106. 石綿を含む材料の石綿繊維飛散性試験

STUDY ON AIR EROSION OF ASBESTOS-FIBER-CONTAINING BUILDING MATERIALS

建設省建築研究所 ○遊佐 秀逸 高橋 泰一
大分大学工学部 平居 孝之

Shuitsu YUSA*1 Yasukazu TAKAHASHI*1
and Takayuki HIRAI*2

〔KEY WORDS〕 Air Erosion, Asbestos Fiber, Asbestos Substitutive Fiber, Fiber content, Bending strength, Asbestos alternative, Durability

〔ABSTRACT〕 近年、我国ではアスベストの危険性に関する問題が社会の関心を集めている。最も緊急な課題は、耐火、吸音および断熱を目的として使用されてきた吹付けアスベストである。もう一つの問題は、アスベストセメント製品の適切な取扱いに関するものである。アスベストはこれらに最も多く使用されており、また建築材料として当該製品は大量に用いられてきた。本研究の目的は、アスベストを含む建築材料のアスベスト繊維の飛散性を、特に新たに開発されたアスベスト低減化スレートについて検討したものである。試験に供したスレートはアスベスト含有率が5％以下のものと、それ以上を含む既存製品である。アスベスト代替に用いた繊維は、ポリビニルアルコール（ビニロン）繊維、ポリアクリロニトリル（アクリル）繊維、および耐アルカリガラス繊維である。材料からアスベスト繊維を発生させるために、ウォッシャビリティマシンを用いた。耐久性試験前後の気中のアスベスト繊維を測定した結果、アスベスト低減化製品からの飛散は極めて少なかったが、耐久性試験後の飛散割合は大きい。これは、曲げ強度の低下に起因するものだと推察される。

※1 Building Research Institute, Ministry of Construction
※2 Department of Architecture, Faculty of Engineering, Ohita University

1. Preface

Steps have been taken to apply safety measurements for asbestos which is considered to be hazardous when it is inhaled in large volume into human body. In order to improve safety of handling asbestos in various stage such as manufacture of asbestos products, processing, construction work and disposal, it is vitally necessary to reduce total volume of asbestos fibers by means of replacing asbestos and also by decreasing added ratio of asbestos in asbestos products. In this study, airborne asbestos fiber was examined by using asbestos-reduced corrugated sheets made by an industrial scale machine as a trial product. Methods to check asbestos fibers into the air out of asbestos containing products is, for example, described in America's ASTM E6 Proposal P189 (Proposed specification for ENCAPSULANTS FOR FRIABLE ASBESTOS-CONTAINING BUILDING MATERIALS, 1989) . This proposed specification is applied mainly to asbestos for spray use and performance of encapsulants are checked by applying air stream to test specimens. The asbestos taken up in this study is the one used in slates which is non friable. Therefore, asbestos fibers were produced by rubbing slate surface with a brush to produce airborne asbetos fiber.

2. Experiment

2.1 Sheets used for the test

The test pieces which contain vinylon fibers are the products that have already been in the market. The test pieces containing acrilic fibers and alkali resistant glass fibers were made specilly for the test. Two types of corrugated sheets, namely, one which is non-asbestos and another which contains less than 5% of asbestos, were made by using acrylic fibers and alkali resistant glass fibers as a relacement of asbestos fibers. Two different kinds of sheets were made for each type and in consequence; four kinds of sheets were made in all. Table 1 shows details of the four kinds of sheets.

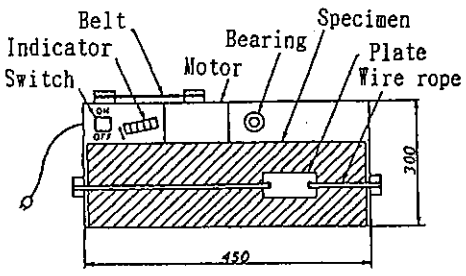
Table.1 Material Tested

Grade	Main fiber	Manufacture
Containing asbestos less than 5%	Vinylon	A,B,C
	Acrylic	Trial D
	Alkali-resistant glass fiber	Trial E
Current products	Asbestos	I,J

2.2 Method of experiments

(1). Method to produce airborne asbestos fibers.

A draft with temperature of 20 C and humidity of 60% (1100mm high by 1600mm width by 600mm depth) is tightly closed to eliminate flow of air. Then airborne asbestos fibers are emitted in the draft out of a test piece, before and after bending test, in accordance with 5.11 of JIS A 6909 (Wall Coatings for Thin Textured Finishes) by using a Gardner straight type washability machine as described in Fig. 1. Asbestos fibers were emitted by 10 shuttle movement of a dry brush at a upper side of corrugation with pressure of 450 gf as described in Fig. 2. The brush used is made from a base of 90mm by 38mm on which 60 holes were made having uniform diameter of 3mm into which bristles of black pig were planted and cut as right anglesto maintain uniform length of 19mm.



unit mm

Fig. 1 Test apparatus for washability

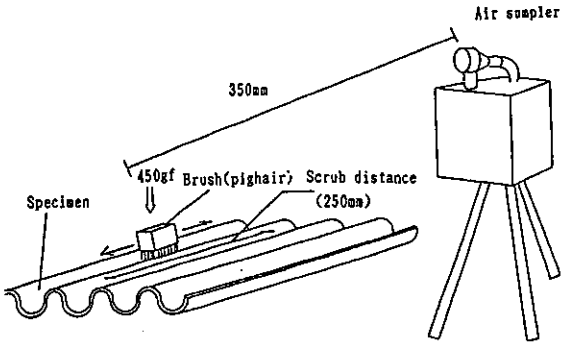


Fig. 2 Measurement of asbestos-fiber in air

(2) Collection of airborne asbestos fibers

As the brush started to move, airborne asbestos fibes are collected on a membrane filter (25 mm diameter) by the air sampler at the rate of 1.5 liter per 5 minutes.

(3) Measurement

The membrane filter is treated by acetone-triacetin method to be transparent and solid and then number of asbestos fibers was measured by observing 50 views of a phase contrast microscope of 400 magnitude. In this case, asbestos fiber was defined to be the one which is longer than 5 micron, less than 3 micron in diameter with aspect ratio of more than 3. Total number of asbestos fibers on the membrane filter was calculated in accordance with the following numerical expression.

$$T = \frac{Af^2 \times F}{K^2 \times 50} \quad \text{---------- (1)}$$

where

T = Total number of asbestos fibers (pieces)
Af = Effective diameter of membrane filter (21.5 mm)
K = Diameter of a field of view of microscope (0.4 mm)
F = Number of asbetos fibers measured

3. Results and discussion

Table 2 and Fig. 3 shows the result of the measurement of airborne asbestos fiber out of specimens of both asbestos-reduced products and conventional asbestos-containing products before and after the weatherability test (exposure test for durability in a weathering

Table. 2 Airbrone asbestos fiber before and after durability test

Specimen	Number of asbestos fiber	
	Before dur. test	After dur. test
A	404	867
B	404	924
C	462	1156
D	520	1098
E	347	867
I	578	1213
J	636	1156

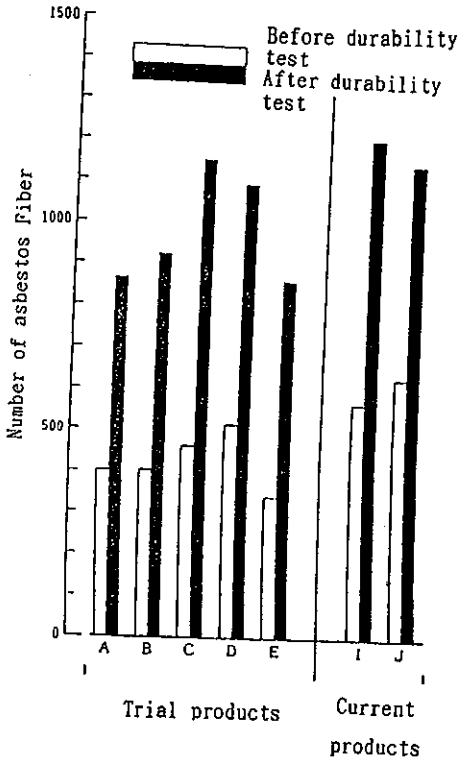


Fig. 3 Comparison of airbrone asbestos fiber

room artificially designed). As compared with conventional products, total number of airborne asbestos fibers out of asbestos-reduced products was less because asbestos fibers contained is less than 5%. But the ratio of total number of asbestos fibers after the weatherability test is, as shown in Fig. 3, about twice as much as that before weatherability test. This ratio of asbestos-reduced products is slightly higher than that of conventional products and it looks that asbestos-reduced products has higher trend of emitting asbesatos fibers after weatherability test than conventional products. It is considered that this is related with relative decrease of surface strength of asbestos-reduced products, as it is reported[3] that bending strength of asbestos-reduced products was decreased by 70 - 90% after weatherability test whereas there was almost no decrease of satrength for conventional asbestos-containing products.

4. Conclusions

Conclusions on this studt are summarized as follows:

(1) According to the result of the measurement of airborne asbestos fibers out of asbestos reduced products as well as conventional asbestos-containing products before and after weathering test, total number of airborne asbestos fibers out of asbestos-reduced products before and after weatherability test is less because of asbestos fibers being less than 5%.

(2) The ratio of total number of asbestos fibers of the asbestos-reduced products before and after weatherability test is as a whole higher than the conventional asbestos-containing products.

(3) There was the trend that emission of asbestos fibers out of asbestos-reduced products after weatherability test is greater than that before the test.

(4) This is related with decrease of bending strength after exposure test and it is considered that decrease of surface strength accelrated emission of airborne asbestos fibers.

[Acknowledgements]

This study is partly comprised from the report of the committee of investigations on asbestos-reduced products, and authors acknowledge contributions from the members of this committee. Special thanks go to Mr. Toshikazu Otoguro, Organic Materials Testing Section, Japan Testing Center for his experimental work.

[References]

[1] ASTM EP189, Proposed Specification for ENCAPSULANTS FOR FRIABLE ASBESTOS-CONTAINING BUILDING MATERIALS, 1986.

[2] Methodology for the measurement of concentration of airborne asbestos fibers in room, Japan Association of Determination of Working Place Environme: 1988.

[3] Report of investigations on asbetos-reduced products, Japan Testing Center, 1992.