Direction des structures

MTQ's Approach to Durable Concrete Repairs

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- Background
- Organization
- Structural concrete repair types
- Materials
- Other concrete repairs



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 As in most North-American cities, the highway network in Québec was built mainly during the 1960's and 70's





In Québec, a lot of concrete was used in structures



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Concrete has played a prominent role in the ability to start and speed the construction of these projects, simply because it is easy to manufacture and more importantly, permanent, versatile, economical and costs little to maintain.

CHURCHES

QUEDEC

PRICE FIFTEEN CENTS

13-20

• Of course, designers at that time did not know their enemy very well...



(MTQ uses over 800 000 M.T. of salt each year on our roads)

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 As a result, some of our "permanent" concrete structures started falling apart after only 30 years of service



 After years of underinvestment in structure maintenance, the budget has tripled in the past years



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- The Ministère des Transports du Québec owns and manages over 9000 structures
 - ±4700 provincial bridges
 - ±4300 municipal bridges
- Provincial bridges (mainly highways)
 - All maintenance done under supervision of MTQ
- Municipal bridges
 - Regular maintenance done by municipalities
 - Repairs done under supervision of MTQ

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 Our territory is divided into 14 regional offices



Great disparity between regional offices





<u>Montréal</u> 500 km² 478 structures <u>Côte-Nord</u> 236,700 km² 278 structures *Transports* Québec *****

- Central office
 - Writes standards and specifications, procedures and typical tender documents
 - Develops maintenance strategies and objectives
- Regional offices
 - Own the structures
 - Prepare the tenders and administer the contracts
 - ...and can modify our typical contract documents

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- Need for intervention on a structure is based on inspection results
 - Thorough inspection every two, three or four years
 - Depending on structure type and condition
 - Basic inspection every year



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Four basic types of structural repairs:

- Surface repairs

- Slab or horizontal surface

 Increased thickness reinforced concrete repairs

Reconstruction



Severity of

defect

- Surface repairs
 - Saw cut on edges of repair
 - Square or rectangular shapes
 - Existing reinforcement undercut 25mm (1 in.)
 - First two layers
 - Minimal depth of demolition of 80mm (3 in.) or sound concrete



- Surface repairs (continued)
 - This type of repair is carried out when local defects can affect the load bearing capacity of the structure
 - This type of repair is prohibited from November to March (inclusively)
 - Because of difficulties in heating the repair zone that can lead to concrete freezing







• Surface repairs - Examples



- Slab or horizontal surface repairs
 - Similar to vertical surface repairs
 - If less than 80mm (3 in) of sound concrete remains on the underside of the slab, full depth repair
 - Used for slabs with less than 30% of defective surface area
 - If more surface area is affected, we recommend to wait and replace the entire slab

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Slab or horizontal surface repairs



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- Increased thickness reinforced concrete repairs
 - Covering of the whole area of a surface
 - Concrete removal
 - Min 10mm on surface (1/2 in.)
 - All delaminated surfaces
 - Pulverized using 2000 psi water jetting
 - No systematic existing rebar undercutting

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- Increased thickness reinforced concrete repairs (continued)
 - Formwork anchors placed at 600mm c/c
 - A specific type of anchor is specified
 - Anchors act as formwork ties and anchorage for new concrete
 - Two additional layers of reinforcement
 - Number 15 (#5) bars at 300mm c/c grid
 - Additional concrete thickness varying from 125 to 200 mm. (5 to 8 in.)
- Can be done in cold weather
 - Isolating mats if temperature drops below 5 C
 - Enclosure and heating required between November and March inclusively

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- Increased thickness reinforced concrete repairs (continued)
 - This type of repair is carried out when damages are present in a significant portion on the surface of a concrete element
 - Although chloride contaminated concrete remains underneath the repair, our experience shows that this type of repair is very durable



Increased thickness reinforced concrete repairs (continued)



 Increased thickness reinforced concrete repairs – Anchor / Formwork tie detail



Increased thickness reinforced concrete repairs - Examples





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 Increased thickness reinf. concrete repairs -Examples



• Increased thickness reinf. conc. repairs - Examples



Concrete removal

- Surface demolishing is usually done with pneumatic hammers
 - Specified in our documents: 15 kg (30 lbs) outer layer of concrete, 7 kg (15 lbs) behind existing rebar
- Use of hydrodemolition equipment is allowed if results are similar to above
 - Hydrodemolition is generally used in urban regions when a large surface has to be demolished

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Concrete removal

- In our standard specifications, we recommend referring to ICRI's No. 310-2 (formerly 03732) guideline CSP 7 for minimal surface roughness
 - Usually, roughness of the demolished surface is not an issue



 Concrete curing - For all our repairs Leave formwork in place or wet burlap and polythene sheets Minimum of 7 days - Only exception, overhead shotcrete repairs



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- Background
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- Surface repairs – Exclusive use of SCC (with 10mm coarse agg.)
- Increased thickness reinforced concrete repairs
 - When additional thickness is less than 150mm, contractor usually has the choice of using SCC (with 14mm coarse agg.) or conventional concrete
 - In some special cases, use of SCC can be required
 - 150mm or more, conventional concrete is usually specified

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- General concrete requirements
 - 28 day strength: 35 Mpa (5000 psi)
 - Resistance to chloride ion penetration (ASTM C1202): 1000 Coulombs or less
 - All mixes contain silica fume (SF)
 - Ternary cements may be used from April thru October
 - Air-void spacing: less than 230 µm
 - Normal concrete slump: 130mm ± 30 (5 in)
 - SCC spread: 675mm ± 50 (26 in)

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- When new reinforcing bars are added (Increased thickness reinforced concrete repairs)
 - Use of
 galvanized bars
 when the annual
 average daily
 traffic of the
 adjacent road is
 higher than
 2500 vehicles





- We do not use any corrosion-inhibiting admixtures
- Why? Because our concrete mixes must be available throughout the province
 - In urban areas, concrete producers are familiar with these products
 - In rural areas, producers are not familiar with complex mixtures involving many admixtures
- Our goal: Produce quality concrete while keeping the mix design simple Transports

Shotcrete

- Almost always considered as an equivalent to cast-in-place concrete
 - Our documents show no preference for either method
- We leave the choice to each regional office
 - Some jobs are more adapted to shotcrete
 - Shotcrete is generally more available near big cities
- We recommend the use of a silane based concrete sealer on shotcrete repairs

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• We do not recommend or use...

- Surface mortar repairs
 - They do not last in our climate
 - Difficult to maintain

- Migrating corrosion inhibitors (surface applied)

- Our concrete is generally too impervious
- Epoxy coated reinforcing steel
 - Past experience has shown damages to the coating as a result of improper handling

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- Concrete slab overlays
 - Use of latex modified concrete (15%)
 - GU-type or Rapid Set cement
- Use of concrete slab overlays is selective
 - Almost always used to strengthen a deteriorated concrete deck and extend it's useful life
- Surface preparation usually done by hydrodemolition
- Finishing done by self-propelled finisher or vibrating screed

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Underwater repairs

- Carried out in a similar way to our increased thickness reinforced concrete repairs
- We require the use of a pump (no tremie)
- We recommend a minimum additional thickness of 200mm for the repair
 - Easier to lower the pumping line to the bottom of the forms



- Concrete sealers and elastomeric concrete sealers
 - We recommend the use of these products on existing concrete surfaces
 - When significant exposure
 - Concrete surface must be of good quality



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 In a few cases, we used induced current cathodic protection

- On some structures, works fine
- We have had issues with the maintenance of the systems



- Externally bonded carbon fibre reinforcement
 - Experimental use over the past 10 years
 - A few reinforcement projects have been done for the last two years
 - Still some concern with
 - Surface preparation vs. existing concrete condition
 - Long-term performance under cold weather exposure
 - Anchorage



Thank you for your attention!



