

## **CHINA FIBRE CEMENT INDUSTRY INTRODUCTION AND ITS APPLICATION DEVELOPMENT TREND**

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### **ABSTRACT**

In recent years, the global economic situation has undergone significant changes and shifts, and as the second largest economy, China has encountered a more complex situation. Many industries and markets have been affected, especially the housing market which has been severely impacted. Elkem Silicon Products Fibre Cement Technology Centre has been working closely with Chinese manufacturers and associations to assist them in developing non-asbestos fibre cement products within a relatively short period of time and participate in the industry's shift towards environmentally friendly and green products. This article introduces the latest developments in China's fibre cement industry and non-asbestos technology and explores product application trends.

### **KEYWORDS:**

Fibre cement industry; Elkem; China.

### **INTRODUCTION**

China's infrastructure projects and real estate market were in a stage of rapid development before 2020. The fibre cement market, especially the flat-sheet market, also experienced rapid growth during this period. However, in recent years, the Chinese economy has faced challenges. In particular, the housing market continues to face downward pressure, leading to a difficult period for the construction market. All industries, including the fibre cement industry, must adapt to cope with new challenges. This paper introduces the development history and current situation of fibre cement industry in China. It discusses the main fibre cement production technologies and product applications currently used in China. The product development progress of non-asbestos fibre cement has been updated, and the discussion on the future development trend of China's fibre cement industry.

### **DEVELOPMENT HISTORY OF FIBRE CEMENT IN CHINA.**

The history of the development of fibre cement in China dates back to the 1930s, beginning with the production of the earliest corrugated asbestos fibre cement sheets. The development of fibre cement products in China has progressed from corrugated sheets to flat sheets, from asbestos to non-asbestos, and from low-end to high-end. Currently, building products produced through this traditional technique are still widely used in construction, and they are continuously being improved in response to the demand for low-carbon, green, and sustainable new materials (Shen and Lin, 2006) or (Lin, 2016). The development history of Chinese fibre cement is shown in Table 1.

**Table 1 Chronicle of fibre cement development in China**

Time	Milestones
~1930	Asbestos corrugate sheet was produced in China.
1960-1970	Asbestos flat sheet was produced in China.
1980-	Non-asbestos concept was promoted in China.
1980-1990	Non-asbestos corrugate sheet was tried in few factories with the support from China building materials academy.
	Asbestos flat sheet had been developed quickly in this period.
1990~2000	Non-asbestos flat sheet was produced successfully.
2000-	Coating technology started to be used on the fibre cement product.
2018	With the development of UHPC products, high-performance decorative fibre cement sheets are gradually developing.

## CHINESE INDUSTRY STANDARD REGARDING THE FIBRE CEMENT

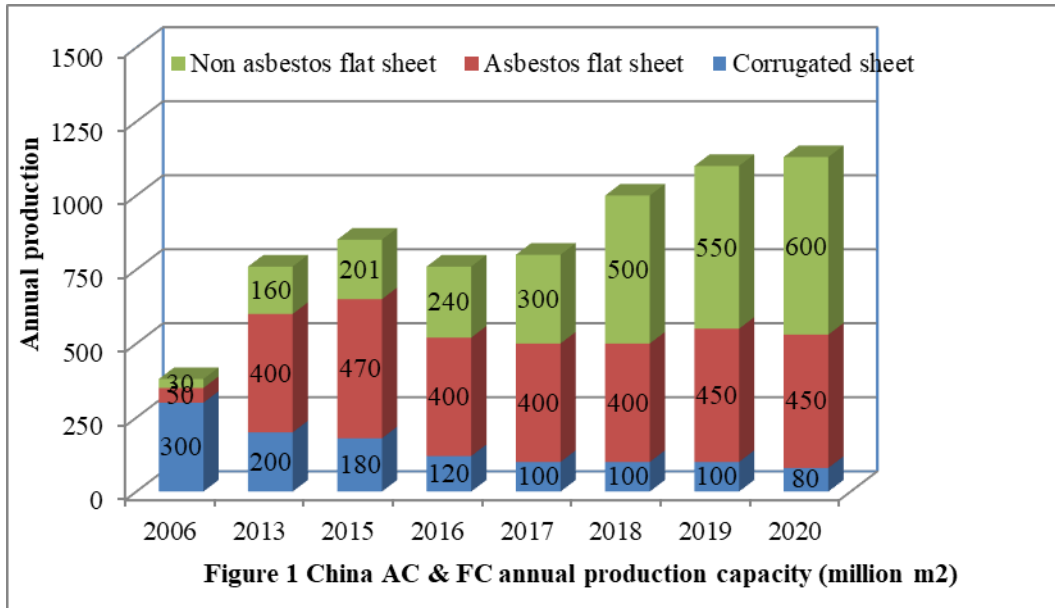
Non-asbestos fibre cement products have been developed in China for many years. However, due to historical reasons, asbestos cement products are still permitted for use in China. The current product standards for fibre cement products in China primarily focus on flat sheets and corrugated sheets. With the development of decorative materials and prefabricated buildings, standards for decorative panels have been successively introduced (Lin and Zhang and Wang, 2011) or (Lin and Zhang and Li, 2014). In recent years, with the rapid development of UHPC products, high-performance UHPC decorative panels have also emerged consecutively. Table 2 outlines the relevant standards for commonly used fibre cement products in China.

**Table 2 Industrial standards for China's fibre cement industry**

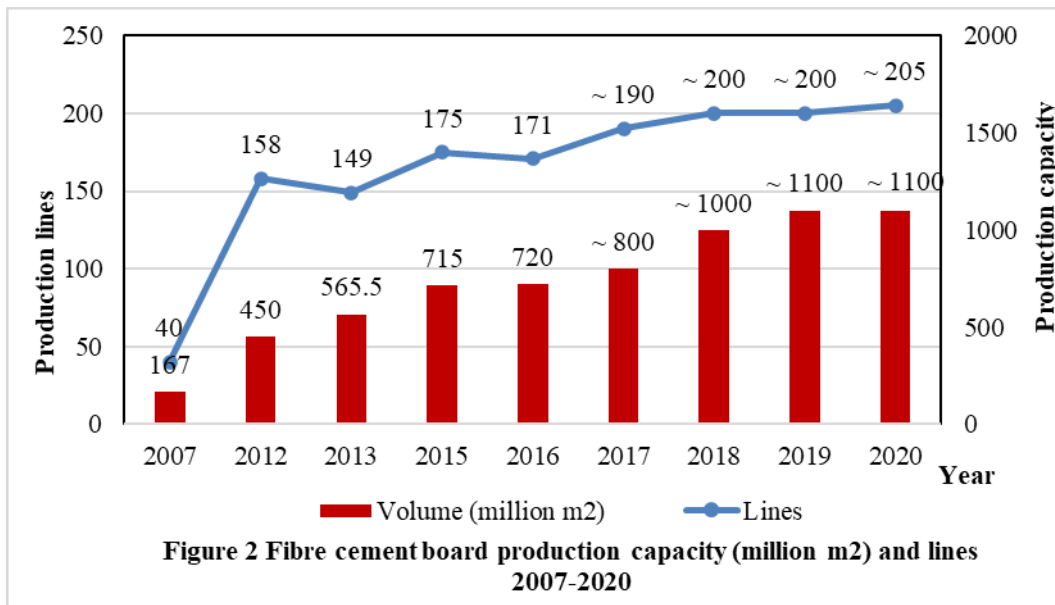
Standard number	Notes
GBT 9772-2009 Fibre cement corrugated sheet and ridge tile	Non-asbestos and Asbestos
JC/T 396-2012 Non-load bearing fibre-reinforced-cement sheet for exterior wall	Non-asbestos product
JC/T 412-2018.1 Fibre cement flat sheets	-
Part 1: Non-Asbestos Fibre cement flat sheets	Non-asbestos product
Part 2: Asbestos Fibre cement flat sheets	Asbestos product
JC/T 564-2018 Fibre reinforced calcium silicate boards	-
Part 1: Non-Asbestos calcium silicate boards	Non-asbestos product
Part 2: Asbestos calcium silicate boards	Asbestos product
T/CBMF 171-2022 /T/CCPA 30-2022 Ultra-high performance concrete (UHPC) panel for exterior wall	Non-asbestos UHPC product
T/CBMF 172-2022 /T/CCPA 31-2022(product standard) Ultra-high performance concrete (UHPC) decorative product	Non-asbestos UHPC product

**CHINA FIBRE CEMENT PRODUCTION CAPACITY**

At present, the total annual production capacity of flat and corrugated fibre cement products in China is approximately 1 billion square meters, including those made of asbestos cement. In China, corrugated sheets are mainly asbestos products; it mainly consists of medium corrugation wave sheets. With the development of new materials, the application scope of asbestos corrugated sheets has gradually shrunk, resulting in a gradual decrease in the production capacity of asbestos corrugated sheets year by year. Currently, its applications are primarily confined to roofing materials for livestock facilities and industrial roofing in remote suburbs. The development of fibre cement production and product structure in China is illustrated in Figure 1.



As a flat sheet of fibre cement, the production capacity has been increasing year by year and gradually moving towards non-asbestos products. In recent years, newly invested fibre cement flat production lines have mostly produced only non-asbestos fibre cement products, and their applications are continuously expanding. (Figure 2)



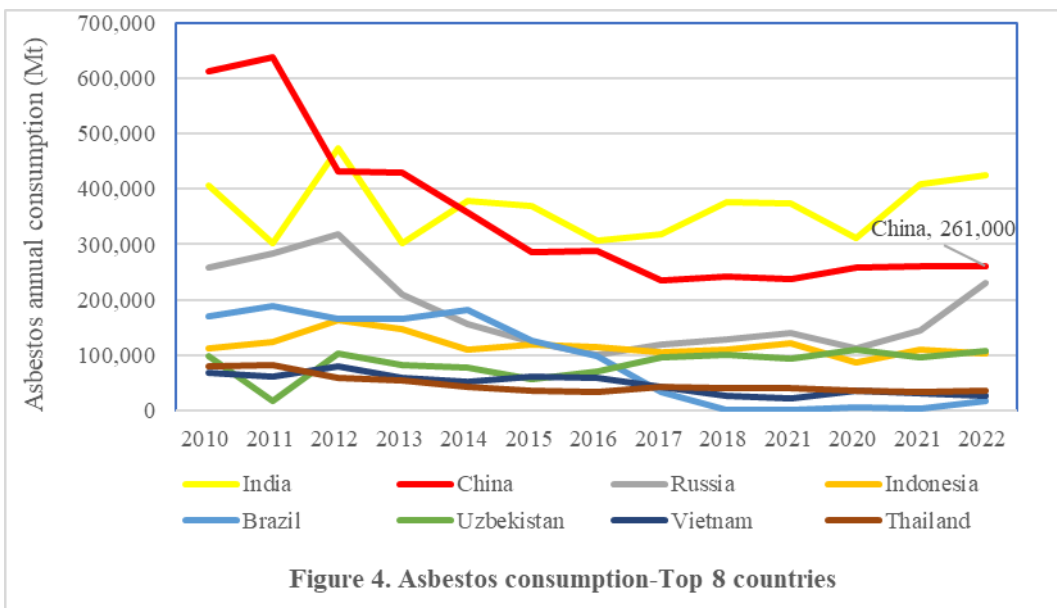
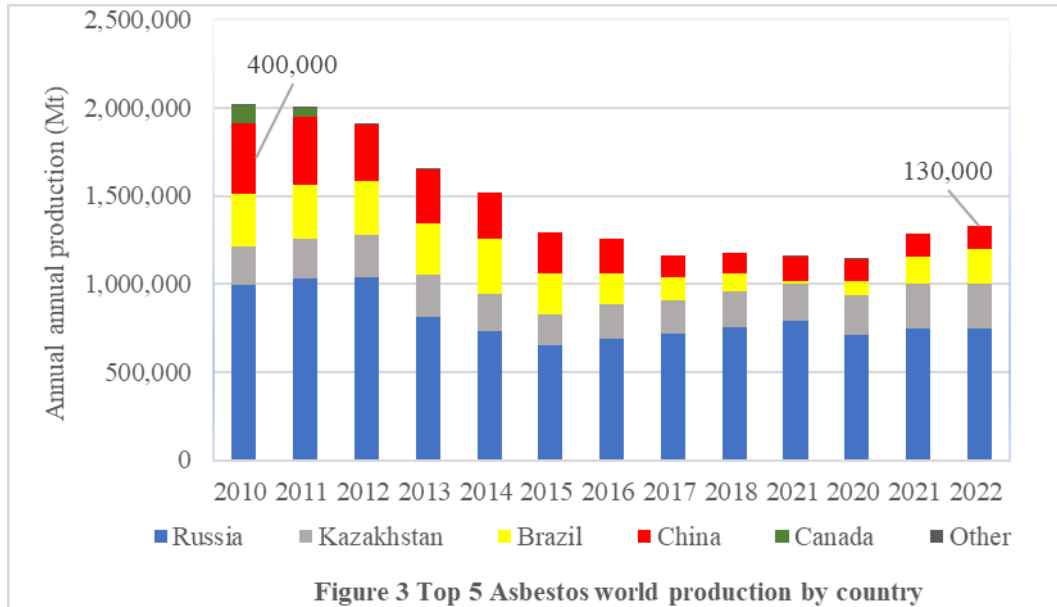
## **CHINA POLICY AND REGULATION TO THE ASBESTOS**

Although asbestos products and asbestos free products still coexist in China at present, since 2010, different industries in China have issued standards and regulations prohibiting and restricting the use of asbestos materials, and new investment projects basically no longer involve asbestos products and asbestos related businesses. The development direction of asbestos free is irreversible.

Asbestos was forbidden to be used in the construction according to one Chinese national standard Uniform Technical Code For Wall Materials Used In Buildings, which was published and implemented since 1st 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.)

From 2010 to 2022, China's production of asbestos has decreased by two-thirds, from approximately 400,000 tons in 2011 to 130,000 tons in 2022, as shown in Figure 3. The consumption of asbestos has also decreased from approximately 430,000 tons in 2011 to 260,000 tons in 2021, as shown in Figure 4.

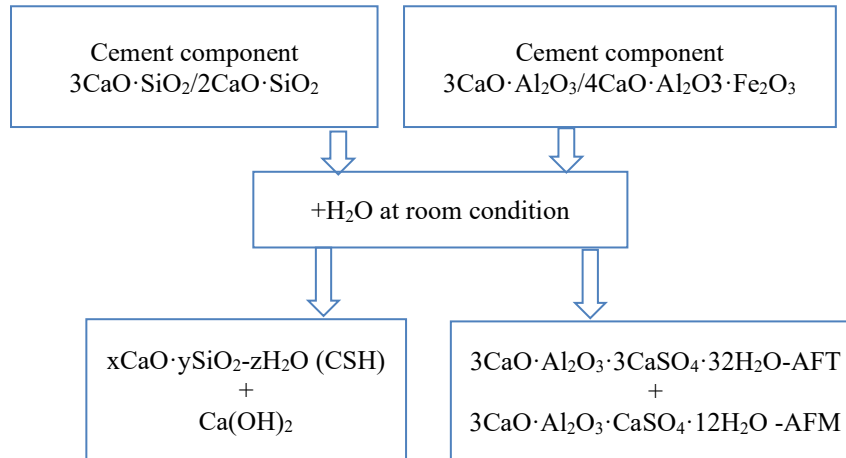


### TODAY TECHNOLOGY TO PRODUCE FIBRE CEMENT PRODUCT IN CHINA

At present, the production processes of fibre cement products in China mainly include the Hatschek process, flow-on process, extrusion process, moulding process, and spraying process; the Hatschek process and flow-on process are still the main production processes for traditional fibre cement corrugated sheets and flat sheets. In China, corrugated sheet products are mainly produced through the Hatschek process, and the production of flat sheets includes both of the Hatschek process and flow-on process. The production and curing system for flat sheets commonly adopts the autoclave curing system, while a small number of enterprises also use the air-cured

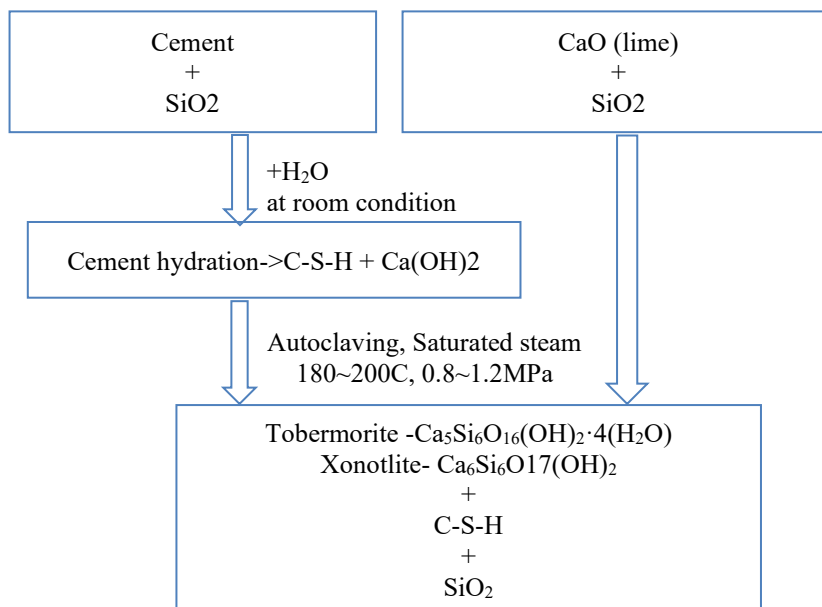
curing system for flat product production, and only the air-cured curing system is used for corrugated sheet products.

According to different curing systems, the raw materials for producing fibre cement products are generally divided into two groups. One group is based on the air-cured curing system and mainly consists of cement-based materials, with the strength and main mechanical properties of this fibre cement product mainly derived from cement hydration cementitious materials, its reaction mechanisms of the cement hydration are shown in Figures 5; the other group is based on autoclave curing system, mainly composed of siliceous and calcium materials,



**Figure 5. Cement hydration mechanism of the air cured fibre cement product**

with the strength and main mechanical properties of this fibre cement product mainly from the strength of the Tobermorite and Xonotlite generated by the reaction of siliceous and calcium materials under autoclaving curing, its reaction mechanisms of this group materials are shown in Figure 6.



**Figure 6. Hydration mechanism of the autoclaved fibre cement product**

In addition to cement, quartz sand, fibre, and other primary raw materials, fibre cement products also use a variety of auxiliary materials and chemical admixtures, including Microsilica, limestone, wollastonite, mica, fly ash, flocculants, defoamers, etc. Some auxiliary materials and additives serve as reinforcing agents, while others

function as process aids. Elkem has conducted research on the auxiliary materials and admixtures commonly used in the fibre cement industry (Lin and Zhang and Li, 2018). Based on these test results and customer feedback, we have listed the primary functions of some commonly used auxiliary materials and additives in Table 3.

**Table 3 Effect of some auxiliary materials and additives on non-asbestos fibre cement product**

<b>Additive</b>	<b>Function in fibre cement production</b>
<b>Microsilica®</b>	Increase the strength and durability, improve the problem of delamination
<b>Mica</b>	Improve the volume stability and reduce the drying shrinkage.
<b>Limestone</b>	Improve the durability and reduce the drying shrinkage
<b>Fly ash</b>	Partial replacement of some raw materials for saving cost. It might give contribution in the strength, but quality of fly ash was very variable and difficult to control.
<b>Rice husk ash</b>	Could increase strength and other performance if quality is controlled in good way.
<b>Wollastonite</b>	Adjust the fibre cement slurry property, as well as some contribution to reduce the drying shrinkage and the thermal shrinkage in a fire
<b>Sepiolite</b>	Adjust the fibre cement slurry for easy control during Hatschek process.
<b>Diatomite</b>	Partial replacement of siliceous raw materials for saving cost, sometimes could adjust the FC slurry property; also acts as density reducer
<b>Bentonite</b>	Adjust FC slurry property.
<b>Vermiculite</b>	Used for low density product. (also for fire resistance purpose sometimes)
<b>Perlite</b>	Used for low density product
<b>Flocculent</b>	Polyacrylamide polymer product normally, it's mainly used to adjust the FC slurry for easy picking up and reduce the amount of particles lost during the Hatschek process.
<b>Defoamer</b>	Generally used to avoid too much foams in the FC slurry, which might be created by the waster papers or off-grade PULP.

## **APPLICATION OF CURRENT PRODUCTS**

At present, corrugated sheets in China are still mainly asbestos products. Some factories produce non-asbestos products only to meet the needs of the orders (Zhang et al, 2016). Therefore, the traditional corrugated sheets in China are mostly asbestos products. Their application markets mainly include industrial factory roofs, rural livestock building, and suburban temporary building roofs, etc. With the development of other new materials and colourful steel panels, the application scenarios of traditional asbestos corrugated sheets in the construction market are gradually shrinking and evolving towards a trend of single type product. Currently, the main fibre cement corrugated sheets in China are median waves asbestos sheets, which are mainly used as roofing materials



for livestock building and a limited number of temporary building roofing materials. Figure 7 is the example of using corrugated sheet for one livestock building.



**Figure 7** Corrugated sheet roofing of livestock building.

Fibre cement flat sheets have been widely used in construction. With the increasing demand for prefabricated buildings and clean production practices, the use of fibre cement flat sheets is increasing, and the quality standards are improved, with their applications becoming more diverse. They are not only used for traditional applications such as interior and exterior wall panel materials, indoor ceilings, indoor and outdoor floors, garden furniture, ventilation ducts, and concrete formwork, but also for special purposes such as fire-resistant board systems and explosion-proof board systems. In addition to serving as substrates for other materials, fibre cement boards can also be directly coated and textured, and are widely used as building decoration materials. Figure 8 illustrates examples of fibre cement board products used in construction.



**Figure 8** Flat sheet application in China



## HIGH PERFORMANCE FIBRE REINFORCED FIBRE CEMENT PRODUCTS

Ultra-High Performance Concrete (UHPC) reinforced with fibres, as a product of fibre-reinforced cement-based composite materials with ultra-high performance, has developed rapidly in China in recent years. UHPC products possess characteristics of high strength and high toughness. According to current specifications, ACI standards require a UHPC compressive strength >150MPa, while ASTM standards demand a UHPC compressive strength >120MPa. The production of UHPC strictly follows basic principles for material requirements and formula design, including ultra-low water-binder ratio design, the use of high-performance additives, high-performance fibres, and highly active admixtures such as Microsilica. Additionally, the particle size of all powdery materials must meet specific requirements, and there must be no coarse aggregate. These requirements make it currently impossible to use industrial assembly lines for mass production of UHPC products. Currently, UHPC projects generally involve on-site concrete casting or on-site installation of prefabricated components, and the production process typically involves moulding or spraying techniques. The market positioning of UHPC products is also different from traditional fibre cement products. Currently, their most common applications are in bridge deck paving and other load-bearing building components, as well as some decorative structures with complex designs and high material performance requirements. In recent years, an increasing number of architectural decoration structures in China are adopting UHPC products, and meanwhile, more and more UHPC standards are being introduced or are currently under development. The current UHPC standards in China are listed in Table 4.

**Table 4 Industrial standards relevant for the UHPC product in China**

Standard number	Notes
GB/T31387-2015, Reactive powder concrete	material standard
T/CBMF 37-2018, Fundamental characteristics and test methods of ultra-high performance concrete	material standard
T/CBMF 96-2020 Premix for ultra-high performance concrete	material standard
T/CECS 10107-2020 Technical requirement for ultra-high performance concrete	material standard
T/CECS 864-2021 Standard for test method of ultra-high performance concrete	test method standard
T/CBMF 185-2022 Specification for Design of Ultra-high Performance Concrete Structures	engineering design standard
T/CBMF 127-2021 Manufacture for production of precast ultra-high performance concrete components	engineering production standard
T/CBMF 128-2021 Recommendations for on-site placing ultra-high performance concrete	engineering technical standard
T/CBMF 171-2022 /T/CCPA 30-2022 Ultra-high performance concrete (UHPC) panel for exterior wall	product standard
T/CBMF 172-2022 /T/CCPA 31-2022(product standard) Ultra-high performance concrete (UHPC) decorative product	product standard

## DISCUSSION

Although China's economic development has slowed down in recent years and the real estate market faces severe challenges, the people's pursuit of a higher quality of life will not weaken, which will force enterprises to upgrade product quality and enter more segmented application markets. With the rise of social media, the use of toxic and hazardous materials will put pressure on the government and enterprises, and the transformation to non-asbestos materials is expected to accelerate.

The low-carbon economy and sustainable development goals have emerged as irreversible global development strategies, imposing new requirements on traditional fibre cement formulations and production processes (Bruno, 2024). The strategic goals of China's low-carbon economy and sustainable development have had a profound and irreversible impact on all industrial sectors. The use of raw materials and production technology in the traditional fibre cement industry will face comprehensive updates and technological changes. It is expected that in the next 5-10 years, the fibre cement industry will widely use low-carbon cementitious materials, high-activity additives, recycled fibres, and adopt low-energy curing systems. Besides the continuous production of traditional fibre cement products, there will also be constant upgrades in technology and expansion of applications. New products and applications will also be continuously developed.

## CONCLUSION

The development direction of non-asbestos fibre cement products is irreversible.

It is expected that there will be no significant changes in the development of corrugated cement sheets in the short term. However, due to competition, the quality and performance of corrugated cement sheets will gradually improve.

In the short term, the fibre cement flat sheet market will not expand, but quality improvement and expansion into segmented markets will continue.

Low-carbon cementitious materials, high-activity additives, recycled fibres, and adopt low-energy curing systems will be studied and tried in the fibre cement industry in China.

The production and application of UHPC products will continue to develop rapidly in China.

UHPC product and its application expansion will be developed fast.

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