Transformation to Fibre Cement from Asbestos cement

Elkem fibre cement laboratory: Lin Zhen
Email: lin.zhen@elkem.no
Asbestos

- Asbestos is a group of nature fibres with excellent mechanical properties.
- For decades it has been known that asbestos constituted a major health hazard, and it was given up by the producers.

<table>
<thead>
<tr>
<th>Asbestos group</th>
<th>CAS No:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Chrysotile</td>
<td>12001-29-5</td>
</tr>
</tbody>
</table>

![Asbestos fiber image](image-url)
Traditional asbestos cement

- Asbestos (10 – 15%)
- Portland cement (85 – 90%)
- Fillers (fly ash, slag…)
- Water

Products

- Corrugated sheets (roofing)
- Flat sheets (side boards etc)
Transformations to Non-asbestos ……

There is no single fibre known that directly can substitute asbestos; new composites have been developed with practically same properties.

Tested materials…

<table>
<thead>
<tr>
<th>fibres</th>
<th>powder</th>
</tr>
</thead>
<tbody>
<tr>
<td>PVA fibre</td>
<td>cement</td>
</tr>
<tr>
<td>cellulose</td>
<td>limestone</td>
</tr>
<tr>
<td>PP fibre</td>
<td>fly ash</td>
</tr>
<tr>
<td>Glass fibre</td>
<td>slag</td>
</tr>
<tr>
<td>Steel fibre</td>
<td>sepiolite</td>
</tr>
<tr>
<td>Carbon fibre</td>
<td>Kaolin</td>
</tr>
<tr>
<td>Coconut fibre</td>
<td>Mica</td>
</tr>
<tr>
<td>……</td>
<td>Wollastonite</td>
</tr>
</tbody>
</table>

Today’s technology…

Air-cured product
- PVA fibre, 4-6mm
- cellulose
- Cement
- Microsilica
- Fillers (fly ash, slag, Mica…)

Autoclaved product
- cellulose
- Cement/lime
- Quartz sand
- Fillers (Microsilica, wollastonite…)

There is no single fibre known that directly can substitute asbestos; new composites have been developed with practically same properties.
Raw materials of fibre cement product

- **Main powder**: Cement, lime, quartz sand
- **Fibres**: cellulose, PVA fibre, PP fibre, Glass fibre and etc.
- **Additives**: Microsilica, Wollastonite, limestone, Mica and etc.
Main powder

Cement

Lime

Quartz
Fibres: Cellulose and PVA fibre

PVA - fibres

Cellulose fibres
Siliceous materials: quartz sand.
Additives: eg. Microsilica®

- Ultrafine, amorphous silica powder
- Spherical particle shape
- Primary particle size: 50-700 nm; av. 150 nm
- Off-white to dark grey colour

*XRD pattern*  
*Typical PSD chart*  
*TEM picture*
Classification of non-asbestos fibre cement product.

- Based on the curing technology
  A. Air-cured fibre cement product
  B. Autoclaved fibre cement product
- Based on the process
  A. Hatschek process
  B. Flow-on process
  C. Extruding process
  D. Spray process (mainly for GRC product)
- Fibre cement product shape
  Corrugated sheet
  flat sheet
  pipe
  others
Hatschek process
Fibre cement production
Cellulose treatment
Application of non-asbestos fibre cement-roofing and pipe
Internal application of fibre cement flat sheet-siding and ceiling
External application of fibre cement flat sheet-curtain wall
Outdoor furniture
Architectural decoration by Glass reinforced cement product

Especially suitable for architectural decorative components and landscape decorative art works.
Weatherability of flat sheets (Japan)

Reference (2% cellulose)

15% asbestos
2% PVA
2% PAN

Source: Kuraray Co. Ltd
PVA-reinforced FC sheets have survived 20 years of exposure without the loss of strength

Source: Kuraray Co., Ltd
Converting from asbestos to non-asbestos – Recipe cost

- It is difficult to give a general figures, since raw materials costs and product specifications differ significantly between regions
  - Raw materials price can vary.
  - Building codes (strength requirements) are different
  - Environmental requirements vary
    - Frost resistance is a major concern in Europe, but hardly in Thailand
- The following is a calculation for a recipe in an industrialised country with high durability requirements
## Cost of mix fibre cement boards – European cost level

**AC->FC, increased ~46%**

<table>
<thead>
<tr>
<th>Raw material</th>
<th>Component kg/MT mix</th>
<th>Unit price, €/kg</th>
<th>Cost in mix €/MT</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cement</td>
<td>900</td>
<td>0.100</td>
<td>90</td>
<td>43.9</td>
</tr>
<tr>
<td>PVA fibres</td>
<td>20</td>
<td>4.0</td>
<td>80</td>
<td>39.0</td>
</tr>
<tr>
<td>Silica fume</td>
<td>50</td>
<td>0.40</td>
<td>20</td>
<td>9.8</td>
</tr>
<tr>
<td>Cellulose</td>
<td>30</td>
<td>0.50</td>
<td>15</td>
<td>7.3</td>
</tr>
<tr>
<td><strong>SUM</strong></td>
<td>1000</td>
<td></td>
<td><strong>205</strong></td>
<td>100 %</td>
</tr>
</tbody>
</table>

**Non-asbestos formulation**

**Asbestos formulation**

<table>
<thead>
<tr>
<th>Raw material</th>
<th>Component kg/MT mix</th>
<th>Unit price, €/kg</th>
<th>Cost in mix €/MT</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cement</td>
<td>900</td>
<td>0.100</td>
<td>90</td>
<td>64.3</td>
</tr>
<tr>
<td>Asbestos, # 4</td>
<td>100</td>
<td>0.50</td>
<td>50</td>
<td>35.7</td>
</tr>
<tr>
<td><strong>SUM</strong></td>
<td>1000</td>
<td></td>
<td><strong>140</strong></td>
<td>100 %</td>
</tr>
</tbody>
</table>
### Cost of mix fibre cement boards – Chinese cost level

**Non-asbestos formulation**

<table>
<thead>
<tr>
<th>Raw material</th>
<th>Component kg/MT mix</th>
<th>Unit price, €/MT</th>
<th>Cost in mix €/MT</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cement</td>
<td>797</td>
<td>40</td>
<td>32</td>
<td>31%</td>
</tr>
<tr>
<td>Cellulose</td>
<td>35</td>
<td>577</td>
<td>20</td>
<td>19%</td>
</tr>
<tr>
<td>Limestone</td>
<td>100</td>
<td>12</td>
<td>1</td>
<td>1%</td>
</tr>
<tr>
<td>HM PVA</td>
<td>18</td>
<td>2076</td>
<td>37</td>
<td>36%</td>
</tr>
<tr>
<td>Microsilica</td>
<td>50</td>
<td>271</td>
<td>14</td>
<td>13%</td>
</tr>
<tr>
<td>Sum</td>
<td>1000</td>
<td></td>
<td>104</td>
<td></td>
</tr>
</tbody>
</table>

**Asbestos formulation**

<table>
<thead>
<tr>
<th>Raw material</th>
<th>Component kg/MT mix</th>
<th>Unit price €/MT</th>
<th>Cost in mix €/MT</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cement</td>
<td>828</td>
<td>40</td>
<td>33</td>
<td>37%</td>
</tr>
<tr>
<td>Asbestos</td>
<td>100</td>
<td>346</td>
<td>35</td>
<td>39%</td>
</tr>
<tr>
<td>Waster paper</td>
<td>12</td>
<td>115</td>
<td>1</td>
<td>2%</td>
</tr>
<tr>
<td>Glass fibre</td>
<td>10</td>
<td>288</td>
<td>3</td>
<td>3%</td>
</tr>
<tr>
<td>Sepiolite</td>
<td>50</td>
<td>346</td>
<td>17</td>
<td>19%</td>
</tr>
<tr>
<td>Sum</td>
<td>1000</td>
<td></td>
<td>90</td>
<td></td>
</tr>
</tbody>
</table>

**AC->FC, increased ~16.5%**
Converting from asbestos to non-asbestos - Investment

- Again, there are large regional variations
  - In China, India, SEA tradition with small machines, many workers
  - In Europe, larger machines, more automated
- Conversion means some significant changes in equipment
  - New equipment for cellulose pulping and mixing
  - Dosage systems for silica fume and possibly fillers
  - New mixers and pumps due to larger water circulation
  - Autoclave and energy cost if you choose Autoclaved product.
- Construction time for a large new production line: 1~2 year
- No major change in manpower required
# Investment cost for FC production lines

<table>
<thead>
<tr>
<th>Location</th>
<th>Description</th>
<th>Capacity</th>
<th>Investment</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Europe</td>
<td>New Hatschek</td>
<td>60,000 tpy</td>
<td>~ 10 mill. €</td>
<td></td>
</tr>
<tr>
<td>China</td>
<td>New Hatschek</td>
<td>60,000 tpy (theoretical)</td>
<td>&lt;1 mill. €</td>
<td>Chinese machinery, little automation</td>
</tr>
</tbody>
</table>
Trends in Asia

• **Trend:** Several plants in Asia are establishing new non-asbestos production lines
  - Japan (whole industry converted to N/A)
  - Korea (NA)
  - Thailand (several companies, developing)
  - China (developing)
  - Vietnam (developing)
  - India (start to move)

• **Drivers:**
  - Authorities, asbestos ban
  - Export to EU and other countries.
  - General public awareness, market does not want asbestos
  - Foreign investors, Tourism
Development of Non-asbestos product in China

- Asbestos product was not allowed in the most of important and well-know projects, such as 2008 Beijing Olympic game; 2010 World Expo in Shanghai, 2010 Asia game in Guangzhou and etc.

- Government also consider to get rid of asbestos product in the construction. Asbestos was forbidden to be used according to one new Chinese national standard Uniform Technical Code For Wall Materials Used In Buildings , which was published and implemented since 1\textsuperscript{st} of June 2011(GB50574-2010).

- Asbestos was classified as toxic and hazardous product according to the government document ‘List of recommended substitutes for toxic and hazardous raw materials-2012’ , asbestos was listed in the class 3 as the no.81 material, and High module and high strength PVA fibre was promoted as the substitute fibre. (Ministry of industry and information technology of the People’s republic of China, Dec 27 2012.)

- Both of Asbestos and non-asbestos product has been producing in China today, however the industry was moving towards non-asbestos gradually.
Conclusions

• Technology for non-asbestos building products is readily available
• Cost of fibre cement recipe will increase, however this gap in China and SEA was reduced gradually because the price to import asbestos was increased with years.
• The market effect of conversion depends on several factors
  • General asbestos ban, increased price of Asbestos
  • Competition with other building systems
• Switch to non-asbestos products also give opportunities
  • New products
  • New application
  • Export possibilities
Thanks you

Mobile: +86 13911739482
Email: lin.zhen@elkem.no