Reuse of Waste Fishing Nets in Construction Materials

Ida Bertelsen
Lisbeth M. Ottosen
ARTEK, DTU Civil Engineering

Circular Ocean Conference, Ålesund, Norway
September 1st - 2nd, 2016
Presentation outline

- The project "Circular Ocean"
- Motivation
- Possible applications
- Methods
- Results
- Conclusion
Circular Ocean

ARTEK’s role in Circular Ocean:

- Focus on the construction industry
- Methodology for properties of fishing nets
- Development of new applications
- Laboratory-scale testing of new solutions
- Pilot-scale testing in the NPA region
Motivation

- Prevent marine plastic litter in the NPA region
- Reuse local waste materials from the fishing industry
- Find a proper application for waste nets in the construction industry
Introduction - Fishing nets

- Fishing industry in the NPA region
- Nets made of high density polyethylene (HDPE)
- Degradation due to abrasion, mechanical load, UV-radiation
- Waste fishing nets are stored at the dumpsite
Introduction - Fishing nets

HDPE nettings from Greenland before use and after disposal

New nets

Waste nets
Possible applications – Fibre reinforcement

Why fibre reinforcing building materials?

- **Primary fibres**: Flexural toughness, Post-crack performance
- **Secondary fibres**: Crack resistance, Shrinkage cracking, Durability

Plastic waste materials used as reinforcement of construction materials

- PET bottles, Textile carpet waste, Nylon fishing nets
Possible applications – Fibre reinforcement

Requirements for fibres as reinforcement

- Must be easily dispersed the mixture
- Must have suitable mechanical and bonding properties
- Must be durable in the environment of the material
Methods – Engineering properties of fibres

- Comparison of fibres from new and waste nets
- Mechanical properties (tensile test)
- Durability properties (immersion in 1M NaOH for 28 days)
- Physical properties (SEM)
- Casting of material samples
Methods – Tensile testing

Tensile testing of single fibres on displacement-controlled Instron:

- Unconditioned/alkali-cured - new/waste fibres of HDPE
Results – Physical properties

- Fiber diameter: $d=270-330 \, \mu m$
- Very smooth fibre surface
## Results - Mechanical properties

<table>
<thead>
<tr>
<th></th>
<th>Tensile stress</th>
<th>Tensile strain</th>
<th>Young's modulus</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$\sigma$ [Mpa]</td>
<td>$\varepsilon$ [%]</td>
<td>$E$ [Mpa]</td>
<td>SD</td>
</tr>
<tr>
<td><strong>Unconditioned fibres</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>New fibres</td>
<td>416</td>
<td>38.2</td>
<td>4.9</td>
<td>1454</td>
</tr>
<tr>
<td>Waste fibres</td>
<td>356</td>
<td>56.3</td>
<td>6.6</td>
<td>1199</td>
</tr>
<tr>
<td><strong>NaOH-conditioned fibres</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>New fibres</td>
<td>413</td>
<td>35.4</td>
<td>4.1</td>
<td>1351</td>
</tr>
<tr>
<td>Waste fibres</td>
<td>355</td>
<td>66.7</td>
<td>6.7</td>
<td>1127</td>
</tr>
</tbody>
</table>

![Graph of new PE fibres - L = 30 mm - NaOH-conditioned](image1.png)

![Graph of waste PE fibres - L = 30 mm - NaOH-conditioned](image2.png)
Results - Durability properties

- Immersion of fibres in alkaline solution (1M NaOH) for 7 and 28 days.

New fibres

(a) New fibre - unconditioned
(b) New fibre - 7 days NaOH
(c) New fibre - 28 days NaOH

Waste fibres

(a) Waste fibres - unconditioned
(b) Waste fibres - 7 days NaOH
(c) Waste fibres - 28 days NaOH
Comparison with other fibres

- Suitable tensile strength
- Low stiffness
- Durable in an alkaline environment
- Smooth surface – poor bonding properties?

Next step:
- Mix fibres into material mixture such as mortar, gypsum or clay
- Test bonding properties in different materials
- Evaluate composite materials
Methods – Casting of material samples

Fibre reinforcement of mortar, gypsum or clay samples
Results – Material samples

Test setup for 3-points bending

Force – deflection diagram

\[ \text{Load, } F_f \]

\[ b = 40 \text{ mm} \]

\[ l = 100 \text{ mm} \]

\[ L = 160 \text{ mm} \]
Possible applications

- Bigger parts of nets as reinforcement
- Geotextile under road – paved or unpaved
- Fibres in fired materials (bricks and tiles)
- Fire safety in concrete tunnels
Acknowledgement

This study was funded through the Northern Periphery and Arctic Programme, the European Union and the Technical University of Denmark.