CLEANING OF FABRIC STRUCTURES

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This paper reviews current fabrics:Their cleaning properties; considerations for constructing fabric structures and implications of design and location with respect to cleaning intervals.

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INTRODUCTION

Fabric structure construction has increased over the last two decades as membrane technology has improved and architects and designers have sought to construct individualistic striking buildings.

However, due to the relatively short period that fabric has been used as a construction material a pool of knowledge has not been accumulated, as there has been with conventional building materials. The conventional materials such as their timber, steel, brick etc., have past track records and maintenance techniques have progressively been developed in order to maintain a convential buildings soundness and appearance.

Unlike these conventional buildings, fabric structures and the materials of construction have under gone constant and rapid changes in design and construction. Whilst developments have been embraced readily by those designing fabric membrane structures, basic maintenance and cleaning is being ignored. This is to the detriment of the appearance of the structure, and increases the possibility of premature deterioration of the fabric membrane.

It is perhaps appropriate that we look to the past and review some established structures in order to examine the issues that face these structures today in terms of maintenance and cleaning.

During the MSAA conference of 1989 a paper was presented entitled "A selective review of the performance and maintenance aspects of fabric membrane structures. In the paper a number of structures were reviewed on various performance criteria. One of the criteria was cleanliness, it was this criteria that received the lowest score with regard to the number of structures that satisfied the criterion. Of the seven structures analysed only three reported satisfaction in this area. Of the three they had:

- Either initiated a regular maintenance program;
- Or had only twelve months to two years operation of the building and regarded the environment as external. One where external cleanliness was less important than externally.

The paper went further and found that cleanliness had several aspects, which were found to be more important for fabric structures than for many conventional structures because:

- Excellent lighting highlights dust, cobwebs etc. Items which would not be as noticeable with a non translucent roof.
- The translucency of the membrane means contamination is obvious whether it be on the inside or outside.
- Many membrane structures have complex or unusual support structure with surfaces and processes which hold dust, attract spiders etc.

- Dirt and discolouration is highlighted because the membrane provides a focus to draw the users attention to where the cleanliness problem is.

- Access to the internal and external surfaces is often difficult and sometime impossible.

This paper will deal with the above issues and others that should be considered in the conceptual and contractual stages of a fabric membranes design.

FABRICS

There are numerous fabrics available today in Australia however the types of base cloth that are utilised do not vary widely. The fabrics are woven to form the base cloth, providing the tensile strength characteristics required of laminated fabrics. The base materials are generally:

- Polyester
- Polyamide
- Glass Fibre

Coatings are then applied to the base cloth in order to project it, and to provide the necessary durability and enhancement of other physical properties.

The coatings include:

- Polyvinyl chloride (PVC)
- Polytetrafluoroethylene (teflon)
- Polyvinyliden flouride (PVDF)

Combinations of base cloth and coatings are basically limited to PVC coated polyesters and teflon coated woven fibreglass.

Over the last decade there has been numerous developments in the coating of polyester base cloth. Predominantly the polyester is coated with PVC. This combination then has a further coating of acrylic. The acrylic coating protects the PVC/polyester combination from UV degradation. Thereby prolonging the life of the PVC/polyester material.
Recent significant improvements have occurred in the acrylic coating improving the ability to clean.

Further coatings have been developed in order to improve cleaning performance of the PVC/Polyester base fabric.

Examples of these further coatings include:

- Tedlar
- Flurolac

In the case of tedlar it is laminated to the top side of the fabric. Tedlar also further improves the resistance to UV.

Further improvements in maintaining cleanliness have been achieved through the combination of polyester with the coating of polyvinyliden flouride (PVDF).

Most of the polyester fabrics are subject to damage if they are cleaned with cleaners that are either high in alkalinity or solvent. Should the acrylic, tedlar, furolac or PVDF coatings, be damaged due to the incorrect application of cleaners the fabrics structural integrity can be compromised, resulting in premature ageing of the fabric. Teflon glass fabric has good cleaning characteristics as teflon perflouropolymer (PTFE) resins are the most chemical inert plastic known and are particularly noted for their ability to withstand UV moisture and smog. Teflon has the reputation of being a non stick surface. However this is still only a reputation as teflon is still subject to soiling. Furthermore if the wrong chemicals are applied in cleaning they may cause wicking in the fibreglass underneath.

POLLUTANTS

Whilst each fabric coating has unique cleaning characteristics each is still subject to the effects of pollution once erected in a structure.

Pollution of a structure can take many forms:

- Mildew and mold
- Spider webs, insect droppings
- Air borne particles
- Industrial
- Excreta

The effect of pollution will be directly proportional to a fabric structures geographic location and the design of the structure.

Mildew & Mold

- A number of fabric membrane structures have been used to enclose common areas of private schools. In Melbourne typically these structures are constructed in the vicinity of trees. Due to the physical location portions of these structures remain in shade during the winter months. Therefore the surface of the structure remains moist for long periods of time encouraging the growth of mold and mildew.

  In tropical areas such as Queensland long periods of humidity may be encountered thus encouraging the formation of mildew and mold to the surfaces of fabric structures.

Excreta

- This is a problem that strikes every structure constructed. No matter the location be it with proximity to the sea, in a bush setting,or in the middle of a city, birds, settle upon all types of buildings including fabric structures. In the normal course of nature these birds leave droppings. These droppings whilst being unsightly also contain various acidic substances that may cause damage to the fabrics. Causing discolouration and ultimately loss of fabric integrity where the dropping has made contact, if not removed in a reasonable timeframe.

Spider webs & insect droppings

- Due to the intricate and complex structure the underside of a fabric structure attracts spiders to spin their webs insects are also attracted to the undersides leaving marks and droppings where they have come into contact with the surface of the structure.

Industrial & domestic pollutants

- By far it is these pollutants along with air borne particles that make up the majority of pollutants that will affect fabric membrane structures.

The environment protection authority in Melbourne has been monitoring air pollution for a number of decades and has analysed the components of air pollution. Not all industrial and domestic pollutants will affect the fabric structures, so we will detail those pertinent.

Sulphur dioxide and particle pollution: This form of pollution is derived from the burning of fossil fuels such as coal and oil. These can be released through industrial furnaces and boiler emissions as well as motor vehicles emissions.

Once released to the atmosphere numerous chemical reactions take place to form aerosols made up of sulphuric acid and ammonia. The effect that may result is that of acid rain.

These hydrated particles may also act as carriers for other substances. Air borne nitrogen dioxide may dissolve in the surface water to form nitric acid. Further more the oxidation of these nitrates washed out of the air by rain leaving an orange brown residue.

The acids that fall as acid rain are all part of what is termed as photochemical pollution. The ultimate consequence if these pollutants pass as acid rain is that they will damage buildings, textiles and cause corrosion on metals and deteriorate a wide range of building materials, including fabric structures.

As these chemicals are washed out of the air they rain down upon fabric structures. No matter the type of fabric as the structure dries the water carrying the particles evaporates leaving behind the acid and residue.

Airborne particles

- Measurements were taken some years ago by the CSIRO of total dust fall, these however were discontinued in the late 1970's. Even then, total annual dust fall in urban areas such as Melbourne was far greater than in rural areas. The figures being of the order of 9-10 tonnes per square kilometre per year in rural areas and 25-27 tonnes per kilometre per year in Melbourne. The EPA report found that these levels would not have dropped.The EPA found that air borne particle concentrations highly dispersed by traffic patterns. Concentrations of air borne particles therefore could be related directly to traffic patterns with the highest concentrations occurring in the eastern and southern suburbs of Melbourne.

These air borne particles are removed from the atmosphere through washout by rain. As found in the Streeton report these particles are hydrated with dissolved contaminates such as the previously discussed sulphuric and nitric acid. Therefore when drying upon the surface of a fabric structure a mixture of acid and particles remains contaminating the structure.

LOCATION

As discussed previously all structures are subject to contamination of various forms. The degree of contamination will vary with each fabric structure and the location of the fabric structure.

Where fabric structures are erected in the vicinity of over hanging trees these structures will have some unique problems. They will be subject to droppings from the trees sap etc. If the trees shade the structure particularly in the winter months as found in thesouthern states then the structures may suffer from mold and mildew. An example of this type of contamination is Tintern Grammar School in Ringwood, Melbourne.

Streetons report found that the distribution of air borne particles has direct relationship on traffic patterns. An example of where this consideration may have influenced the choice of material used and deciding on the cleaning interval required is the Shell service stations on the Westgate freeway in Melbourne. The location is the gateway between the industrial west, the distribution centres of the east and the docklands. Consequently large amounts of heavy traffic utilise the freeway, when the roadways are wet, trucks travelling along the freeway have dirt dislodged by the water on the roadway, this forms a dirty mist which settles upon the structures leaving a dirty film. In addition to the contaminants from the roadway there are a lot of major industries within 5 kilometres of the structures. For instance Newport Power Station. This is a coal burning electricity generating facility. ACI Glass manufacturing plant, Australian Gypsum, manufacture and provide plasterboard and plaster products. On this location there are numerous stockpiles of gypsum. Large chemical facilities also abound within the 5 km radius. These manufacturing facilities produce fine dust which is transported by wind and then settles upon the structures Along with these deposits other chemicals evaporate upon the structures resulting in a mixture of pollutants all combining in the sunlight to form a unsightly layer of brown discolouration.

Even in locations where there may be no industries within close proximity fabric structures can still be subject to soiling. Examples of these are the Centenary Swimming centre. This structure is located in an outer eastern Melbourne suburb. The Penguin Parade redevelopment structure located by the seaside at Phillip Island.

Centenary Swimming Pool suffers from soiling as it is located in an area with proximity to a quarry and open fields the consequence being that air borne particles are transported and able to settle upon the structure. Forming a dark residue consequently discolouring the white fabric of the structure.

Phillip Island redevelopment suffers from soiling as there are a number of unmade roads in the area therefore as the dust settles it does so over the structure. A further contaminant in this case is the salt spray that forms a mist to combine with the dust to form a light brown residue over the blue sails.

DESIGN

Design of structures plays an important part in the overall cleanliness and appearance of fabric structures. Furthermore if certain design features are incorporated into the structures this will aid in reducing cleaning costs.

Structures that have large vertical areas are not as susceptible to soiling as dust and other pollutants cannot settle upon the surface as readily. However structures that have more horizontal surface areas are readily susceptible to contaminantes settling upon the structure. When a number of contaminents settle they then are able to react with the sunlight to form layers of residue upon the structures. When it rains some of the contaminents will be washed off, however some will still remain as the water evaporates from the structure.

Traditionally cleaning of structures required mechanical equipment to access the structures, vehicles such as cherrypickers mobile booms or scaffolding etc. At the design stage eyelets should be incorporated at the apex of structures and other appropriate points to allow for the rigging of ropes which then may be used to support cleaning personnel in order to carry out effective, efficient cleaning of fabric structures.

CLEANING CONSIDERATIONS

As the structures are succeptable to being polluted and discoloured, cleaning is essential. However the techniques for cleaning can also be detrimental to the structures themselves. If cleaning chemicals are used then they must be of specific types so that they will not effect the fabrics. This should be checked with each fabric supplier.

If chemicals are to be used in the cleaning of structures certain environment protection authority laws must be complied with. These are that no chemical is to be released into the storm water drainage system. All drains in the vicinity of the cleaning operation should be blocked and the water pumped to open land in order to be absorbed into the soil.

CONCLUSIONS

1. By the very nature of the environment that we live in fabric structures are subject to soiling by a number of different substances. Location, design and type of material will dictate the cleaning intervals required. Regardless of the type of material cleaning should be undertaken to ensure that pollutants do not accumulate either damaging the structure or diminishing the visual appeal, which has been one of the considerations in originally erecting the fabric stucture.

2. Designers must consider the provision of access points for rigging to ensure that the most economical means may be employed in order to clean the structures. These access points should also be incorporated so that internal surfaces may be cleaned.

3. Clients and owners of buildings should be informed at the contractual stages that to achieve the desired visual effect and to maintain the integrity of the fabric structure that cleaning is an integral part of the structures maintenance.

4. When cleaning fabric structures care must be exercised in the use of chemicals and techniques that are employed to clean the structures.