BUILDING RESEARCH NOTE 39

CENTRAL BUILDING RESEARCH INSTITUTE, INDIA

IMPORT SUBSTITUTION OF ASBESTOS

Asbestos cement industry in India produces a large quanlity of asbestos-cement products such as roofing sheets, building boards, rain-water and pressure pipes and other accessories. The industry uses almost entirely imported chrysotile asbestos for this pnrpose. With the rapid industrialization of the country, demand for asbestos-cement products has considerably increased. Current annual requirement of asbestos by A.C. industry is more than 70,000 tonnes. A major part of this demand is met by imported chrysotile asbestos for which an amount of Rs. 50-60 crores is spent in foreign exchange every year. To economise in the foreign exchange being spent for this purpose, it is necessary to use indigenous amphibole asbestos or some other alternative fibres in A.C. products in full or part replacement of imported chrysotile asbestos or to reduce the proportion of imported chrysotile asbestos in A.C. products. Apart from these factors, the use of asbestos is associated with certain health hazards and therefore by substituting these fibres this problem can also be partly solved.

Extensive research and development work have been carried out in Central Building Research Insfitute, Roorkee to find out the suitability of indigenously available amphibole asbestos and other fibres and fibrous minerals for partial substitutions of imported chrysotiie in A.C. products. Four processes have been developed for partial replacement of chrysotile asbestos in A.C. products.

Utilization of Polypropylene Fibres in A.C. Products

Polypropylene commercially known as proplon is an inert substance chemically. It is highly resistant to acids, alkalies, oxidants and many organic and inorganic chemicals. Its specific gravity is 0.91 and is light as compared to asbestos. Proplon is being manufactured by M/s. Neomer Ltd., Baroda by the method of melt spinning of isotatic poly-propylene resin.

For laboratory investigations polypropylene (PP) fibres of different diameters and staple lengths were evaluated to determine thelr suitability as reinforcing material for the partial substitution of asbestos fibre in A.C. products. As a result of the tests conducted, it has been observed that pp fibres of different lengths can be used in small percentages (up to 1 to 2%) for replacement of asbestos fibres in A.C. products without lowering the transverse strength of the products. Transverse and flexural strength improves if the fibres are properly dispersed in asbestos cement matrix. In order to examine the effect of wetting agent on transverse strength, test specimens were prepared with the addition of wetting agent (0.4% Lubrol-W) and tested. The results show that there is, in general, an improvement both in the transverse and flexural strength as compared to the control mix. Reason for improvement in the transverse strength is the proper dispersion of the fibres in A.C. system by using the wetting agent. Investigations were also carried to find out the effect of fibre length on the transverse strength and it has been observed that pp fibres of 10 and 15 mm length are most suitable for this purpose.

Density of polypropylene fibre is low. These fibres occupy a larger volume and have a higher covering capacity as compared to asbestos fibres. Therefore, in another set of experiments different percentages of pp fibres were added in the mix and asbestos fibre 5-times pp fibre, was reduced in the mixes. Test results show that the strength obtained is equal to or higher than that obtained for control samples.

Impact strength test was also conducted as per IS Specifications and the results show great improvement in the impact strength of test sheets made with partial replacement of asbestos by polypropylene fibres in all the mixes examined in these experiments. It is also quite obvious from the experimental data that by replacing asbestos fibre equivalent to 5 times the weight of the pp fibre up to its 2 percent addition the ultimate cost of the A.C. products would be at par with normal A.C. products.

After completing detailed investigations in the laboratory and assessing their techno-economic feasibility large scale field trials were conducted in factories. The results of these trials conducted at various factories are given below.

1. *Results of trials conducted at A.C. factory No. 1 :*

Trials were conducted at the A.C. factory substituting 4 to 5 parts of asbestos fibre by weight with 1 part of polypropylene fibre.

Plain Boards (4 mm thick)

A. (Four parts of asbestos fibre replaced by one part of pp fibre)

Sl. No.	Test	Required as per IS Specification	Value achieved for pp A.C. Sheets	Value achieved for normal A C. Sheets
1.	Breaking load kg	15 kg (min.)	25.00	19.00
2.	Water absorption%	40 (max.)	32.00	30.00
B.	(Five parts of asbestos replaced by one part of pp fibre)			
	(i) Mix. No. 1			
1.	Breaking load kg	15 kg (min.)	23.92	23.50
2.	Water absorption %	40 (max.)	32.86	29.37
	(ii) Mix. No. 2			
1.	Breaking load kg	15 kg (min.)	27.90	23.50
2.	Water absorption %	40 (max.)	30.30	29.37

Corrugated A.C. Sheets

(Four parts of asbestos replaced by one part pp fibre)

S. No.	Test	Requiremegt as per IS Specification	Value obtained with pp A.C. Sheets	Value obtained for normal sheets
1.	Transverse Breaking load (overall width) in kg.	525 kg (min.)	700	710
2.	Water absorption %	28 (max)	30*	27
3.	Acid Resistance gm/m²	1150 (max)	970	970

*Water absorption can be reduced by increasing the density of the sheets

2. *Results of trials conducted at A.C. factory No. 2 :*

After conducting extensive factory trials, the above factory started commercial production and marketing of asbestos polypropylene blended sheets, Saving in asbestos is about 10%. The manufacturers and users are fully satisfied with this product. Test results of full size corrugated A.C. sheets are given below :

Test results of corrugated A.C. Sheets

S. No.	Test	Value achieved after 7 days curing	Value achieved after 21 days curing	Value for normal A.C. sheets as per IS specifieations after 28 days curing
1.	Transverse Breaking load, kg.	629 kg. 5.85 Nm	640 kg. 5.0 Nm	525 kg. (Min.) 5,0 Nm
2.	Water absorption %	—	20.24	28.0 (Max.)
3.	Acid resistance gm/m²	—	685 gm/m²	1150 gm/m² (Max.)
4.	Flexibility	Increased by 8–10 mm		

3. Encouraged by the results of the factory trials the third A C. factory has also started manufacturing of Asbestos–polypropylene blended A.C. sheets on commercial scale and are saving 10% asbestos fibre.

4 A fourth A.C. factory has started manufacturing A.C. pressure pipes by using this process and have obtained strength values passing the standards laid down by ISI.

5. Another A.C. factory has also carried out large scale trials in their factory and have obtained very satisfactory results. They are planning to go in for commercial scale manufacture of A.C. sheets by using the process.

Apart from this three more parties have conducted plant trials and are using polypropylene fibre for replacement of about 10% asbestos in their products.

Advantages

By using the process about 10% imported asbestos fibre can be saved. This effects a saving of about Rs. 5–6 crores in foreign exchange annually. Apart from this, the production cost will be lower which is a direct advantage to the manufacturers and this is the main reason for their keen inrerest in the process. By the addition of fibres in A.C. products, the transvers strength and other properties are at par with normal products. There is a very high increase in the impact strength of the sheets and the losses in handling and transportation are reduced to negligible. The manufacturers and users are fully satisfied with this product.

Utilisation of A.C. Factory Waste

A vast quantity of waste material is found strewn about at the site surrounding every asbestos cement industry. The waste increases year after year and it poses a problem for its disposal and some expenditure has to be incurred for it. One of the A. C. factories showed considerable interest in the reuse potential of the waste and requested the Institute to undertake the evaluation for the suitability of the waste for either reusing in A.C. manufacture or in the manufacture of some other building material of commercial value.

After detailed investigations, it has been found that the waste after calcining and grinding acts as a cementitious binder with initial and final setting times within the prescribed limits. The calcined product can be used as LP 20 type lime pozzolana mixture as per IS : 4098–1967, and for making asbestos reinforced light weight heat insulation and fire–resistant products passing the tests prescribed in the standards.

The results also show that with the addition of finely ground (100 mesh) A.C. waste, 2 to 5 percent of asbestos fibre can be replaced by the ground waste in the manufacture of A.C. products. As a result of these laboratory investigations, full scale factory trials were conducted at M/s Rohtas Industries Ltd., Dalmianagar. Satisfactory results were obtained by using 2% waste for the production of A.C. building boards and corrugated roofing sheets. There were no problems in the production process employed by the factory with its use and additions upto 2% gave better filterability and smooth production. The test results of A,C. sheets are given below :

Tests Results of Trials at one of the A.C. factories

S. No.	Test	Without addition A.C. waste	With addition of A.C. waste	Requirements on per I.S.I.
1.	Transverse breaking load, N/mm.	6.88	7.91	5.0 (Min.)
2.	Water absorption, %	27.27%	26.46%	28% (Max.)
3.	Acid resistance, gm/m²	980	981	1150 (Max.)

Utilization of Amphibole Asbestos

Asbestos cement products produced by using amphibole asbestos such as anthophyllites and tremolites as available in India are weak and brittle. Therefore, the A.C. industry depends on the imported asbestos for this purpose. In order to cut down the import of chrysotile asbestos and economise in foreign exchange expenditure, it is necessary to use the indigenous amphibole asbests in the A.C. product either as full or part replacement of chrysotile asbestos or to lower down the proportion of chrysotile in the A.C. producfs.

As a result of investigations carried out at this Institute, two processes have been developed for part replacement of chrysotile by amphibole fibres. By using the first process, A.C products such as sheets or pipes are to be made from the blends of chrysotile and amphibole fibres. It necessitates curing of the product in a humid atmosphere of CO_2 gas instead of normal curing in water. The process is simple and needs no change either in machinery or method of production. The A.C. products cured in CO_2 under humid atmosphere gave strengths much higher than the minimum required by the standards. The process has been given factory trials and A.C. pipes of different diameters were made and the pipes cured in the gas chamber have bursting pressures higher than the minimum required by Indian standards.

The second process consists of judicious selection of chrysotile and amphibole fibres and their simultaneous blending and fiberization. A suitable machine for the purpose has been developed at C.B.R.I. The process is simple and needs no pressure. Methods of production and machinery remain the same. The products are cured in water as usual. The process has been given factory trials and A.C. sheets of much higher breaking loads than that recommended by Indian Standards have been produced. About 25–30%, replacement of chrysotile by amphibole asbestos can be done by adopting these processes.

Adoption of these processes will lower down the production cost and reduce the foreign exchange expenditure also.

Many small scale units are making A.C. building pipes by using amphibole asbestos and the blending process is being used by one factory for making building boards and corrugated sheets by replacing about 10% chrysotile by indigenous amphibole asbestos.

Substitution of Chrysotile Asbestos by Wollastonite in A.C. Products

Wollastonite is a naturally occurring calcium metasilicate $CaSiO_3$. It is acicular, fibrous and white in colour. Large deposits of high quality wollastonite have been found in the country. Wollastonite fibres are brittle and

can be easily ground to very fine powder. This powder still retains fibrous nature. Laboratory studies were carried out earlier at this Institute to find out the possibility of using finely ground wollastonite in A.C. products by using amphibole asbestos and encouraging results were obtained. Recently a project was sponsored by the Indian Bureau of Mines, Nagpur and M/s Wolkem Pvt. Ltd., Udaipur for substitution of chrysotile asbestos by Wollastonite in A.C, products.

Detailed laboratory investigations were conducted and on the basis of these results it was concluded that about 10% chrysotile asbestos can be replaced by wollastonite in asbestos cement products without any adverse effects on the properties of the products. On the basis of these recommendations, full scale factory trials have been carried out for making A.C. pressure pipes and A.C. building board at two different A.C. factories. The results obtained, as given below, are quite satisfactory aud pass the Indian Standards.

Test Results of Building Boards

10% Chrysotile replaced by wollastonite

S. No.	Test	Furnish No. 1	Furnish No. 2	Normal Furnish
1.	Breaking load, kg	22.91	21.03	20.73
2.	Water absortion, %	31.15	28.15	27.20
	IS Specification Br. Load 15 kg. min., W.A. 40% max.			

This is apparent from these test results that 10% chrysotile can be replaced by wollastonite in A.C. products without lowering their properties.

There is a demand for short notes summarising available information on selected topics of building research for the use of engineers, architects, builders, building material manufacturers and others interested in building research. To meet this need the Institute was so far bringing out various serial publications, such as, Building Digests, Building Materials Notes, Data Sheets, Information Notes, Technical Notes etc. It was decided in January 1982 to combine all these serial publications into a new serial under the main heading "BUILDING RESEARCH NOTE" and the present one is the 39th in this series.

Readers are requested to send to the Institute their experience of adopting the suggestions given in this publication.

UDC : 666.858
SfB : Dh 1

Printed at :
Jain Printing Press, Roorkee
Copies—2000

Prepared by : Sh. K. D. Dhariyal
Published by :
Central Building Research Institute.
Roorkee, (U.P.), INDIA
June, 1985