

Asbestos in buildings: types and health effects



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Asbestos in buildings – current status

Introduction

Asbestos has been used for more than 2, 000 years. It was named by the Ancient Greeks, its name meaning “ inextinguishable”. Even then the Greeks noted the harmful affects of asbestos, as they noticed the slaves that wove the asbestos into cloth form had developed respiratory problems after studying their lungs. (asbestosresource)

The asbestos fibres fall into two types, amphiboles and serpentines. The blue and brown asbestos fibres fall into the amphibole group. They fall into this group because they are compounds of metal silicates which consist of short and sharp fibres. For this reason they have the ability of remaining within the human body for long periods of time. Also for this reason this group of asbestos is more dangerous than the white fibred asbestos.

(asbestoswatchdog)

Today asbestos is a general term that is given to numerous naturally occurring silicate minerals. There are six forms of asbestos the three that are not very common are known as actinolite, anthophyllite, and tremolite.

Amongst the six naturally occurring minerals there are three main forms of asbestos which are known as Chrysotile, Crocidolite and Amosite. Otherwise they are known in the same order as white, blue and brown. In 1999 The Asbestos Prohibition Regulations banned the use of all new forms of this material.

There has been a gradual decline in the use of asbestos from the early 1960s. Even though a high number of buildings have had the asbestos
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removed and then replaced with a more suitable material, there is still a very high number of buildings that still contain asbestos and most of it is has remained undetected. (Eclipsescientific)

Asbestos has many properties and for this reason it was widely used.

- Strength
- Incombustibility
- Use as a binding agent
- Resistance to high temperatures
- Resistance to electrical current
- Resistance to acids and alkalis
- Absorbs sound (Asbestos-answers)

It can be seen very clearly why asbestos was used on such a wide scale, looking at the properties it seemed to be the only material that had such a variety and was also available on a broad scale.

Asbestos possesses unique tensile strength and flexibility from its fibres and it is for this reason that it was used in the first place. These fibres are too small to be seen by the naked eye. The ability of the asbestos fibres to flex allows them to be woven, though it is harder to weave the amphibole group due to there rigidity. On the other hand the serpentine group was used more due to its flexibility.

There is no simple test to recognize the different types of fibres, and this judgment cannot be made on colour alone, but it requires a lab test to find

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out which type of asbestos it is that they are dealing with. More will be discussed on how the tests are carried out and the types of samples that are used later on in this report.

All these forms of asbestos are known to be very dangerous to human health and can cause illnesses to which there is no cure. The way the asbestos enters the body is through the inhalation of the fibres, these fibres then rest in the lower part of the lungs where they can lay for many years. These fibres cannot be absorbed through the skin. Due to the size of the fibres they can only be seen through a microscope, and their size also allows them to penetrate deep into the lungs, this can cause respiratory diseases or some types of cancer.

“ The principal asbestos related diseases are that of: asbestosis (fibrosis) scarring of the lungs; mesothelioma - a cancer of the inner lining of the chest wall or abdominal cavity; lung cancer; and diffuse pleural thickening - a non-malignant disease in which the lining of the lung (pleura) becomes scarred.” (13/11/07, healthandsafetytips)

The types of asbestos containing materials found in domestic properties are likely to be in ducts, access panels, ceiling tiles, partitions etc. These if still existing in domestic buildings will be found 1960's and 1970's built housing. Most of the materials containing asbestos look similar to those materials that do not contain asbestos. If the materials that contain asbestos are in good condition they can be left in place and managed, but if they are damaged dangerous fibres can be released which have to be removed only by an

approved contractor. Asbestos being a very hazardous material only becomes dangerous when it is airborne and the fibres are inhaled.

Today the types of commercial buildings that asbestos may still remain in are the ones that were refurbished in between 1950 and 1980 as this was the peak time that the asbestos was used in buildings. What will make it more likely for the building to contain asbestos is if the building had a steel frame and contained boilers with thermal insulation. Asbestos wasn't only used in sheet form and as an insulation but also as asbestos cement which was used to cover walls etc. The asbestos was also used in the buildings in the form of a spray which was mixed with hydrated asbestos cement; this was then sprayed on to many of the structural and non-structural members, so the majority of the building may contain asbestos in one form or another. (HSE)

Overtime the members and materials coated with asbestos spray may break down due to wear and tear this will gradually release asbestos fibres into the air which due to their non visible fibres could be inhaled therefore causing health problems.

Before work is started on a building any asbestos containing material cement, plasterboards etc must be identified. Any work carried out on asbestos containing material must be carried out by a HSE licensed contractor. (sutton. gov. uk)

Asbestos

2. 1– Types

As mentioned in the introduction to this report there are six forms of asbestos chrysotile, crocidolite, amosite, anthophyllite, tremolite, and actinolite. Of these six there are the three main forms of asbestos which are amosite (brown), chrysotile (white) and crocidolite (blue). The colours of these types of asbestos are not visible to the human eye, so all the asbestos should be treated as equally hazardous.

Chrysotile or better known as white asbestos is obtained from rocks known as serpentines. This is the only type of asbestos that belong to this rock group. These rocks are found commonly through out the world. This type of asbestos is the only one out of the others which has curly flexible fibres as opposed to the other types of fibres which are straight, sharp like a needle and some are even brittle. This is also the most common type of asbestos as it accounts for about 90% of all the asbestos consumed across the world, when compared to the other types. This is still the most commonly mined form of asbestos till today. (phhenv)

This fibre is known to do the least amount of damage to the lungs. This fibrous material is composed of 40% silica and 40% magnesium, though these fibres have a good heat resistance they can be destroyed by acids. Chrysotile has fibres which have a layered silicate structure. These layers can be regarded as made up from silicon atoms and each of these atoms is surrounded by four oxygen atoms at the corners which creates an almost regular tetrahedron. Then there are the magnesium atoms, of them each are surrounded by six oxygen atoms which creates an almost regular

octahedron. These two are linked by the sharing of their basal oxygen atoms which then forms a continuous layer.

Amosite asbestos is a part of the amphiboles rock group; this is mainly used as a flame retardant material within thermal insulation material such as ceiling tiles. This brown asbestos is typically used in insulating materials. The crystals in this type of asbestos vary and they can be flat prisms, brittle grains or long thin threads. The threads are commonly found in naturally occurring bundles.

The longer and thinner fibres of amosite are rather flexible and curve to form wide arches. These long wide arches of amosite fibres then break into minor groups that consequently form sharp needle-like fibres. The ends of the fibres are plane and do not have tattered or split ends, this is one of the main characteristics that helps differentiate amosite from chrysotile asbestos fibres. Broken bundles also are frequently found and resemble broom tails in appearance. Remains of the crystal fibres can be recognized in some building resources that were manufactured with amosite. (David Cole)

Crocidolite asbestos is one of the five types of amphibole asbestos; this means the fibres in Crocidolite are made up of mineral crystals that look like chains. Crocidolite is often called "blue asbestos," and occurs naturally in Australia, South Africa, Russia and Canada.

Crocidolite was the least type of asbestos used in commercial products. Crocidolite fibres usually bear a resemblance to chrysotile fibres but they are vaguely more brittle. This form of asbestos is harder than any other member in the amphibole family. This is also one of the most carcinogenic fibres as it

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induces the release of reactive oxygen species from phagocyte cells (cells that engulf and destroy invading organisms). This in turn damages the cells DNA and as all cells are programmed to die after a certain amount of time, the damaged DNA changes that and therefore the cell will reproduce uncontrollably. This will eventually result in malignancy and show the result of the carcinogenic properties of asbestos fibres. (carcin. oxfordjournals)

The contemporary use of asbestos dates from the late 1800's where great amounts of asbestos deposits were discovered in Canada. Brusquely after this discovery commercial asbestos mine was opened in Russia. Since then the two former mentioned countries have been the main worldwide producers of chrysotile. There is no asbestos mined in the UK and the largest asbestos producer in the world is Russia. The main sources of asbestos that are imported into the UK are from Canada and South Africa.

It can be seen that Russia has been the largest producer of the most commonly used form of asbestos (Chrysotile). Whereas South Africa has been the smallest producer of white asbestos. These production values have dropped since the ban of asbestos around Europe, hence the amounts of asbestos used has declined.

tonnes. It also indicates the amount of asbestos that America has been using since the 1940's. It can clearly be seen that America was the largest consumer of asbestos until the 1970's when the use of asbestos started to decline. By 1999 the worldwide production of asbestos had also declined by more than a half since 1990. This signifies that around the 1990's asbestos

had started become prohibited around the worlds largest consumers hence the overall consumption of asbestos was rapidly reduced.

2. 3– Processed

Asbestos is processed through a milling procedure, where the useful fibres are separated from the non-useful materials within the asbestos rock. When the fibres are separated they become shorter and also split lengthwise due to their crystalline structure. Many of the fibres that result from the milling process are too small to see with the naked eye. The fibres that are milled are graded by a machine as they pass through it they are caught in a sieve and then measured. This process may vary from mine to mine. There are many different grades of fibres that are used in the construction industry but the focal point is on those fibres that are in the respirable range, as it is these fibres that have the size and shape which can cause damage to human health by penetrating into the depth of the lungs, and this is where they will remain for long periods of time. (Asbestos: from rock to fabric, 1956)

2. 4– Uses in construction

The first use of asbestos for construction purposes was in 1890 in the form of fireproof roofing materials. Later on in the next 10 years on from 1890 the use of asbestos expanded to engine gaskets and boiler insulation, it can be seen that the heat resistance properties of asbestos were being exploited for commercial use. Then from the early 1900's the use of asbestos expanded to building insulation and in the 1930's this had extended to a cement bonding agent. Indicating that asbestos had become a highly sought after material. Up to date it has been estimated that asbestos may be a component of more than 3, 000 types of construction materials (Hess, 1998).

According to figures from the asbestos report from the committee, out of 143 000 tonnes of asbestos that was imported into the UK in 1976, roughly about 42 900 tonnes were used to manufacture construction products such as cladding sheets and roofing tiles (Stationery Office, 1979).

Due to the high heat resistance of asbestos it was mainly used in the construction for fire protection, i. e. to separate rooms. It can also be mixed with cement and used as a spray, which is then sprayed onto articles within a structure. Due to its high-quality weather resistance it was used on a large scale on roof sheets, pipes and guttering.

(Harrogateaccommodationservice)

There were many materials manufactured for construction purposes. They are as follows;

For the roofs of the buildings there were many different materials used, the main materials contained asbestos bonding. Cement roof slates, cladding and roofing sheets all contained asbestos bonding in the form of cement. The former three materials were all designed to be strong as they will face different temperatures and weathering. The combination of asbestos and cement made it very hard for these materials to release fibres, unless they were heavily damaged, drilled or cut using other machinery.

As mentioned above the roofing asbestos products were made to be very strong so therefore they are of low risk when it comes to releasing fibres and danger to human health compared to those asbestos products used on the inside of the building.

The flooring in buildings that were constructed with ACM's may also contain asbestos. This can be in the form of 9×9 inches thick floor tiles which were used in the early stages of ACM's becoming popular. The tiles also come in the 12×12 inches size which is the more common size used for floor tiles today. Linoleum floor sheeting is also another type of asbestos containing material that was used for floors of kitchens and bathrooms but was most commonly used in commercial buildings such as hospitals and school corridors. In addition mastic glue was used to stick the linoleum and tiles to the floor may have also contained asbestos. Like every asbestos product it should be assumed that these products contain asbestos until proven otherwise by microscopic identification (Sandro A, p68). The illustration above shows typical asbestos linoleum floor sheeting and asbestos containing wall tiles which could also be used for the floor.

Insulation was another material used in construction that contained asbestos namely crocidolite. This was used to line the attic of a building and in some cases to line fireplaces and pipes. Asbestos is chemically lifeless hence it has excellent thermal and electrical insulation properties and this is the reason for its use as insulation (Fillmore. W, Galaty, Wellington. J, 2002). It must be noted that asbestos was almost always bonded with other materials that were already being used for a certain job i. e. roof tiles, cladding etc. All the asbestos did is improve the properties of these materials making them more durable, heat resistant and flame retardant.

Acoustic ceiling materials were used to reduce the amount of sound travel between the floors of a building. The asbestos was used as a spray which

was applied to the ceiling; this was mainly to save money from having to plaster the ceiling. The asbestos was bonded with ceiling paint and applied

Carcinogenic agents are those that can influence the carcinogenic development either by mutating vital target genes or by escalating the amount of cells at threat from mutations.

“ Cytogenetic and molecular studies of asbestos-related cancers indicate that inactivation or loss of multiple tumor suppressor genes occurs during lung cancer development. Aneuploidy and other chromosomal changes induced by asbestos fibers may be involved in genetic alterations in asbestos-related cancers”. (Pubmedcentral)

Furthermore, asbestos fibers may influence the carcinogenic process by inducing cells to rapidly multiply and produce new cells or tissues, free radicals, or other promotional mechanisms. This indicates that asbestos fibers may act at numerous stages of the carcinogenic process by both genetic and epigenetic (changes the physical characteristics of an organism) mechanisms. The ability of the asbestos to remain in the lungs and body is undoubtedly important in fibre carcinogenicity. On the other hand, the time necessary for a fibre to remain in the lung to put forth a cancer-related effect is tricky to state. (Pubmedcentral)

Studies of how health-related conditions occur in specific populations show that the amphiboles and chrysotile can increase the risk of lung cancer. The carcinogenicity of chrysotile has been recognised for some time by international bodies,

“ This carcinogenicity was confirmed by the experts consulted by the panel; with respect to both lung cancers and mesotheliomas...we therefore consider that we have sufficient facts that there is in fact serious carcinogenic risk associated with the inhalation of chrysotile fibres” (epa. gov)

The above statement indicates that chrysotile has the carcinogenic ability to be able to cause cancer if people are exposed to airborne fibres.

(Mesotheliomareference)

Details of exactly how asbestos fibres cause malignancy in cells is still largely unknown. Although there is a lack of information of how the malignancy occurs in the cells from these fibres the basics of how these mechanisms occur is known. It is not apparent if the asbestos fibres cause malignancy by encouraging the cells by direct relations or by the toxic materials that are released by the fibres which will eventually cause cancer. The fibres will first cause local irritation and inflammation to the neighbouring tissue, where they will get lodged afterwards. The inflammation and irritation causes the body to release chemicals, these chemicals cause changes in the cells and the interaction with the asbestos fibres and other factors which are largely unknown, will eventually cause the cell to continue onto a malignant change. (medicineworld. org)

The human body has different sets of genes for growth promotion and growth suppression. In a regular healthy state the genes that promote growth and genes that suppresses the growth are in good synchronization, so that the cell growth and cell division occur only when it is needed. These growths related genes are susceptible to and can get damaged by internal or

external factors. Therefore if a growth suppressing gene is damaged the mechanism that controls the suppressing and unwanted growth might be lost.

Alternatively if damage occurs in the growth promoting genes, they might lose their capability to endorse cell growth, but some types of damage can actually increase the growth promoting ability of these types of genes. The result of this type of damage to the cell genes is that it no longer pays attention to the commands of the tumour suppressor genes and continues to multiply. Each cell is programmed to expire after definite number of cell divisions. Due to the damage this programmed cell death does not take place, in turn causing the cell to multiply without any control making the cell almost immortal. This ability to multiply without control and the immortality factor rapidly increases the chances of the cell to develop into cancer.

The asbestos fibre will damage the genes of the cells and causing genetic changes in a cell which is programmed to perform a certain task will almost definitely cause more harm than good, and in this case it can lead to cancer. So asbestos does have a level of carcinogenicity, but the factors that this depends on are varying i. e. length of exposure, type of asbestos exposed to. (Environmental Toxicants: Human Exposure and Their Health Effects, 2000)

3. 1 – Fibre types and Health affects.

3. 1. 1 – Which is worst

Currently there is no strong evidence that supports which type of fibre is the most harmful to the human body. It is stated that chrysotile is the least

harmful and that amosite is the most harmful as it has the highest link to lung and respiratory cancers and conditions.

3. 1. 2 – Why is the worst

3. 1. 3 – Illnesses

Mesothelioma is a cancer of the mesothelium; this is a thin membrane which lines the chest, abdomen and the organs that surround this area. This type of cancer is usually associated with Crocidolite, but it can also be caused by other types of asbestos as well. The cancer can develop even after very little exposure to asbestos fibres, and can take up to 15 years to develop. This is known as the latent period and in some cases it has known to take up to 40 years before it develops. It is also thought that this type of cancer may be related to other malignancies than just asbestos. As with all the types of asbestos cancers smoking can cause the cancer to speed up.

Lung Cancer from asbestos exposure can take two common forms the small cell lung cancer which is as stated by its title a cancer where the cells are small and round. Alternatively there's the non small cell lung cancer, this is where the cancer cells are larger. Out of these two types of lung cancers the small cell lung cancer accounts as the main from by having a cancer relation of 80%, where as large cell lung cancer only accounts for 20% out of the two types.

Asbestosis is the progressive scarring of the lungs; this is due to continuous exposure to asbestos fibres. This illness may take years before it is noticed but the common signs of asbestosis also mimic those of other respiratory problems. The most common symptoms of asbestosis are breathlessness
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and dry coughs, but these can easily be confused with other problems. The asbestos fibres continuously irritate the lung surface causing it to scar and eventually leading to the thickening of the lung surface.

Diffuse Pleural Thickening Benign Pleural Effusion Benign Pleural Plaques
Rounded atelectasis or folded lung Mesothelioma (asbestosawarenesswales)

3. 1. 4 – Occupational exposure

Electricians and construction labourers are one of the most common workers who have a higher chance of being exposed to asbestos. They are more likely to come across ACM's as they work around the area of ACM's, electricians work in lofts or re wire buildings where they have to disturb some of the materials. These materials may contain asbestos and therefore release fibres that can be inhaled and eventually cause disease. Construction workers when carrying out demolition on a building are at a very high risk of disturbing large amounts of asbestos fibres and therefore increase the amount they inhale. These two occupations may come across asbestos more often than any other occupations. (lhc. org)

Insulation workers and Ladders who apply insulation materials can also be at high risk of asbestos exposure, this is because they have to disturb walls and sometimes have to work near the roof of the building and these are the most common areas that asbestos remains in buildings. This is because asbestos was used in the spray form to help strengthen plaster boards and cement products and if any of these are disturbed then they will release asbestos fibres. This will expose the workers to high amounts of asbestos as these

areas are not well ventilated and therefore they will be breathing in more fibres. (Asbestosawarenesswales)

Carpenters, Plumbers and pipe-fitters are also at risk from asbestos exposure because they have to drill through walls to carry out their duties and the drilling will agitate any asbestos fibres and therefore may cause exposure to asbestos.

The asbestos diseases are all caused due to the asbestos fibres causing damage to the body in one form or another, either by damaging the cells at DNA level or damaging the tissue as a whole. These fibres are very sharp when examined under a microscope. It is this sharpness that causes the damage and also the ability of the human body to remove the asbestos fibres, as the cells try to engulf the fibres to destroy them, which is a near impossible task to do they end up being damaged in return. (asbestos.net)

All of the above occupations and many more are at risk from asbestos exposure and the Control of Asbestos Regulations 2006 makes sure that any building that is suspected to contain asbestos records it in an asbestos register and this register is shown to anyone who maybe carrying out work on the site. The regulations will be discussed in more detail during the course of this report.

4. – Remains/Assessments

4.1 – Types of building

Most asbestos will be remaining in buildings that were built, refurbished or repaired between 1950 and 1980, as this was the peak period where asbestos was used in building materials in the United Kingdom. The amount that

remains in buildings is very hard to determine or even estimate as it will be a very time consuming job. All the relevant data that is needed to even make an estimation cannot be found in one place. There are many estimated and approximated figures for the amount of buildings within the UK which contain ACM's. Most of the information is based on commercial and non-domestic properties.

Any buildings that were constructed before the year 2000 is assumed to contain asbestos unless there is strong evidence pointing otherwise. The reason for this is because the final ban on asbestos was brought in during the year 1999. This is also the basis of the estimation for the current status of asbestos in the UK, as the year 2000 was considered the year where all new asbestos building materials were completely banned in the UK.

4. 1. 1 – Commercial/Domestic

While there are no dependable figures, it is approximated that there are still thousands of tonnes of asbestos remaining in buildings. As many as 750, 000 non-domestic premises may contain asbestos. (rgeurope)

Others governing bodies suggest that “ It is estimated half a million commercial premises may contain asbestos” (amsscotland). So the estimated number of commercial buildings that may contain ACM's is around the half million figure. This figure is estimated by adding up of all the non-domestic properties such as offices, schools, factories and hospitals that were built before the year 2000.

5. – Surveys

5.1 – How survey carried out

After an extensive search three types of surveys have been identified.

Type 1: Walk Through Survey

The first survey that is carried out is a presumptive survey. This survey does not involve any sample taking; rather it involves identifying all areas and locations which may have asbestos containing materials (ACMs) by a visual inspection. From this survey the condition of the ACMs are noted and there locations this is for the purpose of benefiting the person that may be carrying out work on a structure or occupying it. This is because any suspected materials have to be treated as asbestos containing materials unless there is a guarantee that the materials do not contain any asbestos. This confidence can only be reassured if the materials are glass, wood or metal. It must also be made sure that these materials that do not contain asbestos are not hiding any materials that do i. e. wooden joist hiding an asbestos ceiling tile etc. (Bridgend)

Type 2: Sampling Survey

This survey is that same as the first survey in all aspects except that samples are collected from some suspected materials and then these samples are sent off for analysis to a lab which will most likely use a microscope to identify the fibres. The sampling can be carried out at the same time as the survey and each suspected material is sampled. Unlike the first survey which can be carried out by an in house member this survey can only be carried out by a qualified and trained professional. (Bridgend)

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Type 3: Pre-Demolition/Refurbishment Survey

This survey is carried out to gain full access to all ACMs and it may involve destructive inspection. This is a must if a building is going to be demolished because if the ACMs are not removed then the dangerous asbestos dust can be released into the air which can cause health problems on a large scale.

This also helps to identify all areas with ACMs so they can be removed before a major refurbishment and replaced with more suitable materials. Therefore this survey is deemed necessary if work is going to be carried out on a large scale, so the current condition of any ACMs is established. As above this survey should only be carried out by a trained and qualified professional.

(Ac-environmental-services)

5. 2 – How to take samples of suspected material

Taking samples of suspected materials depends on the type of survey that is carried out. If there were materials that are suspected of containing asbestos during a type 1 walkthrough survey then no samples will need to be taken, this is because they will just be identified and their location noted. Whereas if type 2 or 3 surveys were carried out then the samples taken could be of thumbnail size or they could be larger. It should be noted that these samples will be identified as ACM's under a microscope so there is a limit to the size that a sample can be. Samples from each suspected ACM are collected and analysed to validate or contradict the surveyor's judgement. Sampling may take place with the survey or, in the case of some larger surveys, as a separate exercise following completion of a Type 1 survey.

5.3 – Procedures and Precautions taken

The procedures for taking samples are that first a site survey must be carried out in the form of risk assessment. Any risk found in the assessment will form the procedure to follow when taking samples. The main and foremost part of the procedures is that anyone taking samples must make sure that any disturbance of suspected ACM's is kept to the bare minimum. This is because it will reduce the amount of fibres that are released. The person taking the samples must take into account that the premises may be occupied and the minimal disruption is caused to the client's daily operations. There may also be employees or tenants on site and all precaution must be taken to protect their health and safety. (HSE)

The sampling personnel must also make sure that the adequate personal protection equipment is worn while carrying out this delicate procedure, as they are the ones closest to being exposed to the asbestos. They must make sure that the bare minimum that they use is disposable overalls, over shoes and a respirator. There may also be other equipment used but this depends on the risk assessments finding for example if the risk assessment found that there was asbestos that has been disturbed then air extraction may have to be used to stop the fibres spreading but if there is just suspected ACM's then basic equipment mentioned can be used. (HSE)

There are different respirators for different types of ACM's, which ever was identified in the risk assessment. The main precaution just before taking samples is to wet the suspected ACM to make sure that the amount of fibres released is minimal. The sample area can be wetted by using basic waster or a wetting agent. Wetting can be done in different ways for different

materials, for boards and sheets the water or wetting agent can be sprayed directly on to the surface, as t