

TITLE: REVIEW THE ISSUES AND PROBLEMS AND ISSUES COMMONLY ASSOCIATED WITH LONG SPAN SHADE CLOTH STRUCTURES

INTRODUCTION:

This report considers the issues and problems associated with Long Span Shade Cloth structures with particular reference to the New Gale Pacific Commercial Heavy shade cloth

The most important principle to remember is that every component of the long span shade cloth structure has to be designed, fabricated and installed correctly.

Long Span shade cloth structures (structures with a span of over approximately 7 metres) come in various forms including;

- Conical,
- Barrel vault,
- Hypar or “twisted”,
- Crossed arch,
- Saddle shapes,
- Ridge and valley shapes.

However, this report will not focus upon the nature of these forms as no matter what the form of the structure the same principles and issues apply to all long span shade cloth structures.

THE IMPORTANCE OF PROPER ENGINEERING

The problems that may be found with long span shade cloth structures can be generally traced to an overall lack of proper engineering which includes the choice of shade cloth, hardware, support framing and footings and poor installation. It only takes one of these items to be done improperly to compromise the performance of the long span shade cloth structure.

It is necessary to ensure that the design of long span shade cloth structures is undertaken by a registered engineer experienced in the design of fabric structures.

This is a list of common manifestations of improper engineering.

A) Lack of curvature in membrane.

The long span shade cloth structure should have fabric curvature and initial pre-tension to work satisfactorily.

A long span shade cloth membrane with significant surface curvature will develop less stress in the fibres compared to one with little curvature. Generally, significant curvature allows a shade cloth to span further and retain its design form better than a shade cloth structure with little curvature.

Lack of curvature issues include;

- Sails which are too flat, (lacking curvature) lead to billowing. This causes the shade cloth to stretch excessively and effectively beat itself to death.
- Flat/insufficient slope panels also tend to fill up with hail.

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- A shade cloth surface has to be 3 dimensional and able to change shape in response to applied loads. Planar surfaces such as flat sheets or triangles only take load by stretching rather than changing shape which leads to greater stress on fibres and generally a shorter service life. These sails once compromised then start to billow in the wind which shortens their life even more.
- The less stiff the shade cloth the greater the problems caused by a lack of curvature.
- When the site conditions restrict the amount of curvature that may be obtained, a very stiff shade cloth with balanced Warp (lengthwise) and weft properties like New Gale Pacific Commercial Heavy reduces the influence of less than ideal curvature.

B) Shade cloth choice, detailing and fabrication

100% monofilament shade cloths are the longest lasting shade cloths and the most suitable for long span shade structures.

When designing shade cloth structures, similar structural properties in both Warp and Weft directions, as exhibited by the new Gale Pacific Commercial Heavy ensure;

- A more even distribution of forces into supporting structures,
- More equal prestress loads in both Warp and Weft directions,
- A better sharing of loads between Warp and Weft fibres resulting in less elongation of fibres over time and thus a better ability for the shade sail to retain its original design shape.

Poor detailing and fabrication of shade cloth issues include;

- Using sewing thread which has a shorter life than the shade cloth itself,
- Sewing which is unable to stretch as much as the shade cloth itself causing failure of the threads
- Poor detailing, especially reinforcing details in areas of high stress
- Poor quality or insufficient sewing in areas of high stress such as corners, reinforcing areas etc.
- Details which cannot cope with the rubbing of uncoated cables in edge pockets*
- Details which are susceptible to fatigue due to movement under wind loads.

** Please note that coated cable although suitable in most areas can become pliable in extreme heat and adhere to the HDPE fabric causing wear and rubbing. A galvanised or stainless cable can be inserted into a sheath of HDPE water pipe, the HDPE water pipe has the same heat characteristics as the HDPE shade cloth filaments.*

C) Footings, framing and attachment points.

Some Long Span shade cloth structures fail or do not last as well as they should. This is often because the designers/contractors do not understand the size and nature of the forces involved in the construction of these structures. For example, as wind speed increases, the wind pressure increases dramatically. The wind pressure at 40metres per second is 4 times the wind pressure at 20 metres per second. In addition, a bored pier 1500mm deep has approximately 50% the strength of one 2000mm deep and 25% the strength of one 2500mm.

One should note;

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- Footings should be designed by an experienced fabric engineer and a site specific geotechnical test to determine the bearing capacity of the soil should be undertaken to determine soil type and class,
- Footings are sometimes positioned too close to retaining walls or other areas of filled ground. Often the soil behind retaining walls, swimming pools and land other land that has been filled has not been properly compacted. Thus this soil has a much lower bearing capacity compared to adjoining land in its natural state, so footings placed in such soil will not perform as expected,
- Wind loads on the structures vary greatly, depending upon wind-speed and exposure of the site.
- Stability of structural footings is highly dependent upon site soil condition. Reactive soils like clay may actually shrink and move away from the footing to a considerable depth.

You may find web sites that give recommended post and footing sizes for various size shade structures along with other “rules of thumb”. Be very cautious about taking advice from such sites. There are too many individual circumstances present in any shade structure to enable “rules of thumb” to be used.

When considering fixing a new long span shade cloth structure to an existing building structure, it is important to remember that the loads from shade structures can be very considerable and many existing structures, especially domestic structures, will not be able to bear these loads. Again, an engineer should be involved in defining the loads and checking the suitability of the existing structure to which one wants to connect.

To maximise the likelihood of being able to attach to an existing structure it is best to attempt attachment to existing lines of structural support such as floor slabs and the intersection of beams and columns.

Attachments to brickwork must be very carefully done as masonry is made to resist compression loads and not the tensile loads of shade sloth structures.

Corrosion is a common problem; cables, bolts, fixings and especially steel frames can rust, especially in coastal environments and materials and finishes must be appropriate to the site requirements.

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D) Lack of adjustment

Many long span shade cloth structures are not designed with enough potential for adjustment. All shade cloths stretch during the life of a structure. When this happens it is very common to run out of adjustment at attachment points. Reasons include;

- Insufficient allowance for shade cloth stretch,
- Turnbuckles/tensioners that run out of adjustment,
- Shade cloth corners often move enough to touch the connection points themselves,
- All cantilever columns deflect under load (this needs to be allowed for in the design).

When the ability to adjust is exhausted, it is not possible to re-tension the shade cloth. It then becomes particularly susceptible to billowing and flogging which always leads to shortening the lifespan of the sail.

However, a shade cloth such as new Gale Pacific Commercial Heavy, with greater stiffness and better balanced biaxial properties requires less re-tensioning and may allow for a longer life due to the ability to maintain both tension and adjustment over time.

E) Installation issues

Many long span shade cloth structures are not installed well. Issues include;

- Structures in which the shade cloth deflects under wind load and comes in contact with items that have been placed too close such as trees, roofs, fences etc,
- Bolts not tightened correctly; turnbuckles and shackles not locked off to prevent undoing. (Long Span Shade cloth structures all move under wind load which causes threads etc to unwind themselves.)
- Most people, including installers, will intuitively position a shade cloth sail loosely at an equal distance from each corner then progressively pull the sail out to all corners. However, this is the **correct** procedure for a shade cloth such as New Gale Commercial Heavy, with balanced warp and weft properties, but **not** for all Heavy Duty 100% monofilament shade cloths on the Australian market.

F) Maintenance

Shade sails should be inspected every year or so. This small item can avoid large costs to replace or repair that may have been avoided. A small problem can be fixed before it becomes a major and expensive problem;

- A common requirement is to re-tension the shade cloth as it may have lost some of its pretension. Once pretension is lost the shade cloth is more susceptible to billowing and flogging.
- Any deteriorating stitching or small tears can be repaired.
- Turnbuckles, bolts, and shackles that have worked themselves loose through movement can be tightened.
- Washing will improve appearance but also removing mould, dirt and dust build up will allow water to pass through the fabric more easily and avoid potential ponding. Structures should be cleaned using manufacturer's recommendations, avoiding solvents etc.
- Metal supporting structures may need rust removal and fixing, chipped paint can be repaired.

Some other issues to remember regarding long span shade cloth structures.

Vandalism

- Consider position regarding distance from fences, roofs
- Climb ability of frame etc
- Visibility from public spaces

Shade

Sun angles move during the day and also during the seasons. It is best to use a software program which shows shade diagrams to make sure that the shade will be where it is most effective for usage. While additional height gives a feeling of space and lightness and discourages vandalism it usually means that the shadow will move more during the day. This is particularly important when used in structures over playgrounds or learning areas.

Certification by Councils

Most councils require a council submission before a shade structure is constructed. The local council must be contacted to find out the legal requirements.

Ignoring planning requirements may result in the structure having to be removed, redesigned or modified at a later date at the cost of the owner. Problems may also arise when selling a property if the searches reveal a structure is not certified.

Colour

Lighter colours tend to show dirt and particularly 'water marking' caused by water pooling and then drying, leaving areas with a dirty stain. This dirt can wash down through the porous shade cloth and be seen on the bottom surface. The same watermarking will occur on darker shade cloths but be much less noticeable.

Warranties

Most warranties on shade cloths refer to UV degradation. Damage or deterioration due to incorrect design, installation, wind forces etc is not covered by warranty. Be aware of the type of warranties offered on components, many shade cloths claim warranties of up to '15 years' but in fact these are pro-rata only. Shade cloths that offer full warranties on UV degradation are preferable.

UV Block percentage and Shade Factor performance

Remember that the published technical data regarding shade factors and UV block etc. are for a shade cloth not under load.

Once a shade cloth is installed and tensioned it stretches and these shade factors and UV block percentages reduce.

Note: The more stretch in the shade cloth when installed and over time the greater the reduction. A stiffer shade cloth used in a structure with good curvature that retains its design form will reduce this reduction.

Generally speaking darker colours will provide better shade factors and UVR percentages than light colours.

CONCLUSION

The importance of proper engineering and consideration of every component of the long span shade cloth structure has to be considered, as overlooking any component can shorten the life of the structure and even cause complete failure of the structure.

Notwithstanding any of the foregoing, it can be noted that The Gale Commercial Heavy shade cloth has the best combination of stiffness and a balanced warp and weft compared to any other heavy duty shade cloth on the Australian market. It also has the following attributes which assist in the design of a successful long span shade cloth structure;

- Be easier to install properly by most installers because of the balanced warp and weft,
- Better retains its physical properties, design shape, safety factors and structural reliability over time, which contributes to lower stretch over the life of the shade cloth structure requiring less re-tensioning and thus is less likely to run out of adjustment at attachment points.
- Better retains its UVR Block Percentage and Shade Factor throughout the life of the shade cloth.

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