NANOTECHNOLOGY APPLIED IN THE DESIGN OF THE NEXT GENERATION OF CONCRETE PAVEMENTS SURFACE

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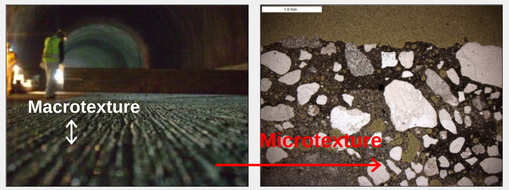
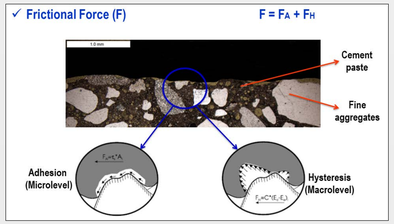
INTRODUCTION

- ✓ The pavement surface should be designed to provide high friction, smooth surface, low noise and adequate surface drainage.
- ✓ PCC pavements has two primary functional “failures”: inadequate skid resistance and excessive tire-pavement noise generation.
- ✓ Friction is affected by both the microtexture, and by the macrotexture. Noise emission is affected mainly by macrotexture.





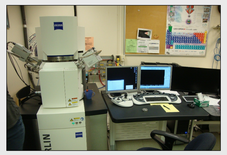
- ✓ Previous research on friction and sound production of concrete pavement mostly emphasized creating different surface textures through macrotexture modifications.
- ✓ In this research the focus is to investigate how friction and sound absorption can be improved by modifying the concrete **microtexture** through nanotechnology and varying surface characteristics through **macrotexture** modifications.

OBJECTIVES

- ✓ Develop a new surface concrete pavement with increased friction and noise absorption (less overall noise production).
- ✓ Develop and propose a new concrete texture with increased durability.

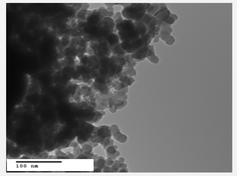
RESEARCH METHODOLOGY

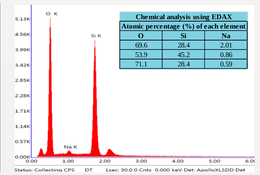
- ✓ To date, several mixes have been evaluated in the laboratory. The mix design was assembled based on the CSA A23.1-09/A23.2-09 standard using the following parameters:
  - Slump: 75 mm to 100 mm; air content: 5% to 8% (tolerance: ±1.5%); specified compressive strength at 28 days: 35 MPa; class of exposure: C – 2, nominal maximum size of aggregate: 20 mm,
- ✓ Concretes mixes include the following materials:
  - Normal Portland cement (Type GU); aggregates (coarse and fine); High-range water reducing (HRWRA) and air-entraining admixture (AEA) and **nanosilica** (defined in proportion to the cement weight).
- ✓ The main tests performed to date are the following:
  - TEM and chemical analysis of nanosilica
  - Slump, air content and density
  - Compressive strength
  - Friction response characterized by the British Pendulum Number
  - Abrasion response using the rotating-cutter drill press
  - SEM of hardened concrete



RESULTS AND DISCUSSION

- ✓ TEM and chemical analysis of nanosilica





- ✓ Slump, air content and density

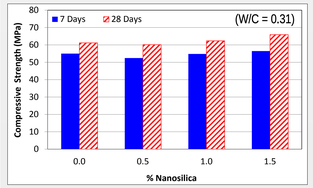
W/C = 0.31						
Mix	Nanosilica (%)	Slump (mm)	Air Content (%)	Density (Kg/m³)	AEA (l/m³)	HRWR (l/m³)
Mix 1 (CC[1])	0	95	4	2436	0.28	3.78
Mix 2 (NSC[2] 1)	0.5	95	5.5	2379	0.60	4.78
Mix 3 (NSC 2)	1	95	5.9	2379	0.72	5.17
Mix 4 (NSC 3)	1.5	90	5.4	2387	0.96	6.57

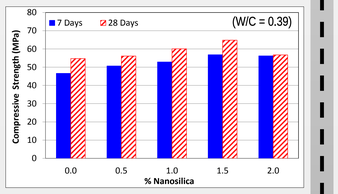
[1]CC: Control concrete, [2]NSC: Nano silica concrete

W/C = 0.39						
Mix	Nanosilica (%)	Slump (mm)	Air Content (%)	Density (Kg/m³)	AEA (l/m³)	HRWR (l/m³)
Mix 1 (CC[1])	0	82	7	2365	0.19	3.10
Mix 2 (NSC[2] 1)	0.5	90	5.9	2379	0.19	3.29
Mix 3 (NSC 2)	1	85	5.2	2379	0.21	3.68
Mix 4 (NSC 3)	1.5	75	5	2401	0.24	4.26
Mix 5 (NSC 4)	2	90	6.5	2365	0.29	4.26

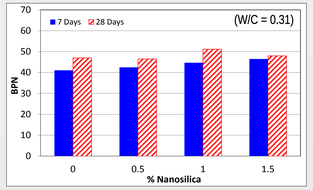
[1]CC: Control concrete, [2]NSC: Nano silica concrete

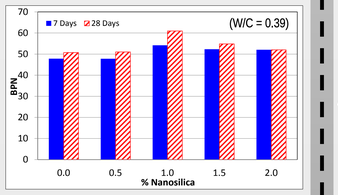
- ✓ Compressive strength



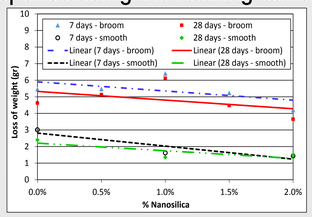


- ✓ Friction using the British Pendulum Number (BPN)



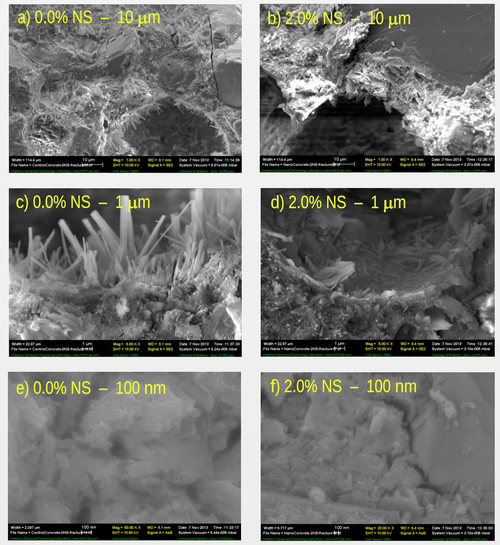


- ✓ Abrasion response using the rotating-cutter drill press (W/C = 0.39)



RESULTS AND DISCUSSION

- ✓ Scanning Electron Microscope (SEM) images of hardened concrete



CONCLUSIONS TO DATE

Adding a small amount of nanosilica to a concrete mix improves:

- ✓ The compressive strength, the friction response characterized by the British Pendulum Number, and the abrasion response.
- ✓ Nanosilica also acts as a supplementary cementing material in the mix, improving the concrete’s microstructure.
- ✓ Improvements in the paste density and in the aggregate-paste bond, and a reduction of ettringuite formation in voids are detected by SEM images.

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