

Use of recycled materials in construction products



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The Hong Kong Polytechnic University

Objectives

⌘ To introduce the use of recycled aggregates in different civil engineering applications

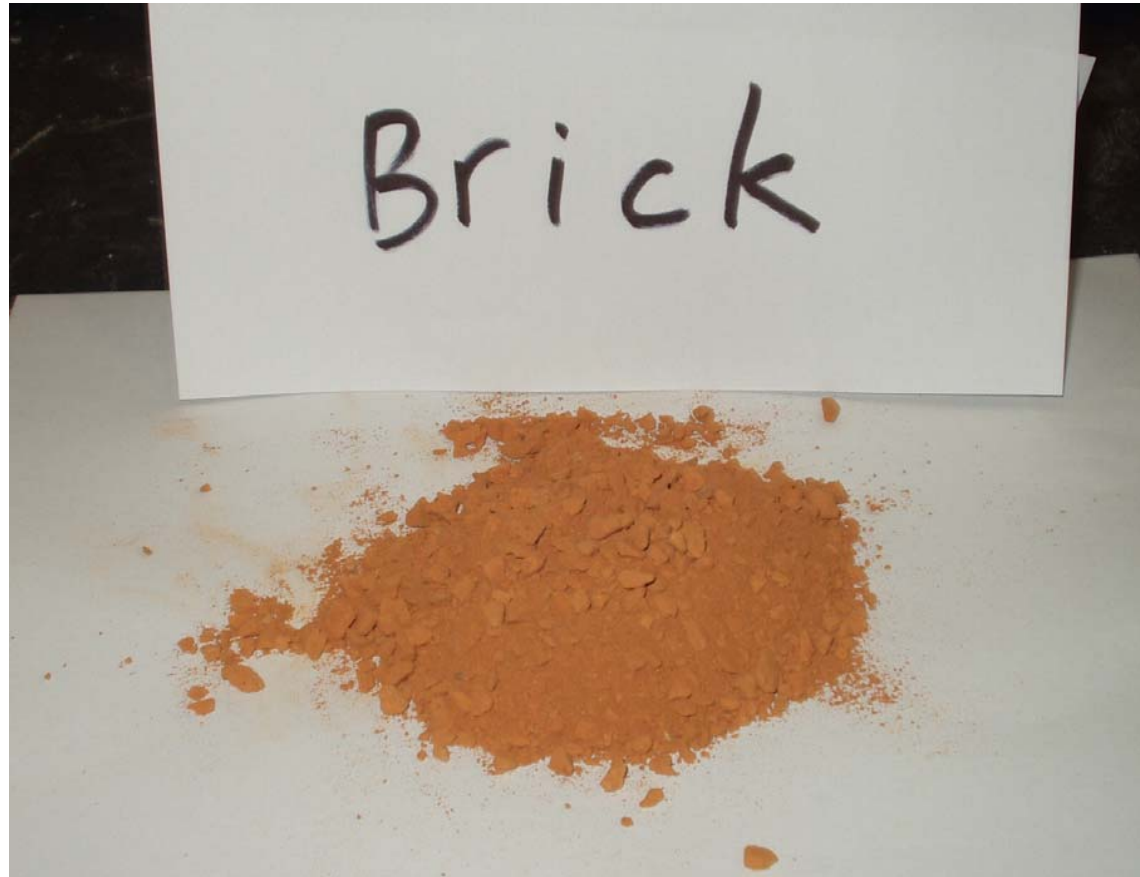


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Recycled Concrete Aggregate (RCA)



Crushed Clay Brick



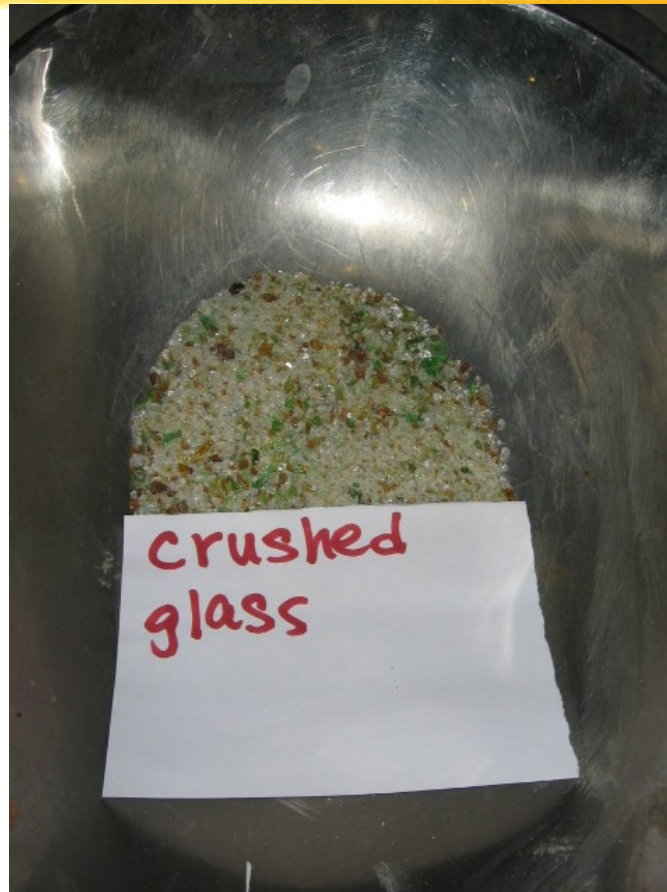
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Crushed Ceramic Tile



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Crushed Glass



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Potential applications of recycled aggregates and glass aggregates

- ⌘ Pre-cast concrete products such as kerbs
- ⌘ Paving blocks
- ⌘ Partition blocks
- ⌘ Terrazzo tiles



Pre-cast concrete products



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Strengths requirements for pre-cast concrete products

In accordance with GS of Hong Kong 1992

| Items | Grade |
|--|--------------|
| Profile barriers | Grade 30/20 |
| Kerbs, edgings and quadrants | Grade 30/20 |
| Foundations and backings to kerbs, edgings and quadrants | Grade 20/20 |



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Production of pre-cast concrete kerbs

Ingredients: cement, natural crushed fines, coarse recycled concrete aggregate (10 & 20 mm) and water.



| | |
|-----------------------------------|------|
| Density (kg/m ³) | 2349 |
| 7-day compressive strength (MPa) | 35.4 |
| 28-day compressive strength (MPa) | 41.9 |
| 3-pt test Breaking load (kN) | 14.4 |



Paving blocks



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Current HK specifications for pedestrian areas

Measured in accordance with BS6717

| | Grade A | Grade B |
|----------------------------|---------|---------|
| Compressive strength (MPa) | >30 | >30 |
| Water absorption (%) | <6 | - |
| Skid resistance (BPN) | <45 | - |
| Abrasion resistance (mm) | <23 | - |



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Current HK specifications for trafficked areas

Measured in accordance with BS6717

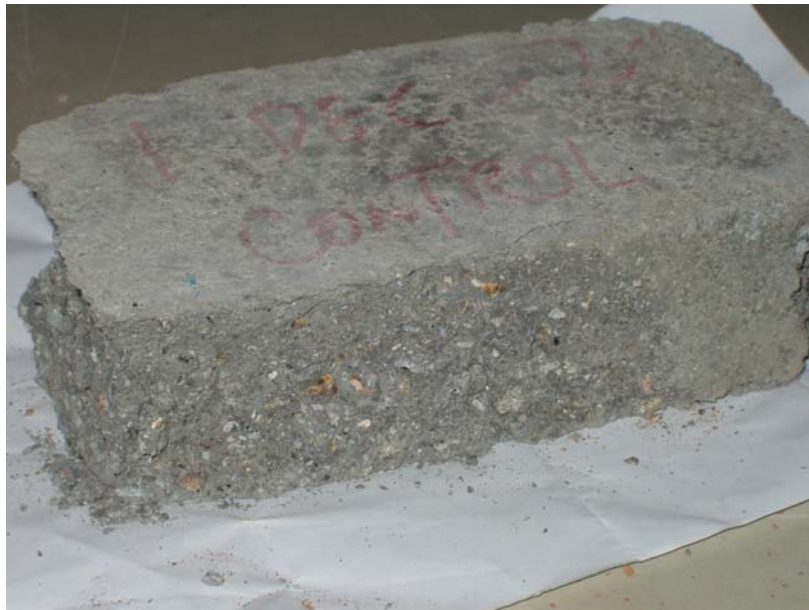
| | Grade A | Grade B |
|----------------------------|---------|---------|
| Compressive strength (MPa) | >45 | >45 |
| Water absorption (%) | <6 | - |
| Skid resistance (BPN) | <45 | - |
| Abrasion resistance (mm) | <23 | - |



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Paving blocks

⌘ Ingredients: cement, fly ash, recycled concrete aggregate and water



| | |
|------------------------------|------|
| Density (kg/m ³) | 2278 |
| Compressive strength (MPa) | 74.3 |
| Skid resistance (BPN) | 106 |
| Abrasion (mm) | 17.0 |
| Cold water absorption (%) | 4.5 |



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Paving blocks

⌘ Ingredients: cement, recycled concrete aggregates (with contaminants and water)



| | |
|------------------------------|------|
| Density (kg/m ³) | 2218 |
| Compressive strength (MPa) | 66.2 |
| Skid resistance (BPN) | 95 |
| Abrasion (mm) | 19.0 |
| Cold water absorption (%) | 7.2 |



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Paving blocks

⌘ Ingredients: cement, fly ash, recycled concrete aggregate, crushed clay brick and water



| | |
|------------------------------|------|
| Density (kg/m ³) | 2116 |
| Compressive strength (MPa) | 44.7 |
| Skid resistance (BPN) | 95 |
| Abrasion (mm) | 17.5 |
| Cold water absorption (%) | 10.6 |



Paving blocks

⌘ Ingredients: cement, natural fine aggregate, waste glass and water



| | |
|------------------------------|------|
| Density (kg/m ³) | 2290 |
| Compressive strength (MPa) | 69.9 |
| Skid resistance (BPN) | 105 |
| Abrasion (mm) | 20.5 |
| Cold water absorption (%) | 4.11 |



The Design

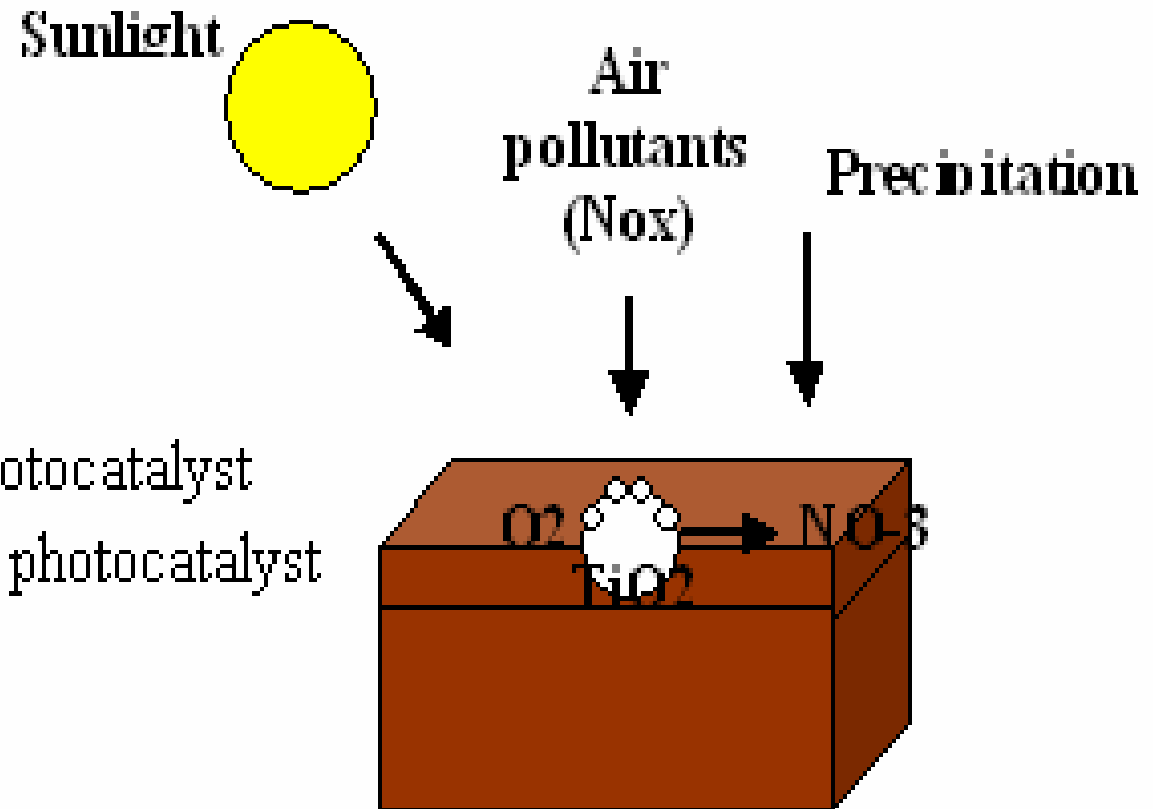
Surface layer

Cement + RA + FBA + photocatalyst

Cement + recycled glass + photocatalyst

Base layer

Cement + RA



Fabrication of Surface Layers



Mixing

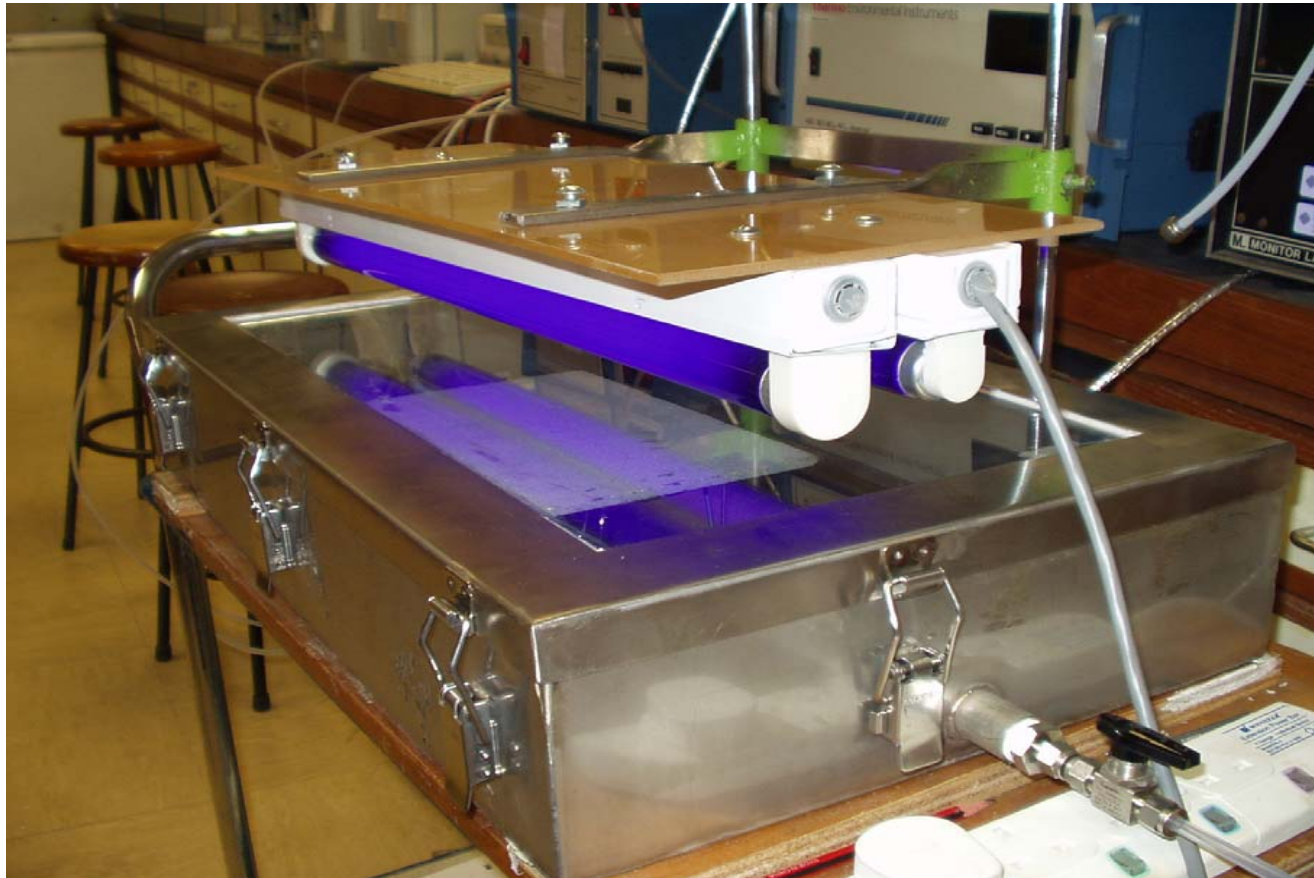


Casting



Compaction

Apparatus



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Production of Paving Blocks



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Field Testing



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**PolyU designed
photo-catalytical
block**



**Commercially
available photo-
catalytic block**

Commercial manufacture



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Trial locations (glass blocks)

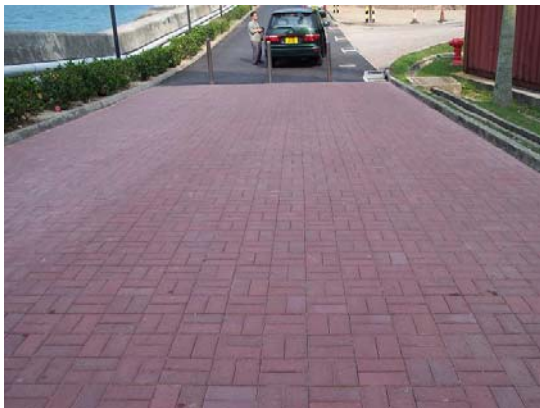
⌘ PolyU

⌘ HKUST

⌘ Tai Koo Shing 太古城

⌘ Tin King 田景邨

⌘ Leung King 良景邨



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Partition blocks



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Specifications for partition blocks

Measured in accordance with BS 6073

| | |
|----------------------------|--------|
| Compressive strength (MPa) | >7.0 |
| Drying shrinkage (%) | <0.06% |



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Properties of partition blocks

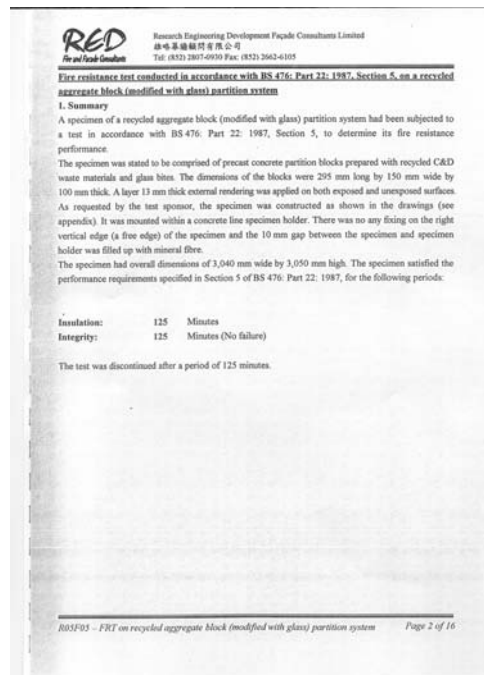
| | Recycled concrete aggregate (A/C = 12) | Glass aggregate (A/C = 10) |
|------------------------------|--|----------------------------|
| Density (kg/m ³) | 2207 | 2094 |
| Strength (MPa) | 8.5 | 13.7 |
| Drying shrinkage (%) | <0.05 | <0.03 |
| Fire rating (FRR) | >2 | >2 |



Trial location

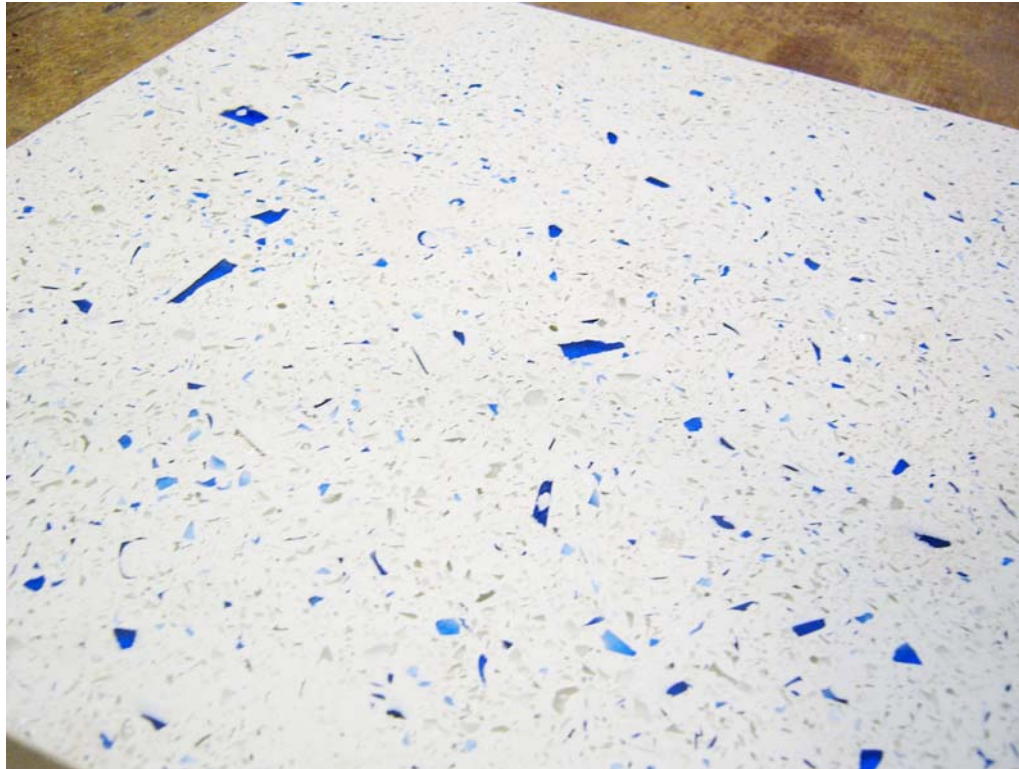
⌘ Sze Wan Shan Shopping Malls 慈雲山商場

⌘ 125 minutes fire test, no failure



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Terrazzo tiles



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Specifications for terrazzo tiles

Measured in accordance with BS EN 13748

| | Mean | Individual |
|--------------------------|------|--------------------------|
| Breaking strength (MPa) | >5.0 | >4.0 |
| Water absorption (%) | - | <8 |
| Skid resistance (BPN) | - | Declared by manufacturer |
| Abrasion resistance (mm) | - | <25 |



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Terrazzo tiles



| | |
|------------------------------|-----------|
| Density (kg/m ³) | 2500-2600 |
| Breaking strength (MPa) | >9.0 |
| Abrasion (mm) | 21-23 |
| Cold water absorption (%) | <6.0 |





The End !



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