

Agileflow™

GENERAL

The following Technical Specification Sheet has been provided by Holcim for use by the design community. Information contained in this document may be used as a reference in detailed drawings or in specification documents.

SUMMARY

Includes: Self-placing, self-consolidating concrete for Agileflow® applications.

QUALITY ASSURANCE

A pre-job conference will be held at the jobsite to discuss site related. Those present shall include the concrete producer representatives, the contractor, the engineer, the architect, and the testing agency. No concrete placements of the Agileflow concrete will be allowed prior to this meeting.

The self-consolidating concrete manufacturer shall make available a qualified individual to monitor concrete quality and performance as specified.

CONCRETE MIXTURE VERIFICATIONS

Submit final concrete mix verification 2 weeks prior to placing concrete. Mixtures shall have over-design in accordance with ASTM C94. The self-consolidating manufacturer, prior to submittal, shall review mix-design. Include the following information for each concrete mix design:

- Maximum size of coarse aggregates: ASTM C33
- Flow: ASTM C1611
- Unit weight of concrete: ASTM C138
- Air content: ASTM C231

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PRODUCTS SPECIFICATION

The following chapter lists the raw materials used to manufacture Agileflow and the product's physical-chemical characteristics

MATERIAL SPECIFICATION

Cement: ASTM C150, ASTM C150M-12 Type 1, 1/2

Blended Hydraulic Cements: ASTM C595

Supplementary cementing materials: ASTM C989, ASTM C618, ASTM C1240

Coarse Aggregate: ASTM C33-0 to comply with durability requirements.

Fine Aggregate: ASTM C33-81; comply with project durability requirements.

Admixtures: ASTM C494-92

Water: ASTM C94

AgileFlow VERTICAL &/OR ARCHITECTURAL

Forming Materials: Forming material shall be steel, aluminum (cured), steel framed plywood, resin impregnated plywood, plastic or paper faced plywood, or if indicated on the drawings, Plexiglas (of the grade, size, and thickness indicated). Formwork used for architectural concrete shall be in excellent condition.

Note: The surface texture and condition of the forming system selected will be directly represented in the quality of the Agileflow concrete surface.

Recommendations:

- Use formwork of the same quality, same nature, same number of reuses
- Avoid surfaces that are too smooth or polished. Mat surfaces are preferable to shiny or polished ones because release agents adhere better
- Clean the form / form liner thoroughly after every usage
- Prevent leakages from formwork and avoid gaps that may open
- Ensure formwork is sufficiently rigid to prevent deformation
- Be aware that:
 - The texture of the formwork may affect the tint of the concrete surface
 - New wood forms contain natural sugars that may affect unexpectedly the set time, the tint and the texture of the surface. In case of using wooden formworks, aged wooden forms prior to initial use and mock up are strongly recommended.

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Demolding agents:

Release agents are often mixtures of oils, additives and solvents. The oil permits the creation of a fatty film and additives cause a delay of hydration of the concrete surface to create an uncured layer of a few microns. This effect is observable on the freshly demolded wall through a slightly dusty appearance.

Quality of finish is strongly influenced by the oil used, its viscosity (the lower the viscosity, the better the quality of finish) and the method of application.

Demolding agents suppliers should be asked for advice and technical specifications of their products. Below is an indicative selection table (1: least relevant, 5: most relevant).

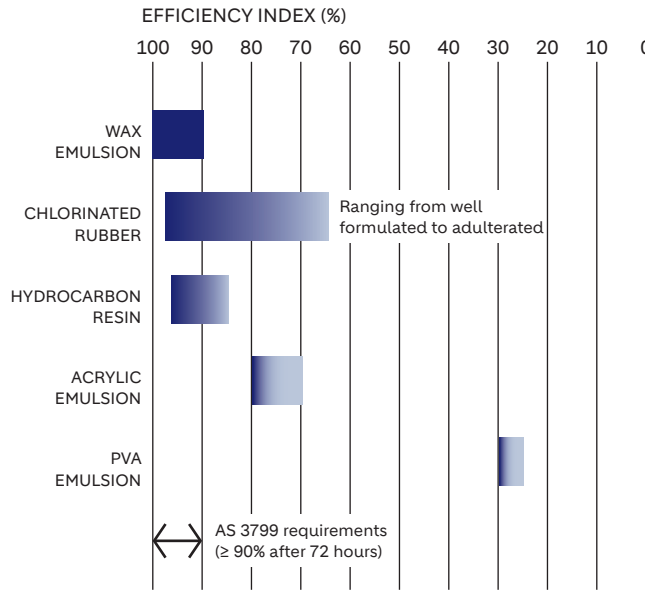
Slump > 6 in and Agilia							
Operating temperature*	< 40°F			40°F < Temp < 85°F			Biodegradability
	metal	wood	polymer	metal	wood	polymer	
Formwork							
min 95% vegetable				5		3	> 60%
vegetable (50%) based				5	3		> 60%
vegetable oil emulsion				4		3	> 60%
pure synthetic	5	3	2	5	5	2	Not applicable
synthetic	5	3		5	4		Not applicable
synthetic oil emulsion				4		2	Not applicable
mineral oil*	1	2		1	2		Not applicable
recycled mineral oil							Not applicable
wax				5	3	5	Not applicable

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Curing compound (ASTM C 309):

Selection of a curing compound should be based on 2 criteria: curing efficiency and type of finish to be applied on the cured surfaces. Both are directly related to the chemistry of the curing compound. As seen on the below graph, wax-based products are the most efficient products in terms of curing.



Source: Cement Concrete & Aggregates - Australia

But wax-based products also affect the bond between concrete and any adhesive coming later on. They have to be grinded first to ensure proper adhesion. Acrylic-based products are less efficient in curing but tend to improve the bond between concrete and adhesive; no grinding required.

The contractor should ask the curing compound supplier for all technical information and requirements.

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CONCRETE MIX DESIGN

Self-consolidating Concrete: Agileflow proprietary ready-mix concrete with the following characteristics:

- Maximum water cementitious ratio: The maximum water cementitious ratio is specified by the Design Project Engineer.
- Air content: Insert air entrainment if the concrete element is required to comply with severe exposure condition
- Flow: 22 in to 30 in
- Compressive Strength at 28 days: 3500 psi to 14,000 psi

The general contractor should proceed with producing a mock up section prior to pouring concrete for the final structure at the beginning of a project. Finally, the owner's representative (testing agency), will make cast concrete cylinders or cubic specimens for testing.

EXECUTION

Concrete characteristics are strongly linked to how it is installed. The following chapter describes how to properly install Agileflow from the base preparation to the care that shall be taken during finishing and curing to assure the quality of the product.

SITE INSPECTION

Verification of Conditions: Examine areas and conditions under which work is to be performed and identify conditions detrimental to proper or timely completion.

Do not proceed until unsatisfactory conditions have been corrected.

SITE PREPARATION

Coordination: Notify others involved, allowing installation and completion of their work prior to concrete placement.

Agileflow VERTICAL and / or ARCHITECTURAL

Formwork Surface Preparation: Based on the final choice of formwork and ambient temperature, Holcim recommends specific types of release agents. These recommendations should be followed. They have for objectives to reduce the excessive presence of bubbles on the surface and to help with the homogeneity of the texture and tint.

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Release agent application:

- Clean formwork thoroughly before applying the release agent
- Apply uniformly and remove the excess. Unevenly sprayed release agent will affect the tint homogeneity
- Avoid exposure to sun, rain and dust in order to retain the performance of the release agent
- Respect waiting time recommendations from the release agent manufacturer

Be careful, an excess of demolding agent will generate bug holes, dusty surfaces and colour variations.

Formwork tightness: Before closing the formwork, make sure that there is no wane or holes bigger than 0.4" in height along the bearing length of the shutters on the support floor. If necessary, fill in the holes with a material that will stay in place while pouring (polyurethane foam, sealant, etc.).

Openings along the length of the vertical joints, between two elements of the shutters or between the end of the formwork and a wall already cast should not exceed two millimeters. These vertical holes should be filled with polyurethane foam.

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Pressure on the formwork: Formwork dimensioning should be done by the producer of the shutters. This is their complete responsibility. In the absence of information obtained from on-site measurements (load sensors), the calculated pressure should not be below the hydrostatic pressure of the Agileflow concrete.

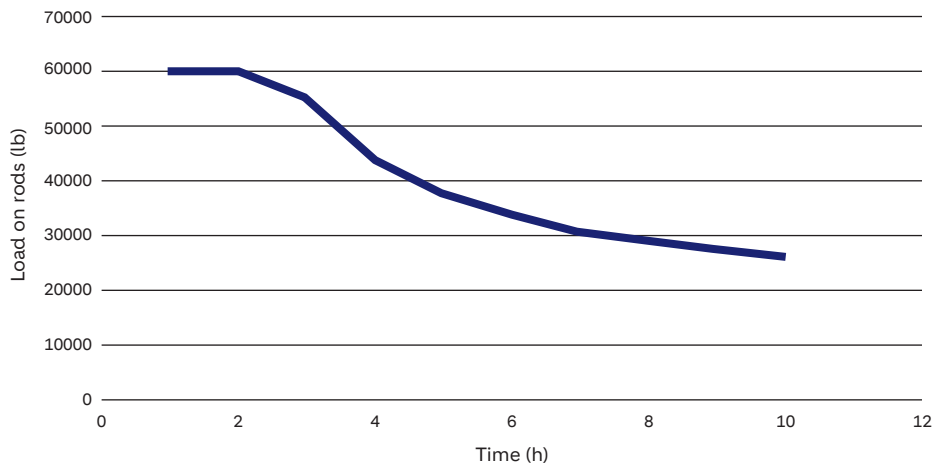
Pressure reductions depend on the pouring length of time when pouring very high walls, even though it also depends on the composition and above all on the temperature of the concrete. The Natural logarithm function of the length of the pouring time in hours can be used to estimate the pressure.

Reduction coefficient $R = \ln(\text{hour duration})$ (for a minimum of 2 hours of pouring)
 Reduced pressure lb/ft² $P = 2.3 \times \text{Height} / R * 186$

Example for a **28ft-high** wall - **7 hours** pouring time:

Pouring time in hours	Hydrostatic pressure	Reduction coefficient R LN(H)	Reduced pressure (lb/ft ²)	Load per rod (for 1 rod per 1.5m ²)
7.0	3753	1.95	1932	31,200 lb

The pressure per ft² of the concrete skin = 1932 lb and on the rods (hypothesis: 1 rod per 16 ft² of surface), a force of 31,200 lb. The rods should therefore be 1in, minimum, otherwise it is necessary to increase the number of rods per ft².



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Surface Preparation: Immediately before concrete placement, thoroughly wet moisture-absorbing material that will be in contact with concrete, without developing standing water. Ensure that concrete steel forms and rebars are not steaming hot prior to pouring Agileflow in the formwork. For flat work/slabs, Agileflow Horizontal can be poured directly on the existing surface if the surface is non absorbent and is clean (ex: steel deck). In all other case:

Substrate types:

- Any stable well compacted substrate free of debris
- Surface must be relatively flat with an unevenness level of less than 13 mm thick for a 1.8 m cross section (rule)

Preparation:

- If the concrete is to be placed bonded to a sub-layer, steel reinforcement mesh will be required. Bonding compounds (such as an SBR type of product) should be applied.
- If the concrete is to be unbonded, a polyethylene membrane with a minimum thickness of 0.005 in must be placed over the sub-base (suggested thickness).
 - The membrane should be secured and overlapped to ensure no movement and no concrete leakage through the plastic layer.
 - At the walls, the polyethylene membrane should extend above the level of the pour.

Perimeter isolation:

- Compressible strips should be fitted around the walls and vertical features such as columns, walls and duct pipes.
- Take particular care to isolate re-entrant corners at doorways, windows and corner walls as these could become a source of radial cracking
- Ensure the perimeter isolation is placed at right
- Compressible strips should be prepared to ensure no movement
- Ethafoam or polystyrene can be used to seal any holes or leaks in the form
- Double up the isolation may be necessary on exterior angles to ensure the minimum thickness is maintained around the angle.

INSTALLATION REFERENCES

Concrete Mixing: ACI 301

Hot Weather Concrete: Comply with ACI 305R when maximum daily temperature exceeds 85°F or rapid drying conditions exist.

Cold Weather Concrete: Comply with ACI 306R when freezing conditions or a mean daily temperature below 40°F is encountered.

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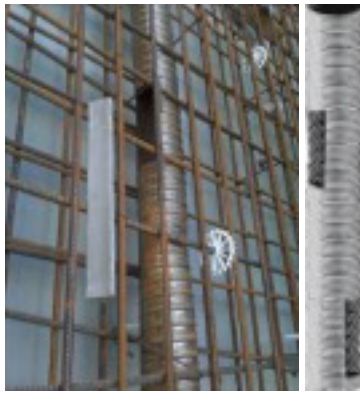
CONCRETE PLACEMENT AND CONSOLIDATION

Agileflow VERTICAL and / or ARCHITECTURAL

Place concrete within 120 minutes of adding the mix water unless our representative has made adjustments to the mix. The truck driver should remix concrete for 3 min prior to discharge. During discharge, the drum should not remain static more than 2 min; it should be continuously rotated in case of delay.

Placing:

Agileflow is placed via bucket or pumped. In all cases, concrete should not fall from the top of the formwork; a hose should guide it till 4 in from the bottom or the formwork. Free fall will generate bug holes. Flexible hoses can eventually stay in place; important to note holes have to be created at different heights to ensure smooth filling and discharge if it stays in place (see picture below). Rigid one have to be removed before concrete hardens. The pictures below are giving examples of setups. Install the tremie before closing the formwork when there is an important density of reinforcement.



Flexible hose

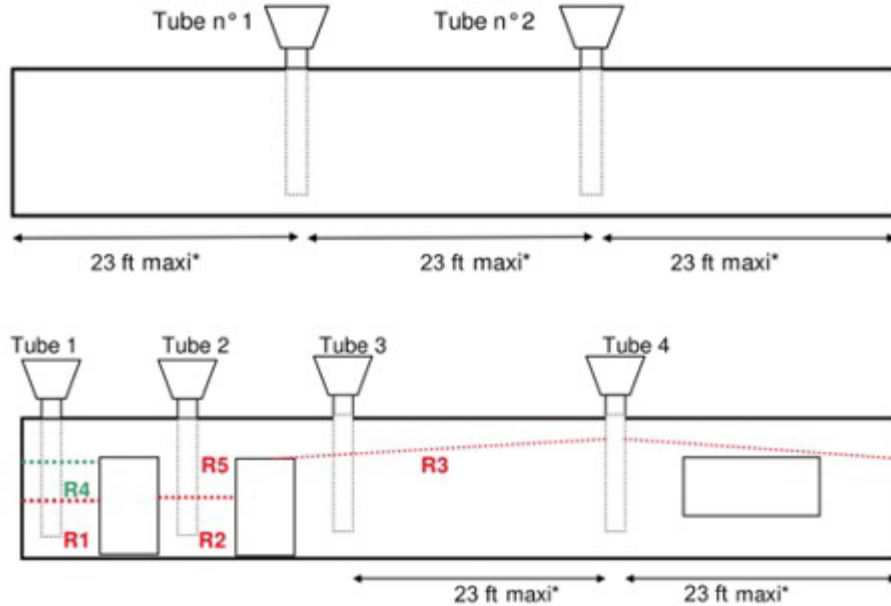


Rigid hose to be connected on the bucket

Pouring points should be positioned so that concrete does not have to flow for more than 7m / 23 ft from each side of the pouring point. The following diagrams are illustrating different configurations.

The plain wall configuration shown on the first diagram is self-explanatory. With openings, pouring points have to be used following a specific sequence starting from R1 up to R5.

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Other aspects:

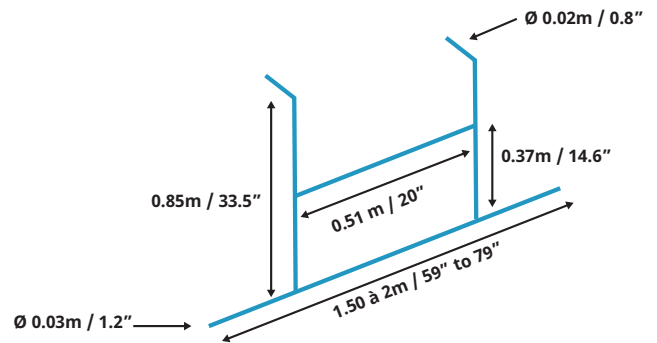
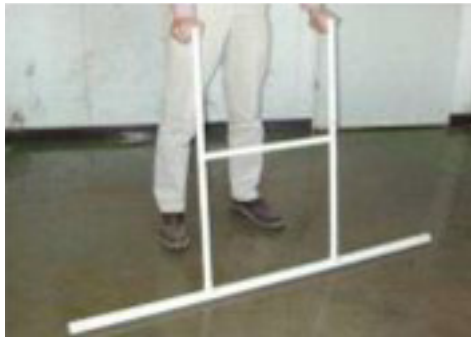
- Do not vibrate Agileflow Architectural.
- Avoid long gaps in placing between lifts to prevent pour lines.
- If the concrete is pumped, the hose of the pump should be immersed in the concrete and raised with the level of concrete.
- Ensure pump lines are primed prior to start. Do not allow priming water/grout to be placed in forms. Pump off concrete until a consistent product is coming out of the line otherwise segregation may occur.
- If using buckets, avoid saturating the bucket with a release agent as this can cause segregation or discoloration. Ensure there is no water in the bucket prior to filling.
- Whatever the placing method used, the flow must be continuous and steady. The speed of pour should be determined during the pre job meeting and approved by the contractor's structural engineer. The speed should be maintained to obtain a consistent surface finish. Pour rates too slow or too fast may contribute to entrapped air in the concrete.
- Avoid splashing Agileflow on form walls while placing as these areas could dry quicker and possibly cause bug holes. It is recommended to leave the hose immersed.
- For large walls, moving the point of placement frequently may be required depending on flow, temperature and rate of placement to prevent a pour/lift line.
- Avoid placing Agileflow Architectural when ambient temperatures exceed 90°F.
- For optimal results, it is important to pour in similar conditions. Cold or warm weather conditions, time to strip the form, sun and wind, will all be factors which can modify the surface appearance.

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For flat work/slabs:

- When Agileflow Horizontal has been placed to the correct level, the surface should be finished with an Agileflow finishing bar.
- The level of the concrete must be verified by the standard equipment and method as it would be for regular concrete.
- The finishing bar is moved across the surface of the Agileflow concrete, in a motion to generate gentle waves in both directions at 90° from each other.
- First pass should be deeper than the second pass to a maximum depth reaching 3/4 of the depth of the finishing bar.
- Second pass should be a light motion over the surface.
- The minimum thickness recommended will depend on the maximum diameter of the aggregates.
- Joints shall be planned following the same rules as for standard concrete. Depth of saw-cut joints shall be greater than 1/3rd of the slab thickness.



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FINISHING METHODS

Agileflow VERTICAL and / or ARCHITECTURAL

Exposed Architectural Vertical Surfaces: Smooth form finish (only where indicated) shall comply with ACI 301 and produce a smooth, uniform texture with an orderly pattern of form marks. Finish surface quality shall be “P-1” as referenced in the ASCC “Guide for Surface Finish of Formed Concrete.”

Concealed Vertical Surfaces and Concrete Walls: Rough form finish shall comply with ACI 301 and produce F-2 texture as referenced in the ASCC “Guide for Surface Finish of Formed Concrete.”

CONCRETE CURING AND PROTECTION

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Recommendations applicable to Agileflow do not differ from the ones for conventional concrete. Contractor should protect freshly placed concrete from premature drying and excessive cold or hot temperatures using an evaporation retarder for “flat work/slabs” covered by these specifications. A wind barrier is also recommended in case surfaces are exposed to wind.

Curing compound is the preferred curing technique as its application can be done at an early stage. It should be applied right after the concrete is finished. It should be applied uniformly using a spraying bottle at the rate specified by the curing compound manufacturer.

FIELD QUALITY CONTROL

Fresh Concrete Testing: ASTM C138, C143, C231

Sampling frequency: ASTM C172

Strength Tests: ASTM C39

GREEN RATING SYSTEMS

Environmental certifications have become more and more used to assess the quality of buildings. LEED, BREEAM and HQE are the most used worldwide and cover a large part of the world. Below are AgileFlow contributions to these certifications

Leadership in Energy and Environmental Design – LEED Project Certification:

Sustainable Site Selection

SSc7.2 Heat Island Effect, Roof Energy and Atmosphere

EAp2 Minimum Energy Performance Materials and Resources

MRc5 Local Materials Innovation in Design

RPc1 Durable Building

BRE Environmental Assessment Method – BREEAM

Wst2 Recycled Aggregates

Haute Qualité Environnementale – HQE

SSc7.1 Heat Island Effect, Non-roof

EAc1 Optimise Energy Performance

MRc4 Recycled Content

ICc1 Innovation

Target 1 Harmonious relationship between buildings and their immediate environment

Target 2 Integrated choice of products, systems and construction processes

Target 3 Low nuisance construction site

Target 4 Minimizing energy use

Target 7 Minimizing building maintenance and repair

Target 10 Visual comfort

Target 11 Measures to control smells

Target 13 Air quality

Ene1 Reduction of CO² emissions