

Master Specification

Part ST-SC-S5

Heat Accelerated Curing

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ST-SC-S5 Heat Accelerated Curing

1 General

- a) This Master Specification Part specifies the requirements where heat accelerated (hot water) curing of precast concrete is to be used for components manufactured in accordance with ST-SC-C1 “Pre-Tensioned Concrete”, ST-SC-S3 “Precast Concrete Units” and ST-SC-C2 “Post Tensioned Concrete”, including:
 - i) the documentation requirements, as set out in section 2;
 - ii) the heat delivery requirements, as set out in section 3;
 - iii) the hot water curing cycle requirements, as set out in section 4;
 - iv) the temperature record requirements, as set out in section 5;
 - v) the hot water cured test specimen requirements, as set out in section 6;
 - vi) the removal of curing cover requirements, as set out in section 7;
 - vii) the additional moist curing requirements, as set out in section 8; and
 - viii) the verification requirements and records, as set out in section 9.
- b) The heat accelerated (hot water) curing of precast concrete must comply with the Reference Documents, including AS 1379 Specification and supply of concrete.
- c) For the purposes of this Master Specification Part:
 - i) “concrete mass” is defined as the concrete product, member or part of a structure, or the concrete in the products on a pre-tensioning bed or in a group of similar products made within the one casting period, to which steam curing is applied;
 - ii) “initial maturity” is defined as the product of temperature of the concrete in °C and time in hours (h), where:
 - A. the temperature is that of the concrete mass at the completion of placement; and
 - B. the time is measured from the time of completion of placement of the concrete mass to the first introduction of steam;
 - iii) “recording thermometer” is defined as an instrument capable of continuously recording and printing a permanent record of temperature vs time. The report must be accurate to within 2°C;
 - iv) “steam covers” is defined as flexible or rigid barriers that retain heat and moisture around the concrete mass and test specimens during steam curing;
 - v) “temperature probe” is defined as a probe with a thermometer which can be inserted under the steam covers to check the steam temperature. The thermometer must be accurate to within 1°C; and
 - vi) “test specimen” is defined as any compression, flexural or other test specimen which is to be tested for the purpose of determining a property of the concrete mass following steam curing.

2 Documentation

2.1 Construction Documentation

In addition to the requirements of PC-CN3 “Construction Management”, the Construction Documentation must include detailed procedures and documentation for curing of precast units by the controlled circulation of hot water.

2.2 Quality Management Records

In addition to the requirements of PC-QA1 “Quality Management Requirements” or PC-QA2 “Quality Management Requirements for Major Projects” (as applicable), the Quality Management Records must include the verification records required by Table ST-SC-S5 9-1.

3 Heat delivery

Heat accelerated curing of precast concrete must meet the following requirements in relation to heat delivery:

- a) heat accelerated curing must involve heating of precast units after an initial maturing period by the controlled circulation of hot water through a series of steel conduits attached externally to the steel mould. A purpose-built tank used for the curing of concrete test cylinders must be connected to the hot water system. Hot water curing must be continuously applied until the concrete has attained the required compressive strength;
- b) the hot water system must be controlled by a thermostat so that the temperature difference between ingoing and outgoing water in the water jacket is not more than 10°C. The Contractor must provide evidence that this requirement has been met as part of the Quality Management Records;
- c) the maximum temperature (refer section 4d)) of the water system must not be exceeded to ensure that there is no localised overheating of the concrete mass; and
- d) unformed exposed concrete surfaces must be covered immediately following the concrete finishing operations to minimise evaporation from the surface of the concrete mass. Curing covers must be heat insulated to prevent surface heat loss during hot water curing.

4 Hot water curing cycle

Heat accelerated curing of precast concrete must meet the following requirements in relation to the hot water curing cycle:

- a) concrete must have an initial maturity of not less than 40°C/h and the duration of pre-setting period must not be less than 2 hours, nor longer than 5 hours, unless wet curing is applied in the interim period prior to heat application;
- b) where necessary, a small amount of hot water heat application may be used to maintain the concrete at the temperature at which it was placed. During this period the temperature at the surface of the concrete mass must not exceed 30°C;
- c) the maximum rate at which water temperature rises / falls must not exceed 24°C/h; and
- d) the target inlet water temperature must be 70°C with a tolerance of $\pm 5^\circ\text{C}$.

5 Temperature record

In relation to temperature records for heat accelerated curing of precast concrete:

- a) a sufficient number of temperature probes and recording thermometers must be used to ensure that any temperature difference between any 2 points in the hot water jacket is detected. Where the hot water jacket consists of more than one section, temperature recording must be undertaken for each section;
- b) recording thermometers must be capable of continuously recording and printing a permanent record of water temperature versus time. The report must be accurate to within 2°C;
- c) temperature probes must be probes with a thermometer, which can be inserted into water-filled temperature stations to check the water temperature. The thermometer must be accurate to within 1°C;

- d) the recording thermometers must be set in operation immediately upon completion of casting and screeding, the temperature sensitive part of each thermometer being installed in position at the same time;
- e) a printed continuous record of temperature variation with time must be obtained;
- f) the Contractor must record the following information:
 - i) description of concrete mass (e.g. pile, girder, etc., with identifying element number);
 - ii) time of completion of concrete placement;
 - iii) thermal properties of the form/insulation on each face and the ground;
 - iv) temperature of the concrete at completion of placement (measured in the member);
 - v) temperature of the concrete at time of commencement of heating (measured in the member);
 - vi) time of commencement of heating;
 - vii) temperature difference between ingoing and outgoing water for each section of the hot water jacket;
 - viii) water temperature in the curing tank;
 - ix) time of shutting off heat;
 - x) time of removing curing covers;
 - xi) ambient air temperature at the member, at the time of removal of curing covers; and
 - xii) name of Contractor and date of operation; and
- g) the records required in sections 5e) and 5f) must be kept until the Date of Completion and must be made available both upon request and as part of the Quality Management Records.

6 Hot water cured test specimens

6.1 General

- a) The sampling and testing of specimens for hot water cured concrete must conform to the requirements of AS 1379 Specification and supply of concrete, as applied to non-hot water cured concrete in ST-SC-S7 "Supply of Concrete".
- b) The test specimens referred to in section 6.1a) must be subjected to the same curing procedure adopted for the elements they represent, including any subsequent moist curing. The test specimens must be located in a purpose-built tank that is filled with water maintained at a temperature within 10°C but not exceeding the maximum temperature of the water in the jacket.
- c) The Contractor must ensure that sufficient cylinders are provided to enable the testing required by section 6.1a) to be undertaken.
- d) The test results of the test specimens required in this section 6 must be submitted as part of the Quality Management Records.

6.2 Testing for transfer or handling

- a) Where an assessment of transfer strength is required, an additional sample with a minimum of 2 cylinders must be taken from the last batch of concrete in the element. The transfer strength must be assessed in accordance with the sampling and testing clauses of AS1379 Specification and supply of concrete.
- b) If, on testing at the end of the heat accelerated curing cycle, compressive strength test specimens made for the purpose of determining the time of transfer of prestressing force or

handling do not achieve the required strength, further curing must be carried out until the required strength is achieved.

6.3 Curing time

If 75% of the target 28-day compressive strength (calculated as the average of the test specimens) has not been achieved by the test specimens referred to in section 6.1a) at the end of the heat accelerated curing cycle, curing by either moist or hot water methods must continue until that strength is reached.

7 Removal of curing covers

Curing covers must not be removed until the surface temperature of the concrete has fallen to within 25°C of the ambient air temperature outside of the curing covers. Curing covers must remain in place longer if the concrete product shows signs of damage due to thermal shock or differential cooling.

8 Additional moist curing

Additional moist curing, if required, must not be applied until the concrete mass has cooled to the ambient air temperature plus 10°C, nor can it be delayed beyond this time.

9 Verification requirements and records

The Contractor must supply written verification as part of the Quality Management Records that the requirements listed in Table ST-SC-S5 9-1 been complied with.

Table ST-SC-S5 9-1 Verification records

Section reference	Subject	Record to be provided
3b)	Thermostatically controlled hot water system	Evidence of thermostat meeting temperature requirements
5g)	Ambient, concrete and water temperature records	Records specified in section 5g)
6	Test specimen testing results	Test specimen testing results, in accordance with section 6