



CARBONCURE

SIMPLY BETTER CONCRETE

How Did North America's First Portland Cement Concrete End Up in Halifax Harbour?

Sean Monkman PhD PEng
CarbonCure Technologies Inc

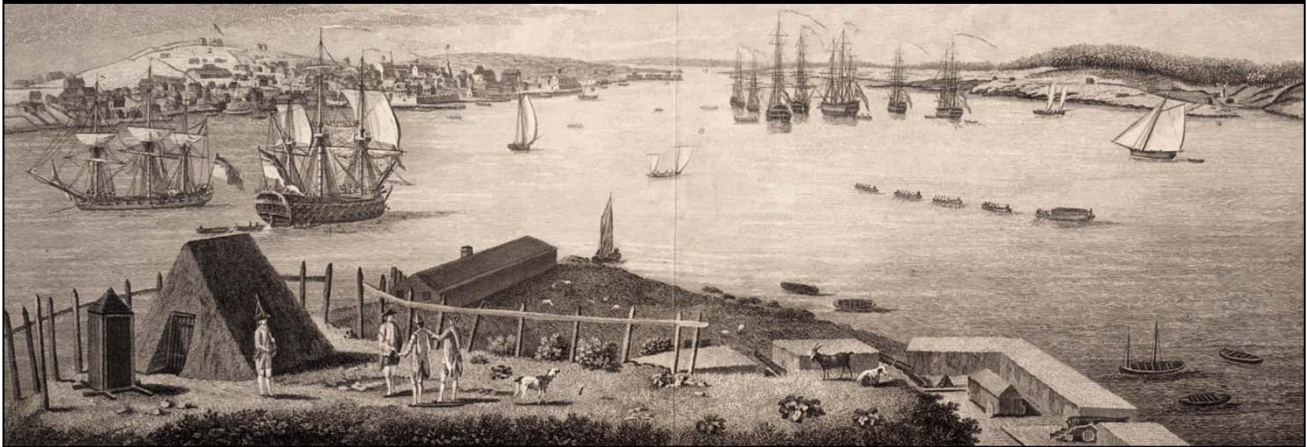








Georges Island with northern parts of fortifications built in 1750



*Halifax and the Harbour from the north end of Georges Island, looking north-westward (1759)
Richard Short (1764)
Toronto Reference Library, JRR 49 Cab IV (Short)*

In 1794, Prince Edward, later the Duke of Kent, arrived as the commander of the Halifax forces.

He orders the construction of a star-shaped fortification on the island (Fort Charlotte)



View of Halifax from Georges Island
George Isham Parkyns 1801
Toronto Reference Library, JRR 2148 Cab IV (Parkyns)

<http://www.virtualreferencelibrary.ca/detail.jsp?R=DC-JRR2148&searchPageType=vrl>

View of Halifax from George's Island

Toronto Reference Library

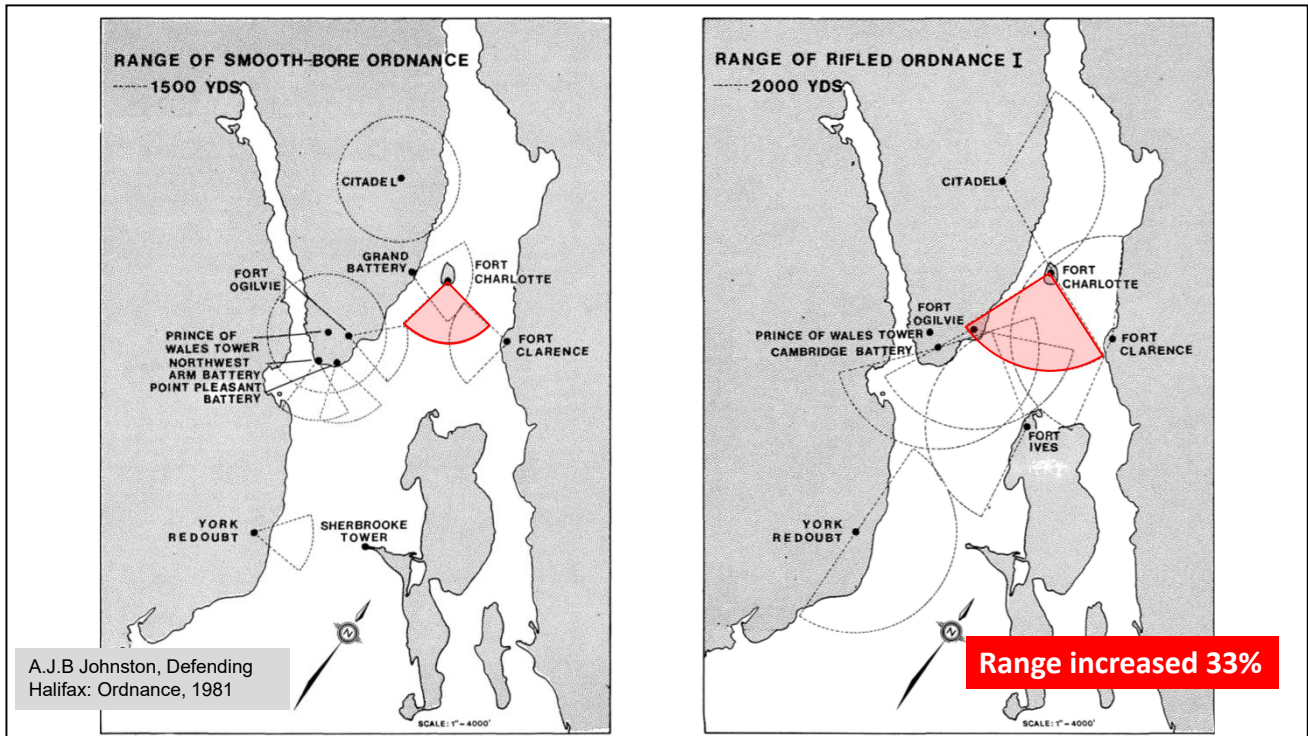
JRR 2148 Cab IV (Parkyns)

George Isham Parkyns, 1801

Fort Charlotte redevelopment in 1860s

- The 1860s saw the deployment of rifled muzzle-loading artillery
- **Rifled** - Helical grooves along the inside of the barrel
- **Muzzle-loading** - Projectiles are loaded through front of the barrel
- **Projectiles** - 250 to 256 lbs palliser shot, armor piercing for attacking warships, up to 50 lbs gunpowder used





Defending Halifax: Ordnance/ 1825-1906 – A.J.B. Johnston, Parks Canada, 1981, ISBN: 0-660-10842-9



RML at York Redoubt



The gun was designed in 1865 as a broadside gun for ironclad ships and harbour seafront defence. A total of 190 were made. The gun was last fired in 1903.. This gun was first mounted in Halifax Nova Scotia until 1878, then at Bermuda until 1881 and then at Sheerness England until 1885. It was mounted at Middle North Battery Simon's Town in 1896 where it still exists. The gun, carriage, slide and mounting were restored in the East Dockyard Gun Shop in 1984.

https://en.wikipedia.org/wiki/RML_9_inch_12_ton_gun

CONCRETE IN THE EARLY TO MID 1800S

Early negative opinion on concrete

- 1824 Aspdin patent for Portland cement
- Royal Military Academy at Woolwich – **Major Charles Pasley** oversaw instruction of Royal Sappers and Miners
- Carries out experiments with water cements and various types of limes
- By 1838 he has published work that **concludes concrete would not be suitable** as a replacement for masonry and brickwork



Concrete reconsidered

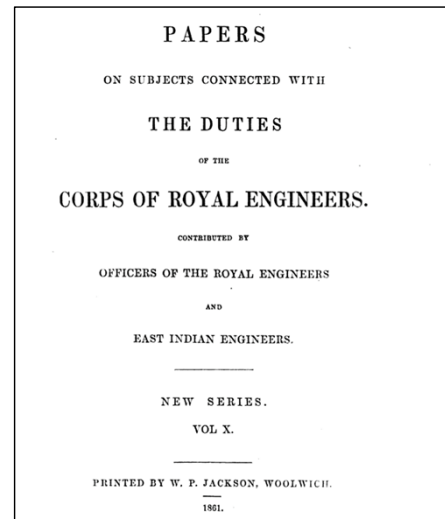
- By 1850s Portland cement is established as a reliable construction material in masonry
- Captain Henry Scott takes charge of the RMA chemistry lab in 1855
- Research into limes and cements
- Using Portland cement he challenges Pasley's conclusions about concrete (whose work had used James Parker's "Roman Cement")
- By early 1860s Captain Scott and Captain Francis Fowke encourage the use of concrete in the construction of fortifications



Scott and Fowke recommendations

- Given that masonry is expensive, slow and required skilled labour
- **Use concrete instead of stone** for casemates, magazines and revetments
 - Save time
 - Save money
 - Use unskilled labour
- Disseminated through lectures and publications (Professional Papers V XI)

example



History of Concrete session • ACI Fall Convention • Las Vegas • Oct 2018

Captain Henry Scott info - Substance and Practice pg 42

Basis for Portland Cement Concrete Use in Halifax

- Halifax in the early 1860s – heavier guns are on the way, two issues
 - Recent bad experience – lime concrete gun foundations several years earlier had not set properly.
 - Lack of skilled labour for masonry
- **The Royal Engineers in NS take notice of advice from England and order some Portland cement for their work**
- Cement acquired from England in barrels of 4 bushels apiece

Lieutenant Colonel Hassard writes to the Commanding Royal Engineer, Canada, on 2 Feb 1866 enclosing three reports on the use of Portland cement concrete at Halifax between 1862 and 1865

Cement.

Royal Engineer Office
Quebec 2^d Feb. 1866. Report sent to Insp^d
16/2/66

Sir In compliance with
your mem^o du dated
forwarding War Office
letter 8 Nov 1865 $\frac{2}{1580}$
relative to the water
cement of General
Baddley I have now
the honor to report
that having perused the
accompanying papers
and made such
enquiries as my office

Memorandum on the use of cement
concrete at Halifax N.S. during the
years 1863-4, & 5 (Fort Charlotte -)

Materials
Employed

The materials used here for concrete
are broken stone, shingle, sand and

Memorandum on the use of cement
concrete at Halifax NS during the
years 1863-4 (Fort Charlotte)

The question of labour

Force would be divided somewhat as follows.

4 mowing

2 wheeling

2 levelling and ramming (1 Sapper)

1 supplying water

3 measuring and preparing materials
for next batch. —

The question of labour

A Gang would be divided somewhat as follows

- 4 mixing
- 2 wheeling
- 2 levelling and ramming (1 Sapper)
- 1 supplying water
- 3 measuring and preparing materials for next batch

Mix proportioning (several examples provided)

One cubic yard of concrete

- 16 bushels broken stone (two sizes)
- 5 bushels fine shingle
- 7 bushels sand and $3\frac{1}{2}$ bushels cement
 - about $8\frac{1}{2}$ bushels of mortar
- An excessive amount of cement was used in this case because the cement was not fresh.

Estimate of the cost of the concrete used...
(Military Labour)

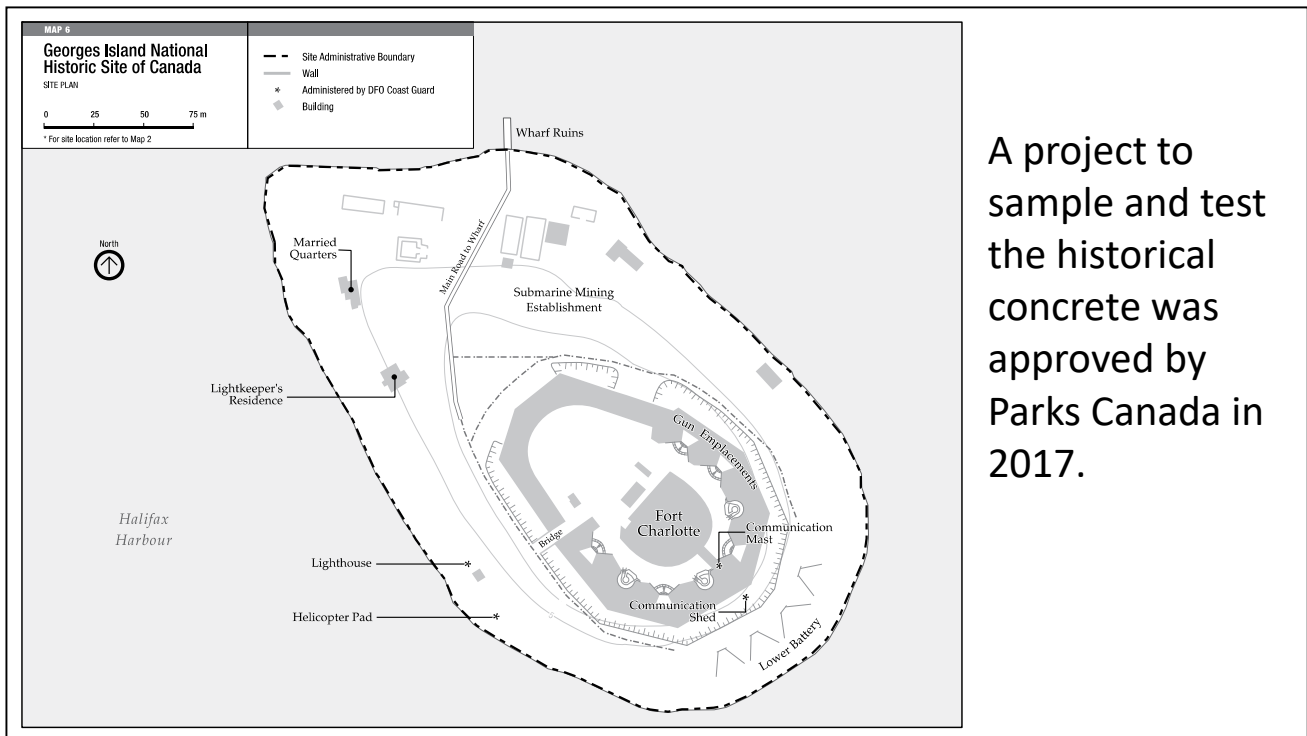
2 yds ironstone	1-6	Task for breaking	1 9/12
1 yd granite	1-10	" " "	5-4 9/12
Cost of unbroken granite	-6		
21 bushels sand - 3 ^d	5-0	including waste)
8 do cement	32-6		
Mixing wheeling etc	2-6	Task for mixing etc	1 9/12
Water (very scarce)	1-0		
Truckage sand & cement	1-6	Note	
Plant & Superintendence	1-6		
(Staff) 1/2			
Add for condensation	17-10		
	2-8		
	50-6	for 3 yards	
Cost per yard	16-10 ^d		

Cost per yard

- Materials and labour
- 16s 10d
- est. £382 today

Fort Charlotte Today





<http://parkscanadahistory.com/publications/halifax/mgt-plan-e-2009.pdf>

Site Visit July 2017

1860s concrete described in
Gun foundations
Escarpment walls
In place of brick arches in galleries
Expense magazine

ACCESS 2

ACCESS 1

Youtube – Brinton Photography

Brick arched galleries



Concrete arched galleries





Concrete sampling Sept 2018



Project Plans

- Four cores acquired, two from each gallery of interest
- Material characterization
- Two project PIs
 - Doug Hooton, U Toronto
 - Mike Thomas, UNB



Acknowledgements

- Thanks to Parks Canada for approving and supporting the project
- In memory of Bill Naftel





CARBONCURE

SIMPLY BETTER CONCRETE

“...for economy, dispatch and military labour the advantage of concrete is undoubted”

Sean Monkman, PhD PEng
VP Technology Development
smonkman@carboncure.com

 @carboncure

