reinforcement, although with sufficient expertise, larger diameter bars and closer bar spacing can be accommodated. The greatest advantage of shotcrete is elimination of the need for formwork. Since mobilization effort required is greater than for some other repair methods, small repair quantities may not be cost-effective.
  - Common applications include vertical surfaces of walls, columns, beams, and pier caps; horizontal surfaces including soffits of slabs, beams, and overhangs; and tunnel linings. Overhead thicknesses are typically limited to several inches in a single lift unless accelerating admixtures are used.

Guide for Selecting Application Methods for the Repair of Concrete Surfaces – Pneumatically Applied Dry Mix

- Material Requirements:
  - Materials conform to ASTM C1436 or ASTM C1480/ C1480M. Aggregate gradation generally conforms to one of two gradations presented in ASTM C1436, containing nominal maximum size aggregates (MSA's) of either 3/8" or approximately ¼", although sometimes ½" nominal MSA has been used. Synthetic micro and macro fibers and silica fume are frequently included in shotcrete mixes. Admixtures may include air-entraining agents, accelerators, and others. Materials may be transit mixed, packaged, or site batched.

Guide for Selecting Application Methods for the Repair of Concrete Surfaces – Pneumatically Applied Dry Mix

- Advantages:
  - Repairs accommodate vertical and overhead configurations with minimal, if any, formwork.
  - Repairs provide efficient application of large areas of repair material, although placement rates of dry-mix are generally less than for wet-mix shotcrete.
  - Repairs allow instantaneous control of mix water and mix consistency to accommodate variable field conditions.
  - Repairs lend themselves to curved and irregularly shaped surfaces
  - Repairs generally allow thicker buildup than wet mix shotcrete on overhead surfaces in a single lift
  - Very low water/cement ratios are used, typically resulting in high strength, and low permeability repair material.
  - Repairs are easier to start and stop than other pneumatically applied methods since materials remain dry until they reach the nozzle.

Guide for Selecting Application Methods for the Repair of Concrete Surfaces – Pneumatically Applied Dry Mix

- Advantages con't:
  - Longer and lighter / more flexible hoses are possible than for wet mix shotcrete, allowing placement in tighter conditions. Delivery hose can extend 1000 ft or more to reach remote areas where concrete delivery is impractical.
  - Dry-mix shotcrete guns are usually smaller and more portable than wet-mix pumps.
  - Delivery hose pressures are lower than with wet-mix shotcrete and easier to control if plugging occurs.
  - Repairs can be performed by robotic or remotely controlled equipment.
  - Cleanup of equipment including pumps and hoses is simpler than for wet-mix shotcrete.

Guide for Selecting Application Methods for the Repair of Concrete Surfaces – Pneumatically Applied Dry Mix

- Cautions and Limitations:
  - Method requires highly skilled nozzlemen, proper materials, and optimum equipment where large diameter bars or reinforcing steel congestion is present. A higher level of onsite inspection or independent testing of installed repair material may also be required in such circumstances.
  - Operator qualifications are more critical than for wet-mix shotcrete since water and admixtures are added at the nozzle. Improper technique can lead to sand lenses and entrapment of rebound and overspray. ACI conducts nozzleman certification, but project specific qualification testing may also be necessary, especially if applying material in difficult access conditions or in conditions with congested or large diameter reinforcing steel.

Guide for Selecting Application Methods for the Repair of Concrete Surfaces – Pneumatically Applied Dry Mix

- Cautions and Limitations con't:
  - Debris/waste and dust generated by rebound and overspray is greater than that generated by wet-mix shotcrete. Attention to protection and cleanup is necessary. Enclosures, lighting, and ventilation will be required in enclosed spaces.
  - A staging area is required for material and shotcrete equipment such as a high-volume air compressor and shotcrete gun. Dry-mix shotcrete uses a larger air compressor than wet-mix since the dry repair materials are conveyed through the delivery hose completely by air flow.
  - Noncontact lap splices are recommended to facilitate complete encapsulation. Beveled substrate profiles at deep repair perimeters help avoid entrapment of air and rebound.

Guide for Selecting Application Methods for the Repair of Concrete Surfaces – Wet-Mixed Shotcrete

- General Description:
  - Pre-batched and thoroughly mixed repair material is placed into a concrete pump and transported via pump line to an exit nozzle where compressed air and admixtures, if any, are introduced. The repair material is propelled onto the surface by the compressed air. The repair material is sprayed at a high velocity (60 to 80 mph) to achieve proper in-place compaction and bond to the substrate.

Guide for Selecting Application Methods for the Repair of Concrete Surfaces – Wet-Mixed Shotcrete

- Best Application:
  - Wet-mix shotcrete repairs are best suited for large vertical and overhead areas or curved surfaces with small diameter bars, No. 6 (3/4”) or less, and minimal congestion of reinforcement, although with sufficient expertise, larger diameter bars and closer bar spacing can be accommodated.
  - Greatest advantage of shotcrete is elimination of the need for formwork.
  - There is a considerable mobilization effort required, small repair quantities may not be cost-effective for wet-mix shotcrete.
  - Common applications include vertical surfaces of walls, columns, beams, and pier caps; horizontal surfaces including soffits of slabs, beams, and overhangs; and tunnel linings.
  - Overhead thicknesses are typically limited to several inches in a single lift unless an accelerating admixture is used.

Guide for Selecting Application Methods for the Repair of Concrete Surfaces – Wet-Mixed Shotcrete

- Material Requirements:
  - Materials conform to ASTM C1436 or ASTM C1480/ C1480M. Aggregate gradation generally conforms to one of two gradations presented in ASTM C1436, containing nominal maximum size aggregates of either 3/8” or approximately ¼”.
  - Synthetic micro or macro fibers and silica fume are frequently included in shotcrete mixes. Steel fibers may be used when repair sections must have additional impact resistance or toughness.
  - Admixtures may include air-entraining agents, water reducers, accelerators, and others.
  - Materials may be plant mixed, transit mixed, packaged (mixed onsite before pumping), or site batched.

Guide for Selecting Application Methods for the Repair of Concrete Surfaces – Wet-Mixed Shotcrete

- Advantages:
  - Repairs accommodate vertical and overhead configurations with minimal, if any, formwork.
  - Repairs provide efficient continuous application of large volumes of repair material (not suitable for frequent start-stop operations). Wet-mix shotcrete generally has greater placement rates than dry-mix shotcrete.
  - Repairs generally result in more uniformity than dry-mix shotcrete since water is premixed instead of being added at the nozzle.
  - There is generally less rebound than with dry-mix shotcrete. Consequently, less site cleanup is required.

Guide for Selecting Application Methods for the Repair of Concrete Surfaces – Wet-Mixed Shotcrete

- Advantages con't:
  - Repairs lend themselves to curved and irregularly shaped surfaces
  - Delivery hose and steel pipe can extend 500 ft or more to reach remote areas where concrete delivery is impractical.
  - Repairs can be performed by robotic or remotely controlled equipment, a significant advantage in hazardous locations or for large applications.

Guide for Selecting Application Methods for the Repair of Concrete Surfaces – Wet-Mixed Shotcrete

- Cautions and Limitations:
  - Method requires highly skilled nozzlemen, proper materials, and optimum equipment where large diameter bars or reinforcing steel congestion is present. A higher level of onsite inspection or independent testing of installed repair material may also be required in such circumstances.
  - This method is highly dependent on the skills of the nozzleman. ACI conducts nozzleman certification, but specific qualification testing may also be necessary, especially if applying material in difficult access conditions or in conditions with congested or large diameter reinforcing steel.
  - Debris/waste is generated by rebound and overspray, although less than that generated by the dry-mix process. Considerable protection and cleanup is necessary. Enclosures, lighting, and ventilation will be required in enclosed spaces.

Guide for Selecting Application Methods for the Repair of Concrete Surfaces – Wet-Mixed Shotcrete

- Cautions and Limitations con't:
  - A sizeable staging area is required for material lay-down and shotcrete equipment such as concrete pumps and high-volume air compressors.
  - Repairs cannot be built up in a single lift as thick as with dry-mix shotcrete on vertical and overhead surfaces.
  - Noncontact lap splices are recommended to facilitate complete encapsulation. Beveled substrate profiles at deep repair perimeters help avoid entrapment of air and rebound.
  - Cleanup of equipment including pumps and hoses is more time consuming than for dry mix shotcrete.
  - Certain safety risks apply since pump pressures can climb almost instantaneously in the event of a blockage, potentially causing hose rupture, and the hose can whip upon sudden release of a blockage.

Guide for Selecting Application Methods for the Repair of Concrete Surfaces – Low Pressure Spray

- General Description:
  - Low-pressure spray applied mortar/concrete is sprayed at a much lower velocity than shotcrete. The spray is applied using small concrete pumps or heavy-duty repair material pumps to force the low slump mortar through a hose. Air is added at the nozzle to impel the repair material. Bond with the prepared substrate is achieved through a combination of proper surface preparation, material properties of the packaged repair material, low-velocity impact, and pressure applied by hand tooling the fresh material.

Guide for Selecting Application Methods for the Repair of Concrete Surfaces – Low Pressure Spray

- Best Applications:
  - Low-pressure spray is typically used for vertical and overhead repairs. Successful applications have included structural repairs to bridges, bridge and building piers, structural slab undersides, tank walls (interior and exterior), stadiums, tunnels, and retaining walls. The placement thickness can be ½” to 4” in a single lift.
- Material Requirements:
  - Low-pressure spray applied repair materials are typically proprietary, low-slump, packaged cementitious products. Due to the need for a very cohesive material, silica fume is often included.

Guide for Selecting Application Methods for the Repair of Concrete Surfaces – Low Pressure Spray

- Advantages:
  - Less rebound is created by this pneumatically applied method than by either wet or dry process shotcrete due to the low pressure of the spray.
  - Compared to either wet or dry process shotcrete, this method allows the spray nozzle to be much closer to the repair surface. This allows use in tighter spaces.
- Cautions and Limitations:
  - Method is not appropriate for use where large diameter bars or steel congestion is present.
  - Considerable caution should be exercised when using this repair method. Shotcrete uses high velocity material to achieve bond and compaction/consolidation. Low pressure spray lacks this feature and therefore requires attention to achieve and verify proper bond and consolidation.
  - There are few standards directly applicable to low pressure spray application. Structural repairs utilizing low pressure spray are best performed by highly experienced contractors with over-sight by a qualified design professional.

Guide for Selecting Application Methods for the Repair of Concrete Surfaces – Low Pressure Spray

- Cautions and Limitations con't:
  - Nozzlemen certifications are not available for low pressure spray application although operator qualifications are critical. Particular attention should be given to operator experience and proper qualifications should be demonstrated for structural applications.
  - Low-pressure spray application is typically limited to vertical and overhead repair applications less than 4" thick. Thicknesses greater than 4"are possible in multiple lifts.
  - Because of the non-bleeding, sticky nature of these materials, use of an evaporation control film to reduce moisture loss prior to finishing is recommended.
  - A considerable staging area is required for material lay-down and low-pressure spray equipment including repair material pumps, air compressor, and mixer.
  - Special repair detailing is recommended including noncontact lap splices and beveled substrate profiles and saw cuts if compatible with structural requirements to help avoid entrapment of air and rebound.

Guide for Selecting Application Methods for the Repair of Concrete Surfaces – Conclusions

- Questions?