



Innovative DESIGNS for Manure Storage FACILITIES

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OBJECTIVES

Investigate the suitability of innovative design procedures for reinforced concrete manure storage tanks using GFRP as internal or external reinforcing element.

Determine the degree of protection of GFRP spray and PVC cover as external material to protect the reinforced concrete in manure environment.

RESEARCH

PROBLEM

Contamination of the ground water due to seepage from manure storage tanks, and short service life of manure storage tanks.

CAUSE

In a reinforced concrete structure, hostile service environments cause the steel reinforcement to corrode and concrete to degrade leading to severe deterioration and failure of the structure.

SOLUTION

Use of glass fibre reinforced polymers (GFRPs) as an internal or external reinforcing element and protective cover.

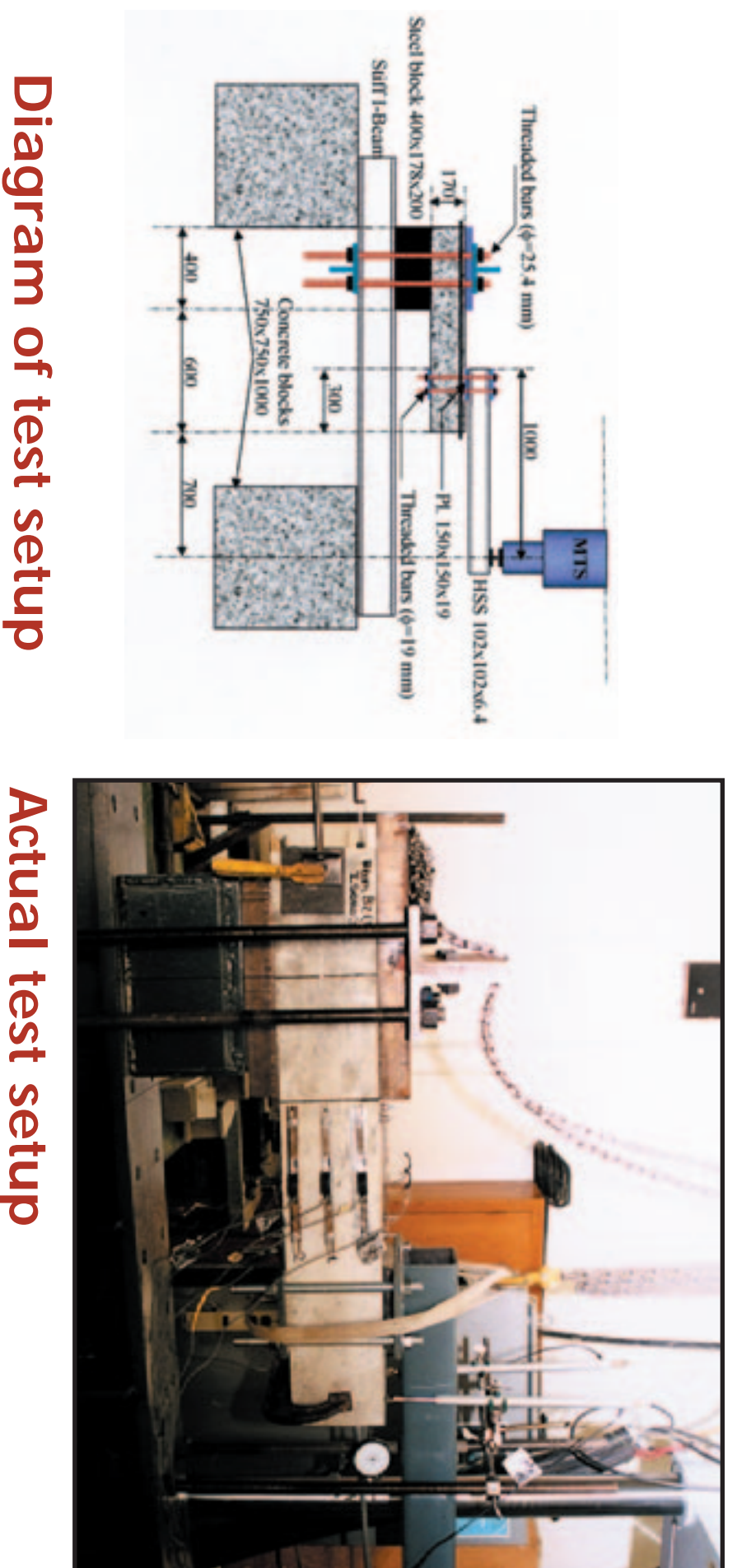
Experimental Program - Test Variables

Concrete Type	Reinforcement	Confinement (failure from name)	Exposure time to manure
Ordinary concrete	1 - Steel rebar ($\phi = 6.35$ mm)	a - no isolation	$t_0 = 0$ (control)
	2 - GFRP C-BAR ($\phi = 10$ mm)	b - GFRP spray	$t_1 = 4$ months
	3 - GFRP ISOROD ($\phi = 10$ mm)	c - PVC (Oxidform)	$t_2 = 8$ months
	4 - GFRP spray (coating - 3.5 mm)		$t_3 = 12$ months
			$t_4 = 18$ months

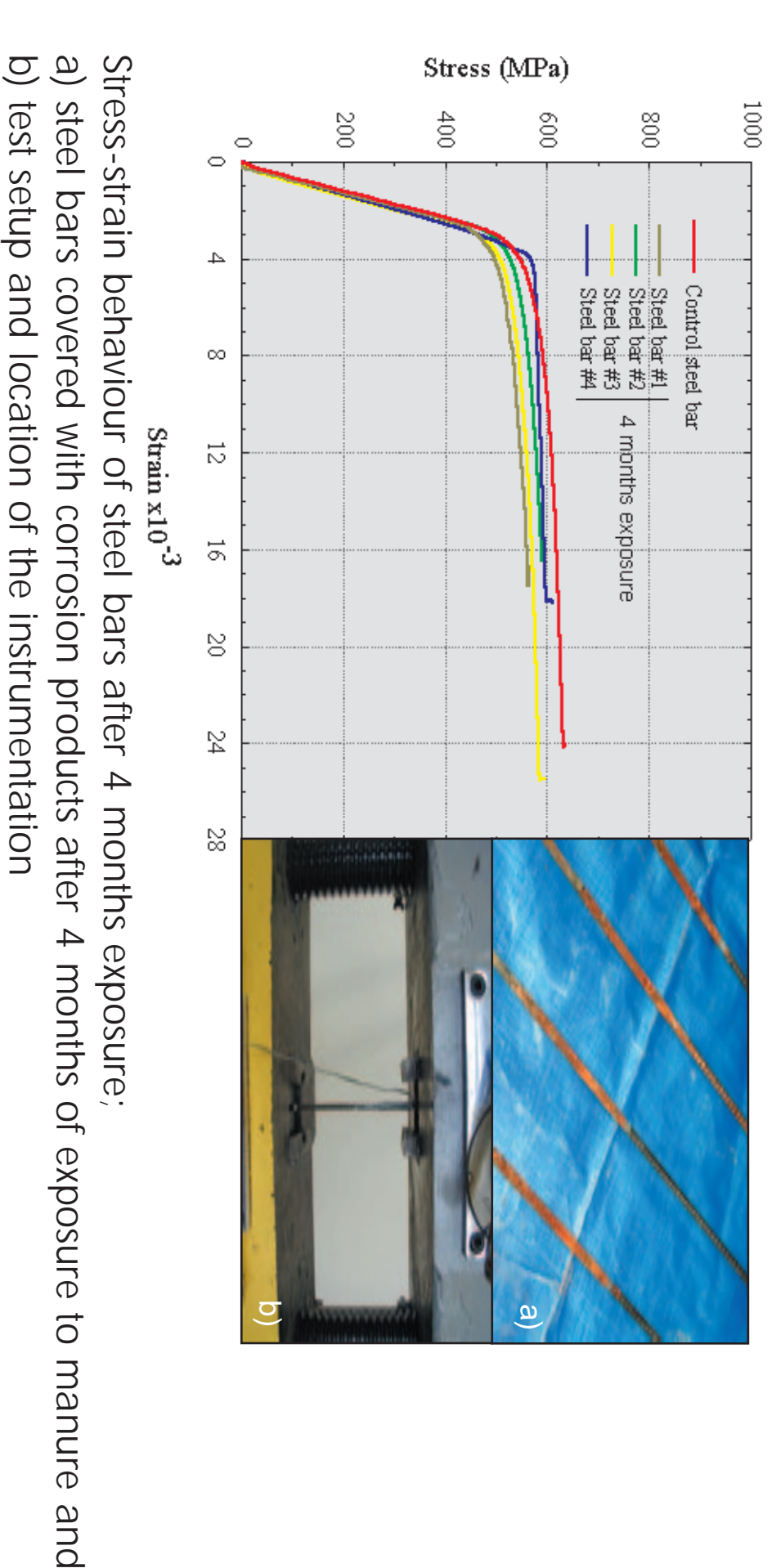
Experimental Program - Reinforced concrete beams in contact with manure



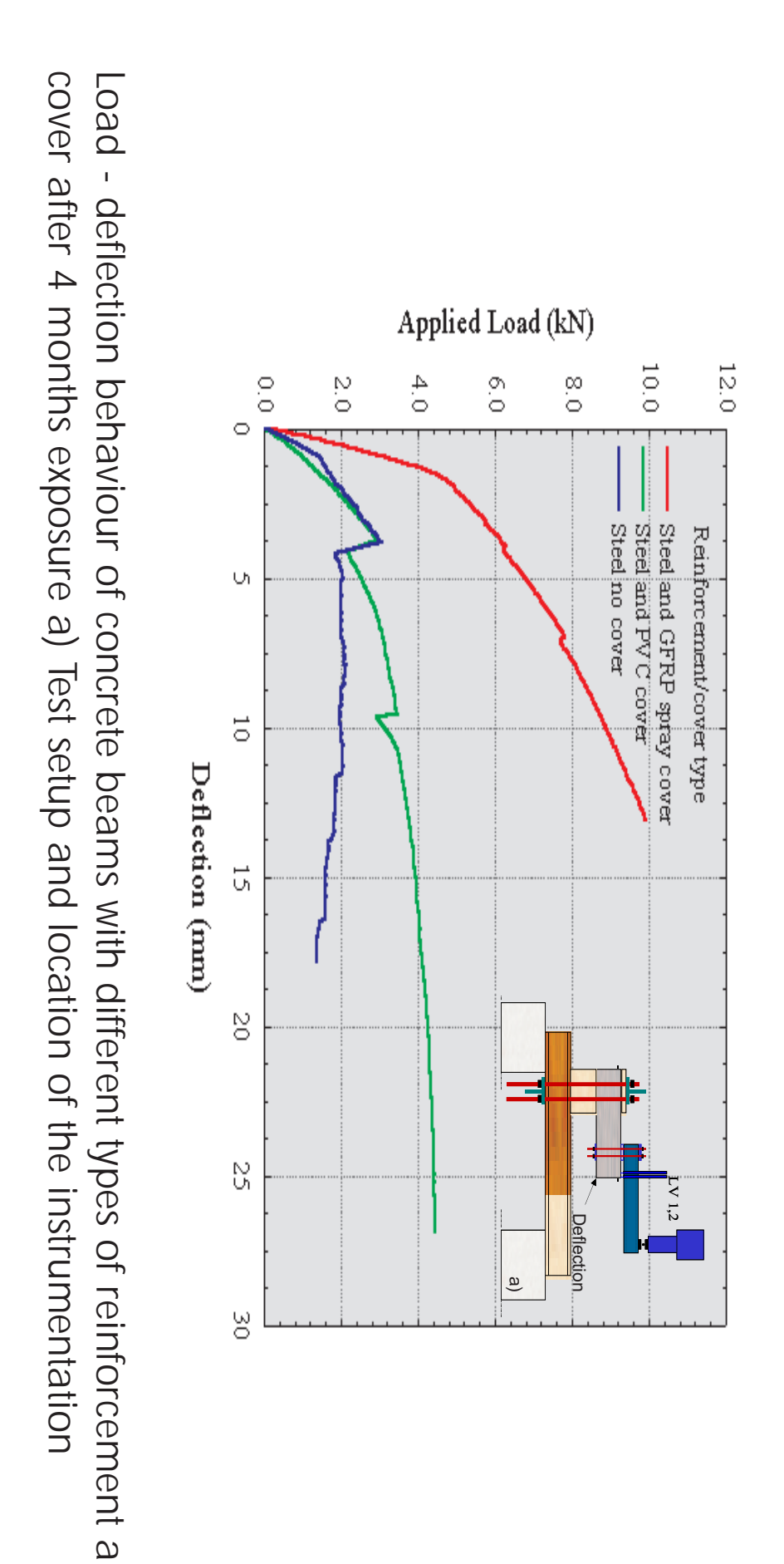
Experimental Program



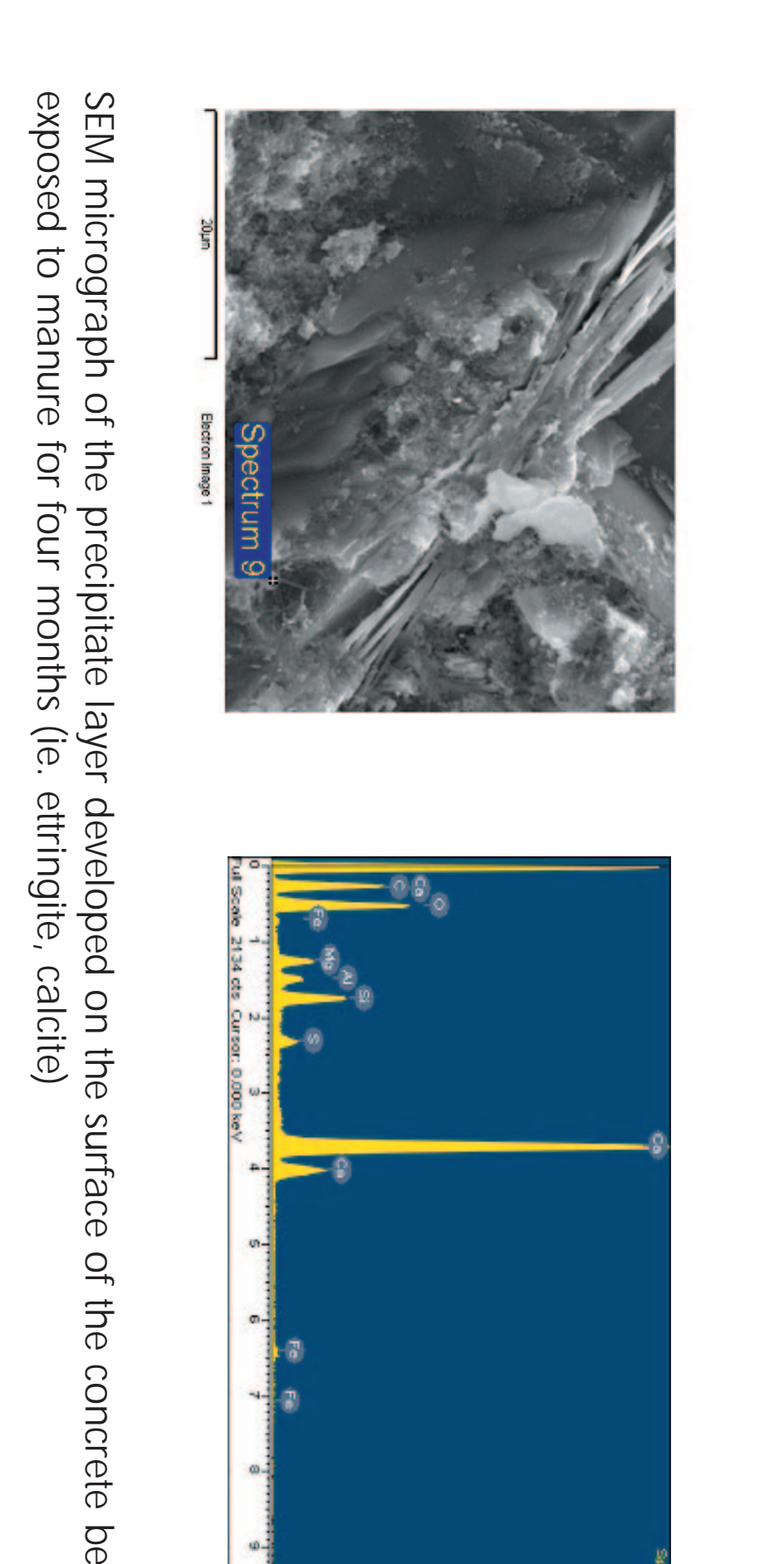
Experimental Results - Steel bar reinforcement, stress-strain



Experimental Results - Load deflection behaviour of concrete beams



Experimental Results - Microscopic examination of concrete surface



FINDINGS

- The yield strength of steel bars decreased about 7%.
- The E_{gfrp} of C-BAR and ISOROD decreased by 6% and 12% respectively.
- All reinforced concrete beams failed in a similar manner by rupture of the reinforcement.
- The reaction between concrete and manure is accompanied by the formation of a reaction layer, including precipitation and growth of an assemblage of secondary phases.



steel

- steel reinforcements corrode causing concrete to crack and deteriorate



fibre reinforced polymers

- 6 times stronger than steel
- 80% lighter
- non-corroding

PARTNERS

ISIS Canada

Intelligent Sensing for Innovative Structures

Manitoba Agri-Food Research & Development Initiative

Manitoba Livestock Manure Management Initiative Inc.

Manitoba Triple S Hog Manure Initiative

Aquarium International

Nelson River Construction