

S-9 CONCRETE

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9.01 SCOPE OF WORK

Work shall consist of supplying, delivering, placing, finishing, and curing Portland cement concrete as directed and of a nature that will conform to these specifications.

Ambient and forecast temperatures shall be those reported by Environment Canada at the Windsor Ontario Airport.

9.02 REFERENCES

This specification refers to the following standards, specifications, or publications:

- City of Windsor General Conditions & Special Provisions
- S-5
- S-6
- S-7
- OPSS.MUNI 904

- OPSS.MUNI 1350
- OPSS 350
- OPSS.MUNI 351
- OPSS.MUNI 353
- OPSS.MUNI 360
- OPSS.MUNI 362
- OPSS.MUNI 1001
- OPSS.MUNI 1002
- OPSS.MUNI 1305
- OPSS 1315
- Canadian Standards Association CSA (A23, A3000)

9.03 MATERIALS

All materials used in the production of concrete shall be according to OPSS.MUNI 1350 unless otherwise approved by the City Engineer. Coarse aggregate size for full depth repair of concrete pavement and concrete base shall meet the requirements of OPSS.MUNI 360.

9.04 PERFORMANCE REQUIREMENTS OF CONCRETE

Unless otherwise specified in the contract documents, concrete shall be 32 MPa at 28 days and will satisfy the requirements of OPSS.MUNI 1350 and the City of Windsor Plastic Properties (2022) table below.

The performance of the concrete shall be measured at 28 days and will be determined by the average compressive strength of at least two cylinders cast and cured according to CSA A23.2.

When the average compressive strength of two 28 days performance cylinders fail to meet the compressive strength requirements an additional cylinder may be tested at 56 days at the discretion of the City Engineer. If the compressive strength at 56 days fails to meet the required strength, the concrete shall be considered non-compliant to the City specification.

The compressive strength of cored concrete samples will not be considered for acceptance purposes.

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City of Windsor Concrete Properties (2022)

APPLICATION	CSA EXPOSURE CLASS	MAXIMUM W/CM RATIO	RANGE FOR SLUMP* (MM)	28 DAY COMPRESSIVE STRENGTH	PLASTIC AIR CONTENT **RANGE	MAXIMUM NOMINAL AGG. SIZE (MM)	DISCHARGE TEMP*** °C	CITY OF WINDSOR SPEC.
CONCRETE BASE (FORMED)	C - 2	0.45	50-110	32 MPA	4 - 7 %	37.5	10 - 28	S - 7
PAVEMENT (FORMED)	C - 2	0.45	50-110	32 MPA	4 - 7 %	37.5	10 - 28	S - 7
PAVEMENT (SLIP-FORM)	C - 2	0.45	20-60	32 MPA	4 - 7 %	37.5	10 - 28	S - 7
CURB & GUTTER	C - 2	0.45	20-60	32 MPA	5 - 8 %	19.0	10 - 30	S - 5
SIDEWALK	C - 2	0.45	80-120	32 MPA	5 - 8 %	19.0	10 - 28	S - 6
FAST TRACK PAVEMENT	C - 2	0.45	150 MAX.	32 MPA	5 - 8 %	19.0	15 - 35	
UN-SHRINKABLE FILL	N/A	N/A	150 MIN.	0.7 MPA MAXIMUM	N/A	25.0	10 - 28	S - 24
ALL OTHER MIXES	AS SPECIFIED							

*Slump, Slump Flow CSA A23.2-5c
 **Air Content CSA A23.2-4c or A23.2-7c
 ***Concrete Temperature ASTM C 1064

Concrete not meeting the plastic properties shown above are rejectable and are not to be included in the work unless such variances are pre-approved and accepted by the City Engineer.

9.05 TESTING

The frequency of testing shall be determined by the City Engineer.

The contractor will assist the City of Windsor in the taking of randomly timed samples as required.

The City Engineer shall perform the field testing of the materials plastic properties and will cast performance cylinders in accordance with CSA A23.2.

Field cured cylinders (cured to mimic the conditions and temperatures experienced by structure) for the purpose of estimating placed concrete strength development may be cast from time to time but are not the responsibility of the City of Windsor. Such cylinders may be used for information only and are not to be used as the 28 day design strength value.

The Contractor is responsible to notify the City Engineer a minimum of 24 hours prior to the placement of concrete to set up the required testing. Failure to provide 24 hours notice shall result in the Contractor being responsible to retain the services of a third party Geo-Tech Consultant to undertake the required field testing and cylinder casting required by the City Engineer. The field and lab test results must be provided to the City Engineer prior to payment of the placed concrete.

9.06 PRODUCTION

Concrete will satisfy OPSS.MUNI 1350.07

All Batching Plants and equipment shall be according to the certification requirements of Concrete Ontario or an equivalent certification.

Proof of certification must be available to City Engineer upon request.

Concrete produced without such certification or equivalent thereof will not be acceptable.

9.07 DELIVERY

Delivery of concrete will satisfy OPSS.MUNI 1350.07.05

All concrete delivery trucks and equipment shall be according to the certification requirements of Concrete Ontario and shall be equipped with an onboard, self contained washout system or equivalent to eliminate the discharge of any waste water into the environment.

All site adjustments to the delivered concrete materials are to be disclosed to, approved, and witnessed by the City Engineer.

9.08 PLACING

Any concrete placed without expressed consent from the City Engineer is subject to removal at the Contractor's expense.

Concrete is to be placed in accordance with OPSS.MUNI 904.07.06 and the relative City of Windsor Standard Specification.

- In any conditions, at time of discharge, the concrete is to be between 10°C and 28°C unless otherwise specified or pre-approved by the City Engineer.
- Immediately prior to concrete placement the base is to be made wet by means of a uniform spray of water sufficient to wet the base thoroughly without leaving standing water (regardless of "hot" or "cold" weather considerations).
- In lieu of the water spray, a sub grade moisture vapour barrier satisfying OPSS.MUNI 1305 may be used.
- Concrete must be placed and consolidated such that segregation of the aggregate does not occur.
- Complete discharge of the concrete from the truck shall be completed within 90 minutes after the introduction of mixing water.
- Concrete delivered by non-agitating equipment – discharge of concrete shall be completed within 30 minutes of the introduction of the mixing water to the cement and aggregates (OPSS.MUNI 1350.07.05.01.03)
- The batch time is the time printed on the ticket is the start of the 90-minute period.
- The discharge time is 60 minutes when hot weather concrete protocols are in effect.
- Concrete not placed within the allotted time is not to be accepted.

Concrete placing restrictions as per OPSS.MUNI 904

Cold weather

Cold weather conditions exist when the ambient air temperature is at or below 5°C and or is forecast to be at or below 5°C within 96 hrs of concrete placement.

- No concrete shall be placed out of doors when the ambient air temperature is below 0°C
- No Concrete shall be placed on a base that is frozen or snow covered
- Any surfaces against which concrete is to be placed must be at or above 3°C

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- Concrete placed on a granular base that has been subjected to de-icing chemicals shall be protected from that base by a continuous moisture vapor barrier for all flatwork and whenever possible
- Curing compounds shall not be used during cold weather concrete placement. Rather:

Crystal-Loc or similar approved sealants are to be applied according to the manufacturer's instructions shall, in concert with adequate vapor barrier curing and thermal protection be used for all concrete placed on or after the first day of November or whenever the likely hood exists of de-icing of other chemical attacks on the concrete can be anticipated within the 28 day curing period.

Every effort will be made to minimize the time the concrete is exposed to cold weather conditions during the initial period of curing. Protection removed to allow for cutting, spraying, form stripping or other necessary operations to take place is to immediately replaced and secured for the completion of the required curing period.

Hot weather

Hot weather conditions exist when ambient air temperature is at or above 28°C or is forecast to be at or above 28°C within 24 hours of concrete placement.

- Concrete delivered by means of an agitating truck mixer must be completely unloaded within 60 minutes from its batch time during "hot weather"
- Surfaces against which concrete is to be placed must be wet and shall not exceed **35°C** at time of placement
- No concrete is to be placed or scheduled to be placed when the ambient air temperature exceeds 32°C for concrete pavement and concrete base or when the ambient air temperature exceeds 35°C for curb and gutter or sidewalk
- Curing protocols are to commence immediately

Any concrete placed in a condition outside of these specifications may be subject to removal at the contractor's expense.

9.09 FINISHING

Finishing operations shall be according to OPSS.MUNI 904 and the appropriate City of Windsor Standard Specification or OPSS Specification listed below:

- S-5 Concrete Curb and Gutter
- S-6 Concrete Sidewalk and Driveway Approaches
- S-7 Concrete Pavement

- OPSS 350 – Concrete Pavement and Concrete Base

Finish Tolerances

Finished concrete tolerances shall be according to the appropriate City of Windsor Standard Specification.

9.10 CURING

All poured concrete must be appropriately cured.

Curing shall be according to OPSS.MUNI 904 with the exception that all concrete is to be cured for a minimum of 5 days at a temperature not below 10°C or above 70°C

All curing materials and equipment are to be on site and in working order prior to the start of concrete placement.

In the case of liquid compounds, the curing application shall commence immediately. The application start time may vary with site conditions, sun, temperature and/or wind and is to be done to the satisfaction of the City Engineer. The concentration and application of the curing compound shall be consistent with the manufacturer's written direction.

Unless otherwise specified and pre-approved, all curing compounds are to be of the white-pigmented variety and be according to OPSS 1315.

Immediately prior to application, the curing compound is to be mechanically agitated to the satisfaction of the City Engineer.

In the case of a moisture vapour barrier being used for curing, it shall be done according to OPSS.MUNI 1305.

Application of moisture vapour barrier curing shall commence as soon as practical after the finishing operation without marking the finished product.

Edges and seems are to be fastened tightly, sealed and secured.

Concrete not adequately cured will not be accepted.

9.11 MEASUREMENT FOR PAYMENT

Measurement for payment for concrete will only be made of that material accepted by the City Engineer.

The Unit of measurement will be that as provided for in the Form of Tender.

9.12 BASIS OF PAYMENT

Payment will be made at the unit prices bid on the Form of Tender and for the quantities determined by the applicable method of measurement.

Payment will only be made when the finished product is deemed acceptable by the City Engineer.

Such payment shall constitute full compensation for supplying, delivering, placing, finishing, curing, protecting and maintaining and any other cause whatsoever for all work performed in connection with the supply of the materials and any other incidentals necessary to complete the items which are not herein specified for payment otherwise.

Where high early strength concrete fails to meet the 3 days strength requirement the concrete shall be considered non-compliant and the Contractor shall be paid standard concrete price as noted in the Form of Tender subject to the concrete meeting 28 days compressive strength requirement.

Cooling of concrete during "Hot Weather Concreting" and associated costs will not be paid unless pre-approved and accepted by the City Engineer in cases where it is agreed to be necessary to meet project schedule or where concrete must be placed for other necessary circumstances.