TDA in Stormwater Infrastructure: Structural Performance, Benefits, and Sustainable Advantages

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Problem Overview

It is estimated that about **1.5 billion** tires are disposed of globally per year, with projections indicating this number will increase to **2 billion** by 2030.

Potential for fire

Huge landfill space

Breeding ground for mosquitoes and vermin

TDA Overview

✓ Finding ***sustainable ways*** to dispose of these tires continues to be a problem throughout the world, not only in North America.

✓ Accordingly, scrap tires are recycled and used in various forms.

Market or Disposition	USA[1]	Canada[2]
Tire Derived Fuels (TDFs)	~ 32%	~ 6%
Rubber Crumb	~ 32%	~ 39%
Tire Derived Aggregates (TDA)	**~ 6%**	**~ 14%**
Total used in other Markets	~ 30%	~ 41%

[1] US Scrap Tire Management Summary, (2022).
[2] Canadian Association of Tire Recycling Agencies (CATRA), Annual Report, (2022).

TDA facts

- ✓ TDA has excellent geotechnical properties, maintains its structural integrity and weighs **50% to 60%** less than conventional earth fill.

- ✓ The economic and environmental benefits of using TDA as a fill material are twofold:
  - *Large volumes of used tires are diverted from stockpiles and*
  - *Comparable volumes of non-renewable aggregates are spared from consumption.*

TDA facts (cont'd)

Weight	TDA weighs **one-third** of what soil does, reducing the stress on buried pipelines and culverts
Permeability	TDA drains **10 times** faster than soil
Insulation	TDA insulates **eight times** better than natural soils and can increase energy efficiency in basements
Cost	TDA costs less than conventional soil
Vibration Control	TDA provides a better vibration mitigation compared to conventional soil

TDA facts (cont'd)

ASTM Specification - ASTM 6270 - 20

TDA Type A

ASTM Gradation Specifications

% of Passing	*Sieve Size*
100%	100 mm
min of 95%	75 mm
max of 50%	38 mm
max of 5%	4.75 mm

Applications

- Drainage
- Insulation
- Vibration Dampening

TDA Type B

ASTM Gradation Specifications

% of Passing	*Sieve Size*
min of 75%	200 mm
max of 50%	75 mm
max of 25%	38 mm
max of 1%	4.75 mm

Applications

- Light backfill material for Embankments and Retaining walls

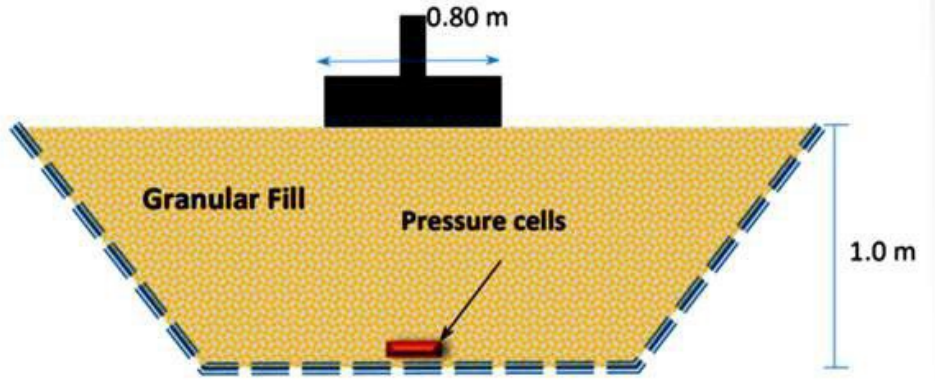
Using TDA as an Engineered Stress Reduction Fill

Sponsored by:

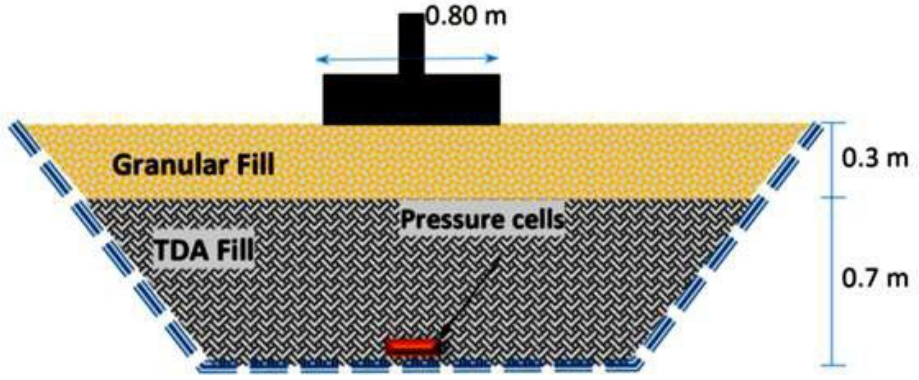
Objectives

- Field tests executed at Antrim, NS to examine the **behaviour of TDA materials as a lightweight backfilling material underneath shallow foundation** under static loading conditions.

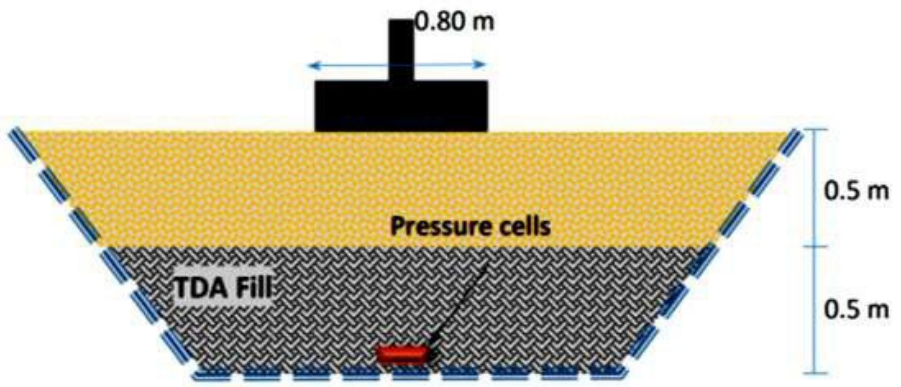
Testing Setups



a) Control Case – all granular fill

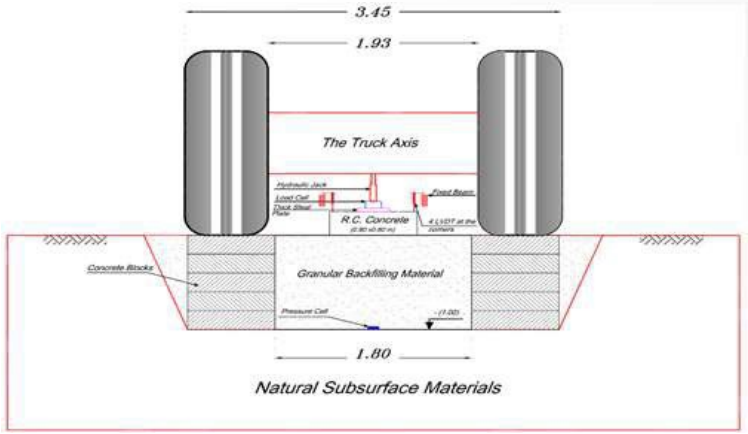


b) Mostly TDA fill – 70% TDA

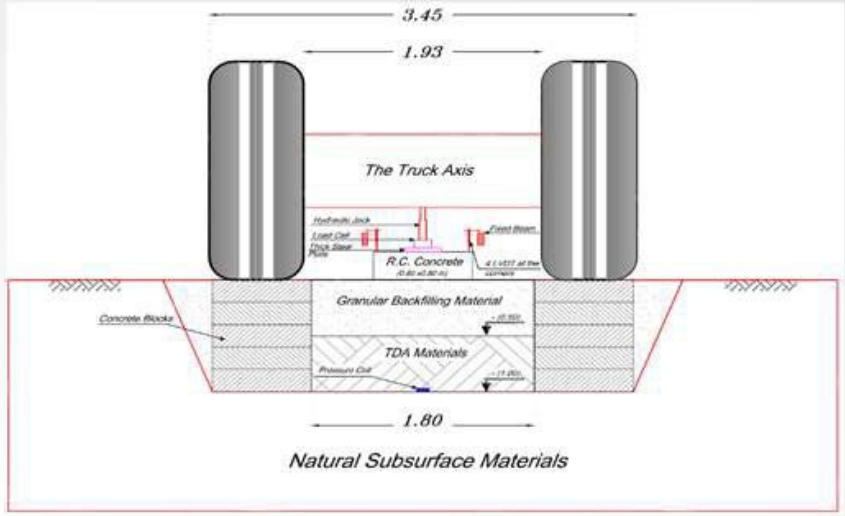


c) Half-Half TDA/granular fill – 50% TDA

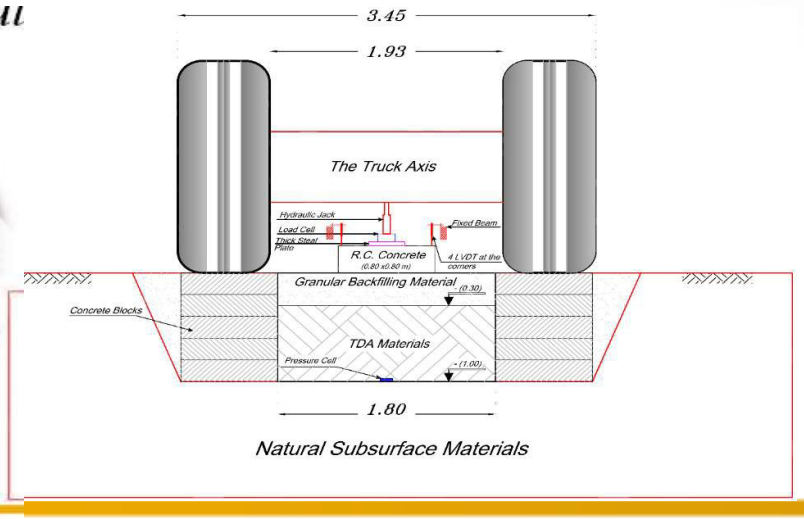
Testing Setups (Cont'd)



Setup1 (1.0m backfill with granular materials)



Setup 2 (0.5m granular materials+0.5m TDA)



Setup 3 (0.3m granular materials+0.7m TDA)

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Testing Setups (Cont'd)

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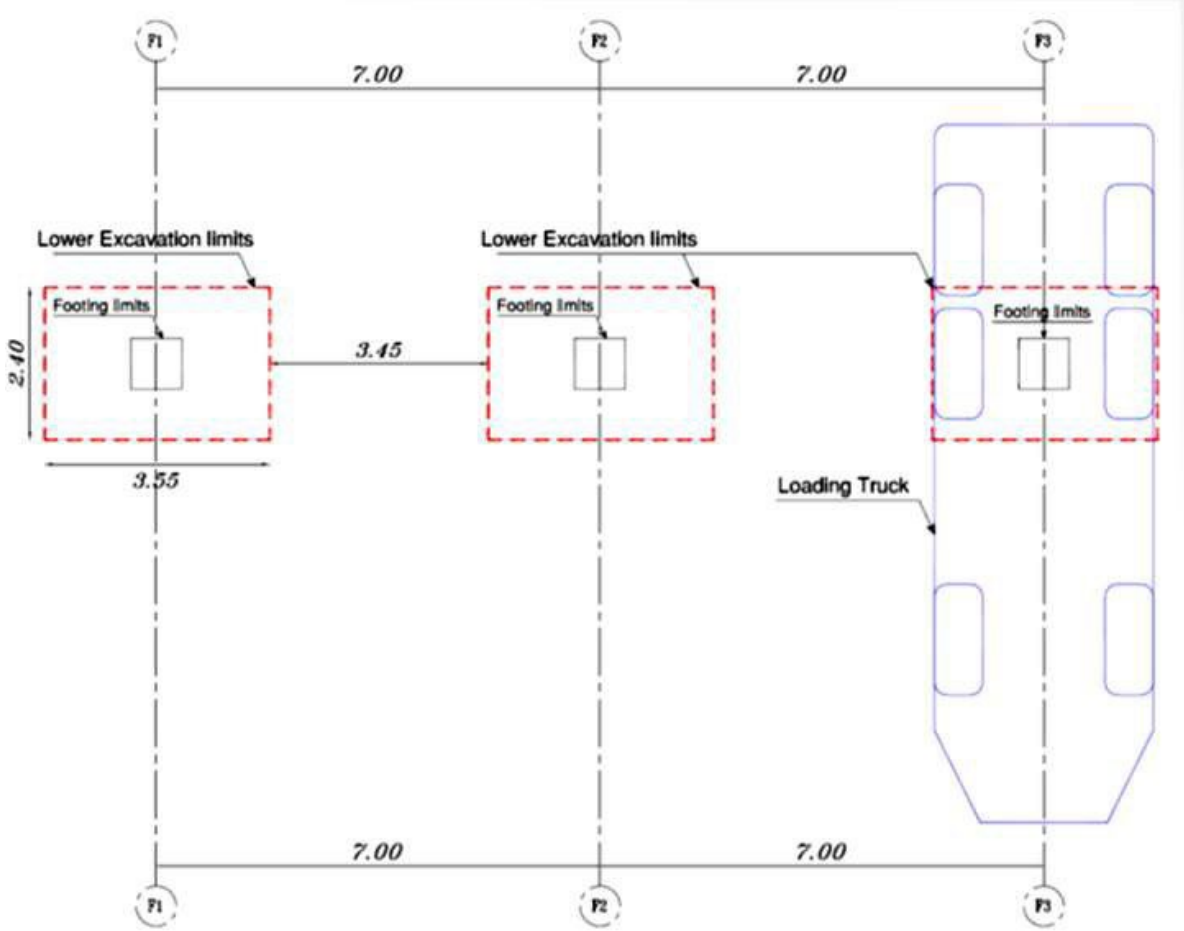

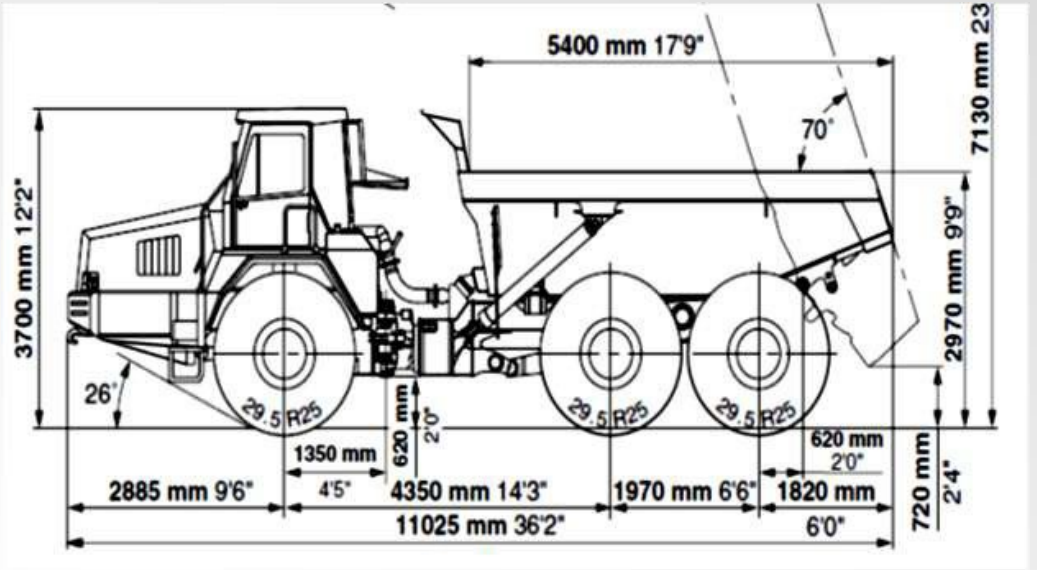

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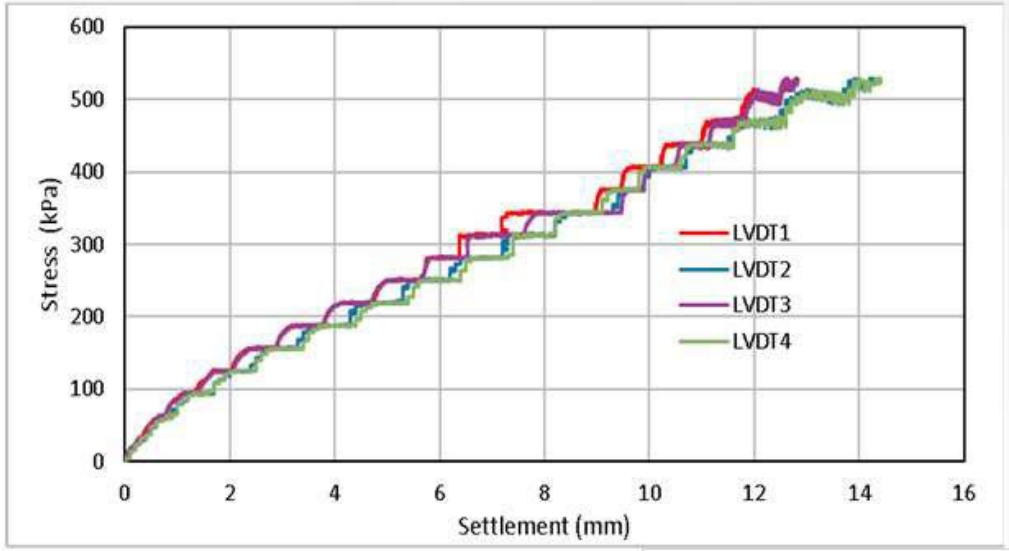
Results and Discussion



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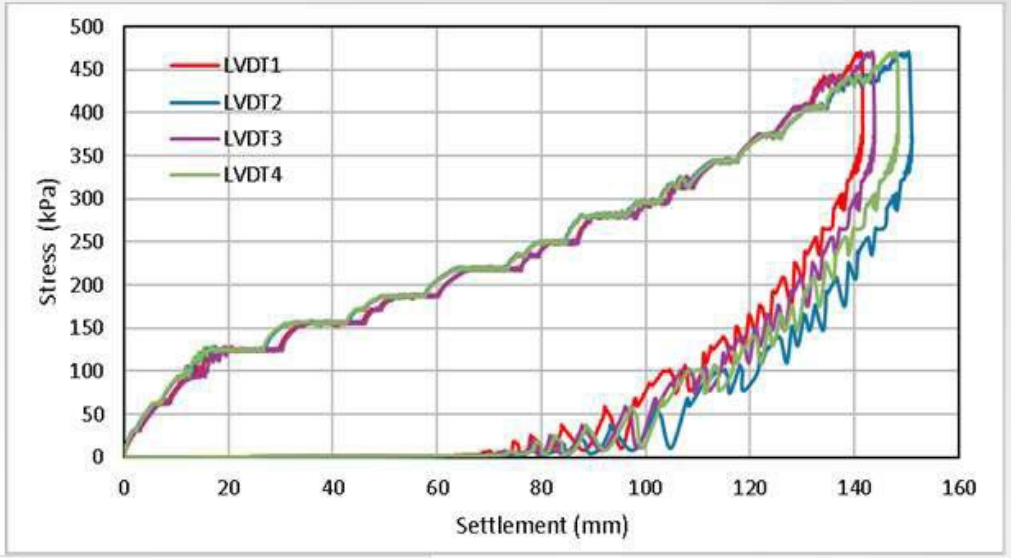

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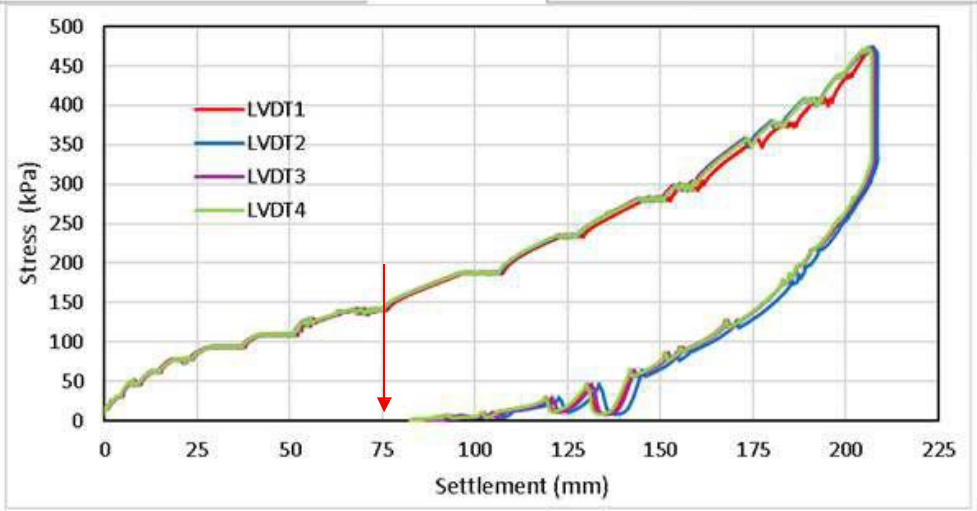
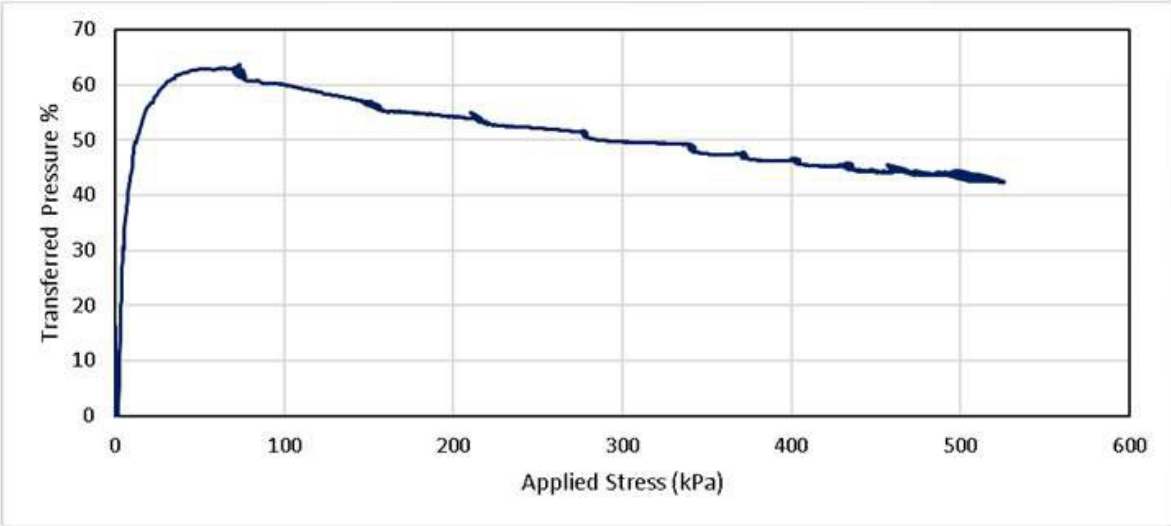


Setup 3

Results and Discussion



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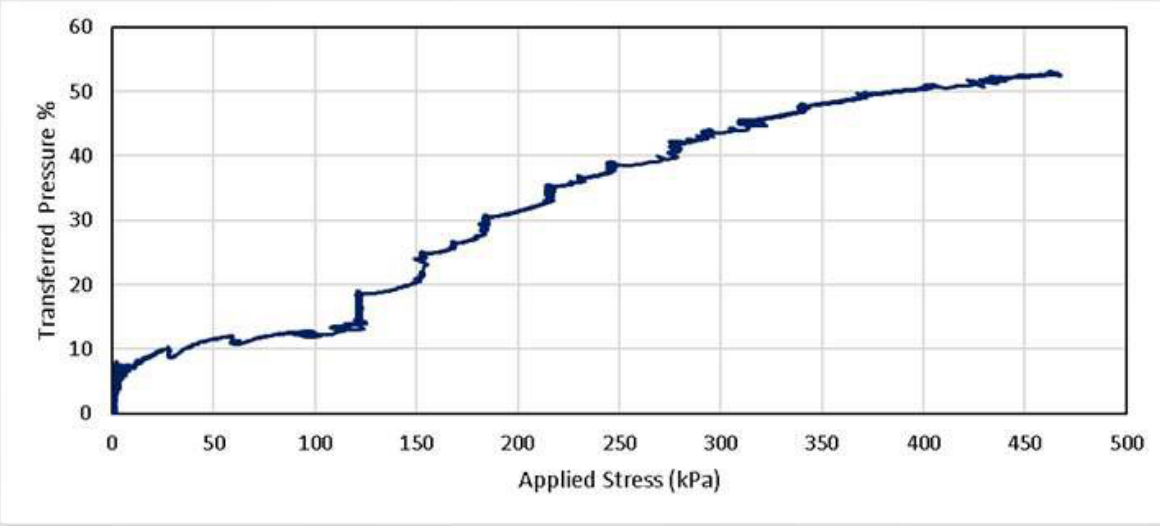

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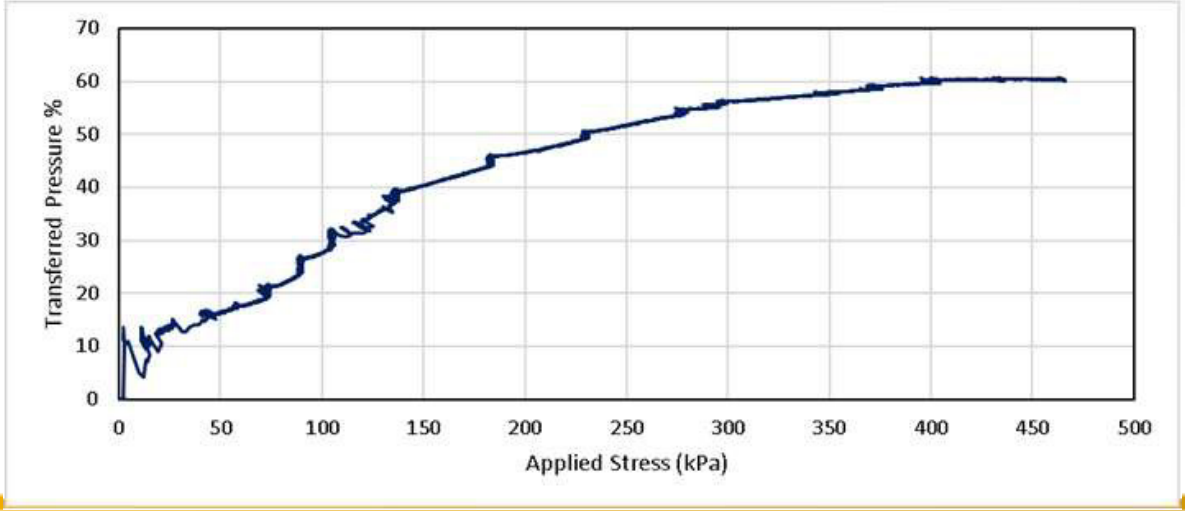

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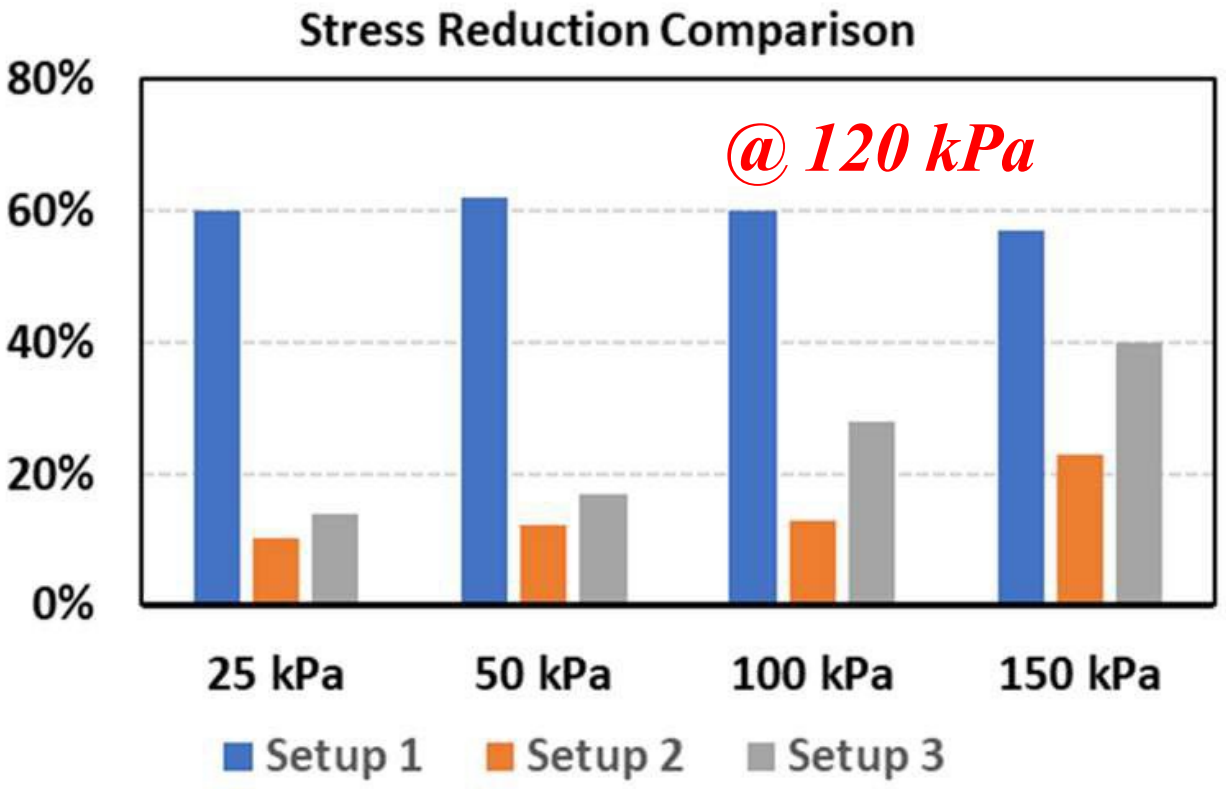


Total settlement at different stress levels

Stress Level	Conventional Backfill	50% TDA	70% TDA
25 kPa	0.50 mm	2.00 mm	2.00 mm
50 kPa	0.75 mm	4.00 mm	10.0 mm
100 kPa	1.50 mm	14.0 mm	37.0 mm
150 kPa	2.40 mm	32.0 mm	75.0 mm

*** differential settlement is negligible**

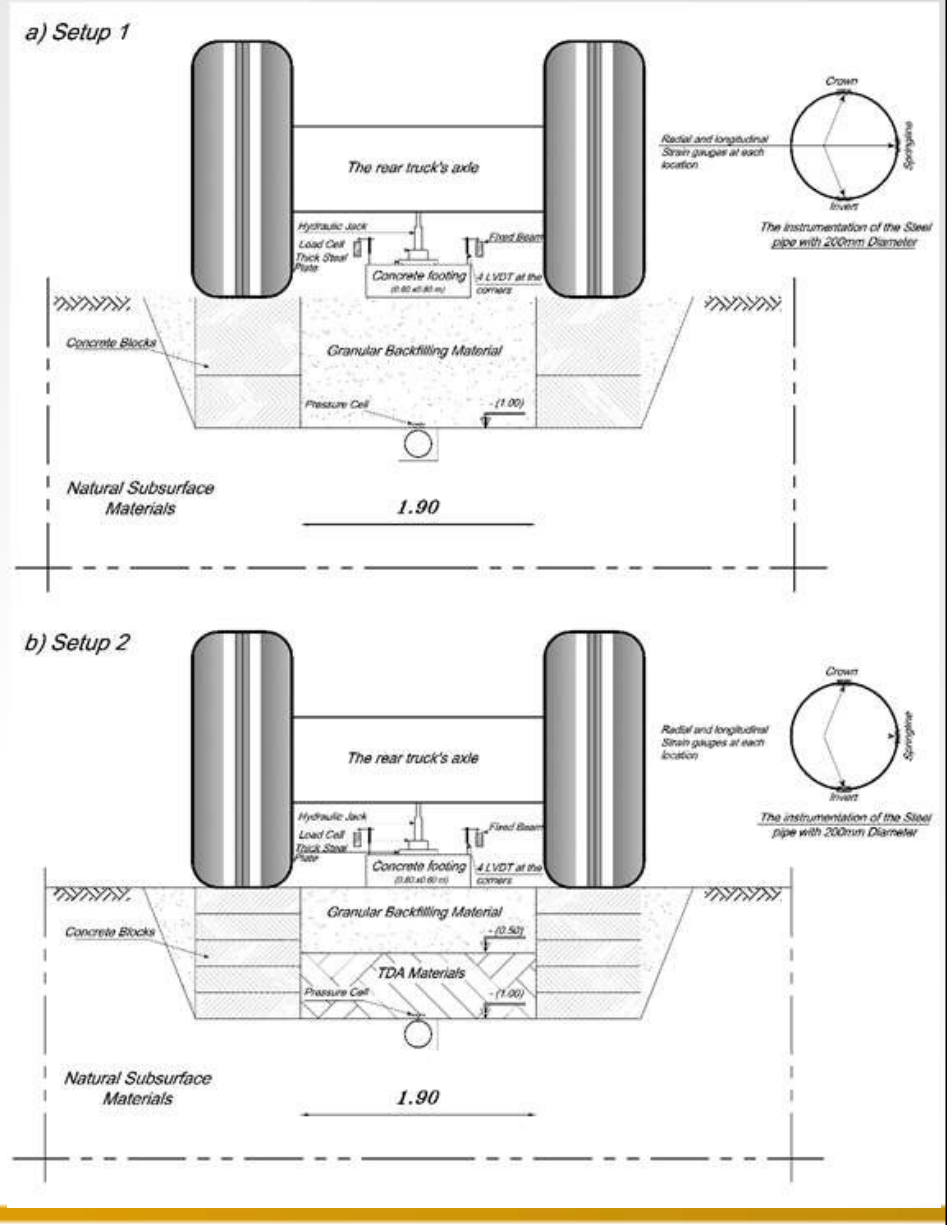
Using TDA over Pipes to Reduce their Internal Stresses

Sponsored by:

Objectives

- Field tests executed at Antrim, NS to examine the **behaviour of TDA materials as a lightweight backfilling over pre-existing pipes** under static loading conditions.

- All of the construction activities that were carried out at HCD's facility were managed by HCD. The instrumentation and the data collection and analysis part were undertaken at Dalhousie University and was managed by Dr. El Naggar.



Testing Setups (Cont'd)

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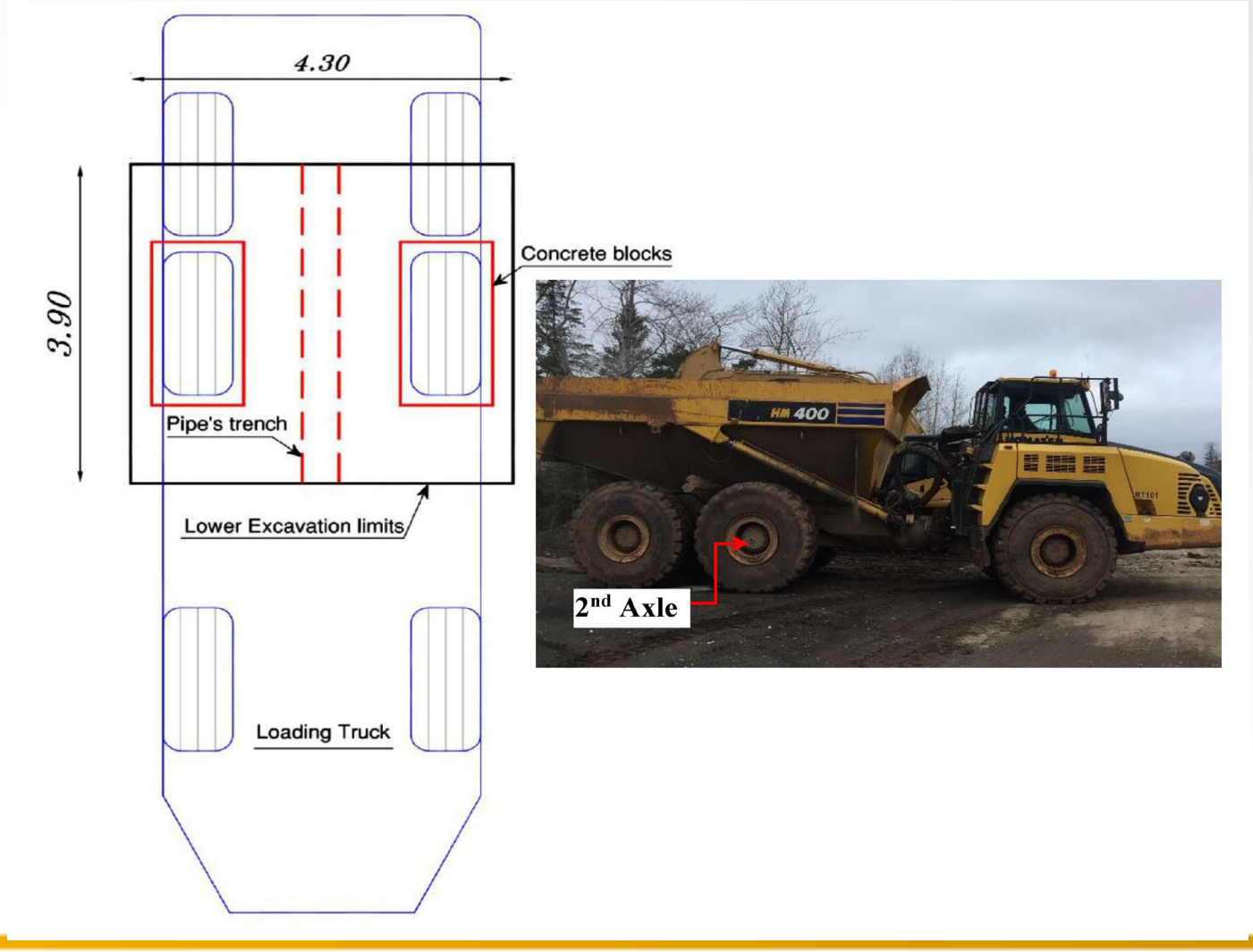
Testing Setups (Cont'd)



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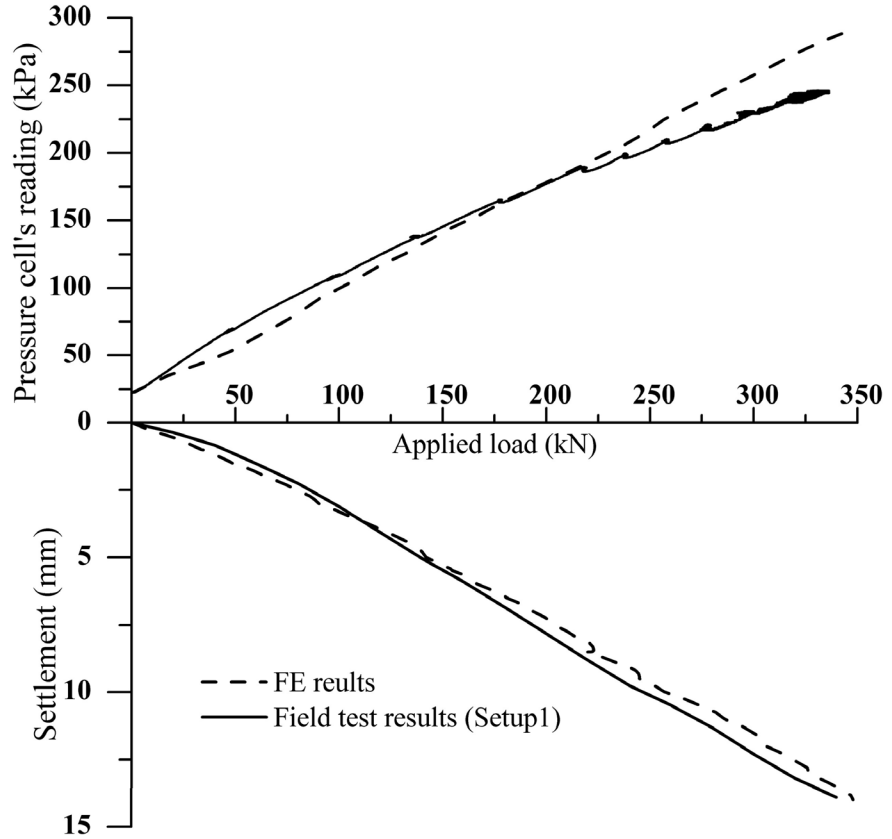

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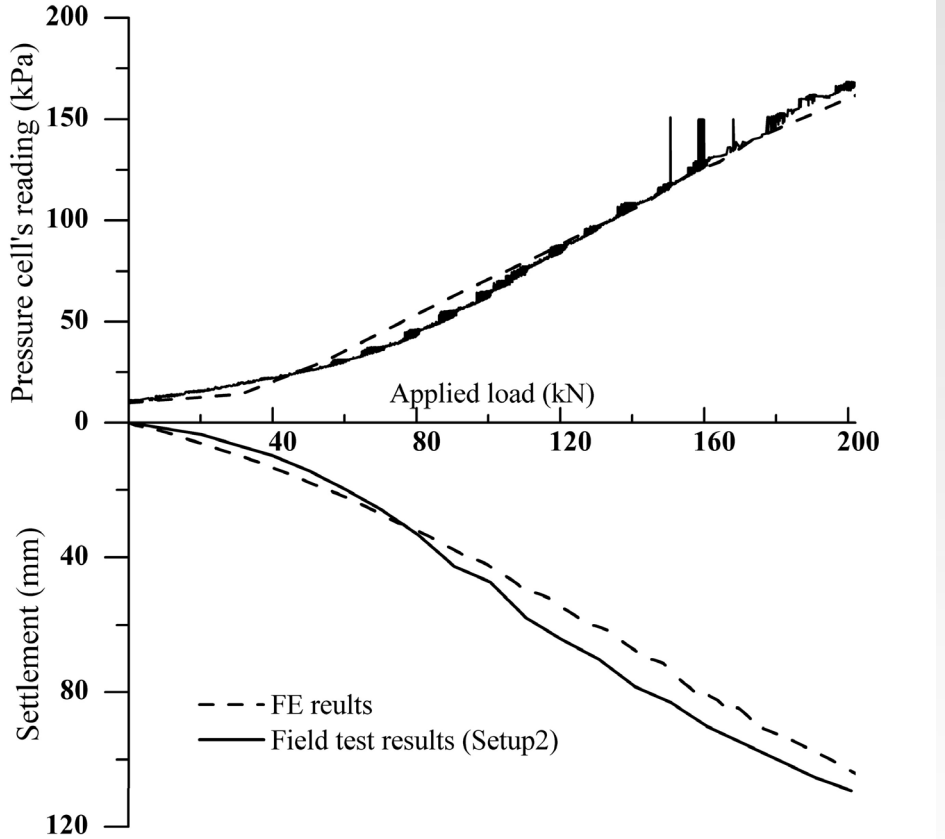
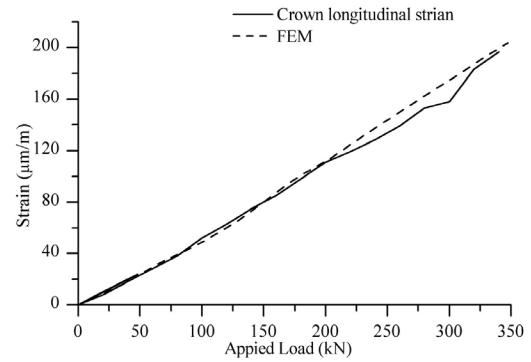
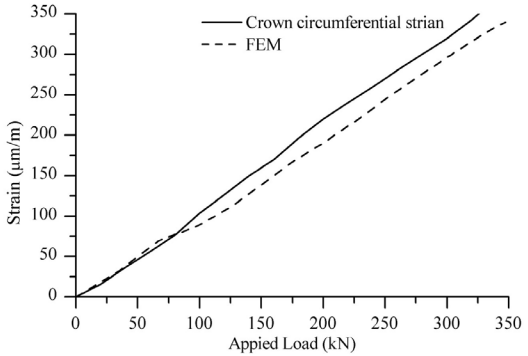
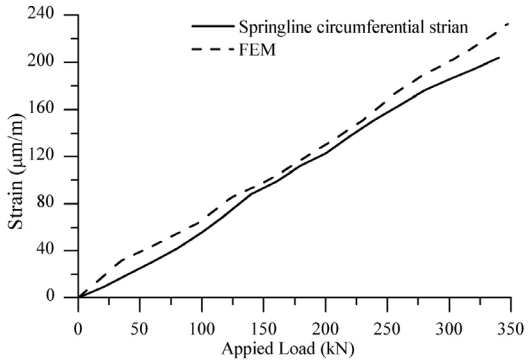


Setup 2

Results and Discussion







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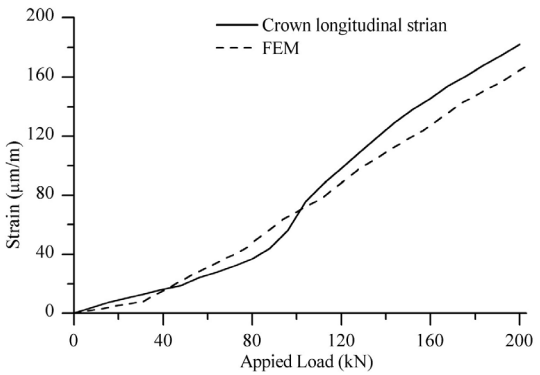

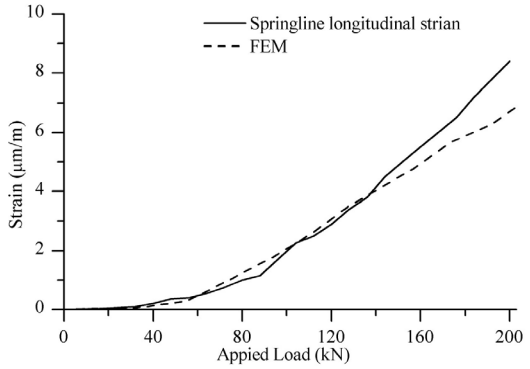

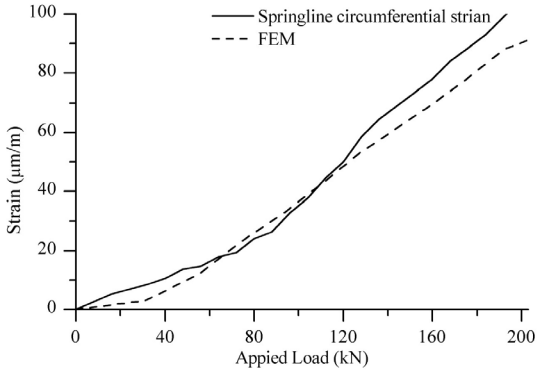

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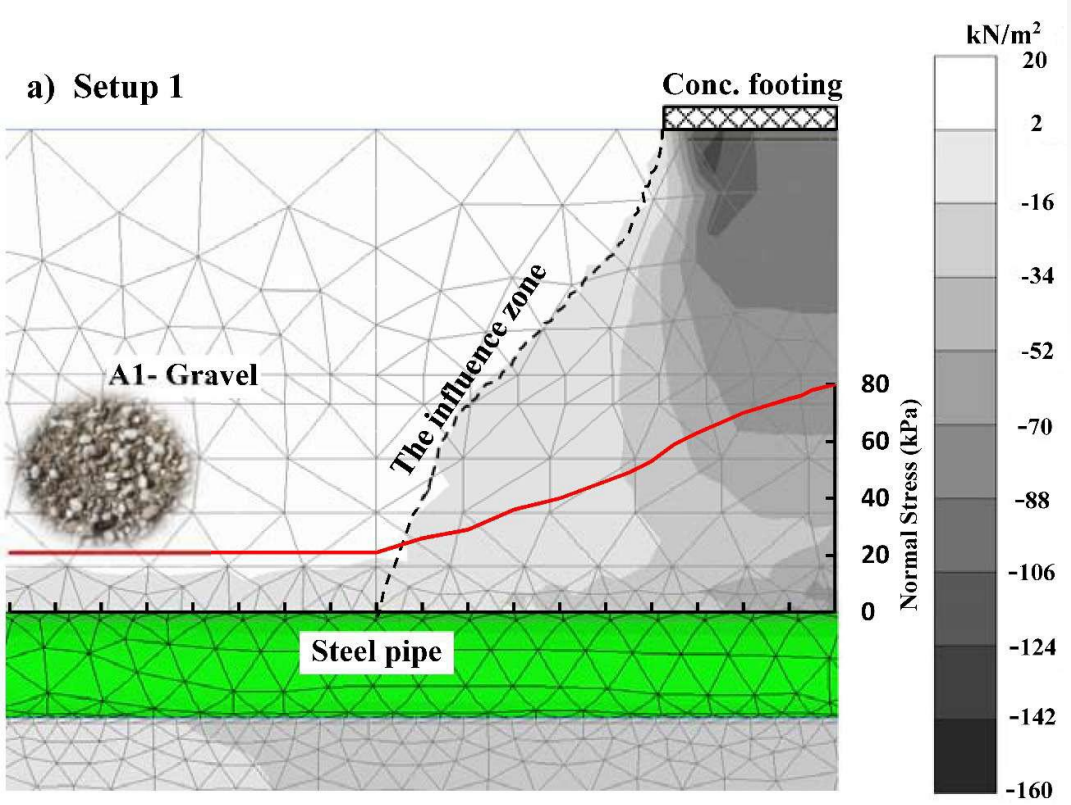

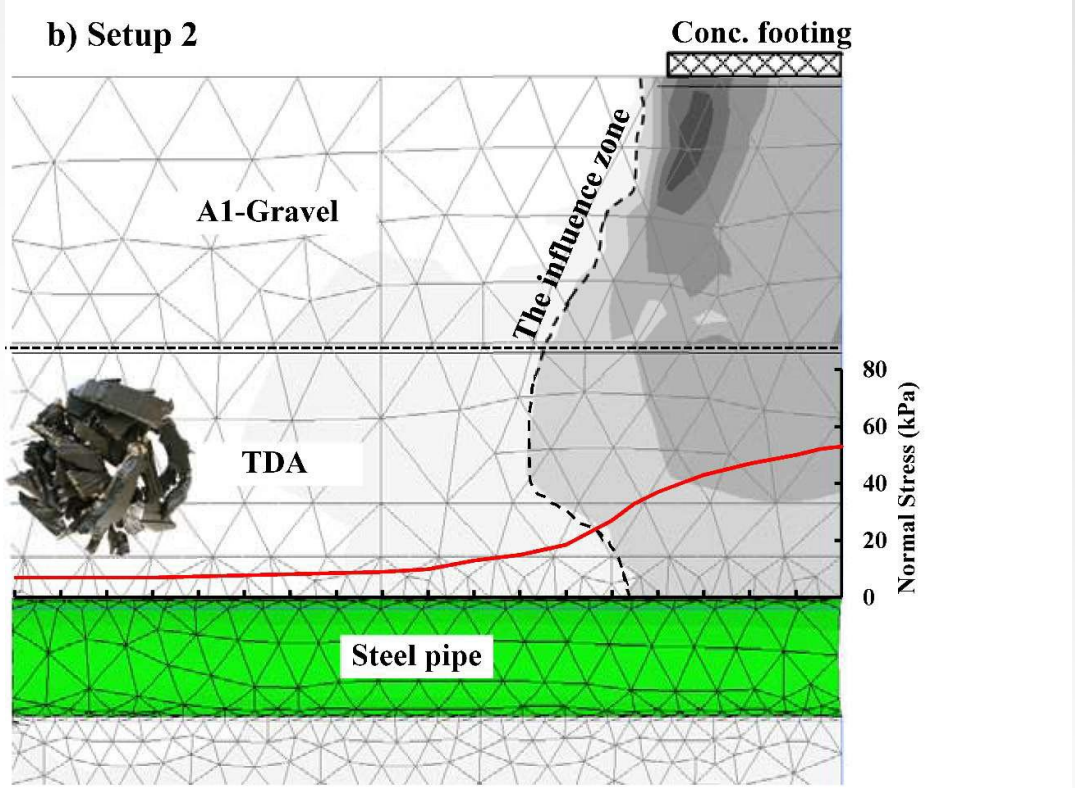

Summary & Conclusions

Full-scale field tests and 3D Finite Element models (FEM) were conducted to evaluate the benefits of using a layer of TDA above pipes to enhance the **stress arching mechanism** (i.e., ***stress bridging***).

The following conclusions can be drawn based on the results of the study:

- The field results showed that using a layer of TDA over the pipe is significantly effective in reducing the pipe's stresses and magnitude of transferred pressures compared to using conventional backfill.
- TDA acted as a stress cushion that absorbed the imposed stresses and minimized the exposed area of the pipe to the stresses.

TRANSFORMING END OF LIFE TIRES INTO A RESOURCE: THE ROLE OF

TIRE DERIVED AGGREGATES

IN CIVIL ENGINEERING

HANY EL NAGGAR
PROFESSOR, DALHOUSIE UNIVERSITY

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Thank you

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