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# Fabric structures subjected to wind and snow loads

Khalid Abdel Naser Abdel Rahim
Department of Civil Engineering, Faculty of Science and Technology, University of Coimbra,
Rua Luis Reis dos Santos 290, 3030-790 Coimbra, Portugal
*Corresponding author: khalid.ar@outlook.com

**Abstract -** Fabric materials are widely used nowadays in the construction of structures. However, fabric structures are constantly under the risk of tear and damage due to the stress-induced loads created by snow and wind. It is essential to improve the behavior of fabric structures by increasing its tearing resistance to protect the architectural beauty of fabric structures. This analytical technical note statement discusses the dynamic behavior of fabric structures exposed to wind and snow loads. Besides recommendations to future work will be presented to improve the tear performance of fabric structures under such loads.

**Index Terms** – Fabric, Snow load, Structures, Wind load.

## 1 INTRODUCTION

Nowadays fabric structures are widely used for their architectural modern beauty. Moreover, fabric materials are used in many structures including stadiums, external car parking, public tents, shelters, restaurants, swimming pools, and hotels. The main issue with fabric structure is its short lifetime service, majorly due to snow and wind loads. This manuscript proposes ways to increase the lifetime service of fabric structures and makes it permanent with some maintenance from time to time.

Fabric structures behave dynamically under snow and wind loads. Even though the mode of failure of a fabric structure is very common "tearing failure". Factors such as type of fabric, design, joints, fixtures, and external frame have a major impact on the response. Therefore, to improve the behavior of fabric structures subjected to wind and snow loads several procedures maybe implements to achieve a long term permanent service.

## 2 OVERVIEW

Irwinr and Wardlaw (1980) have elastically modeled a fabric roof with supporting cables for the Montreal Olympic stadium and investigating its wind behavior. Also, Tryggvason (1980) conducted aeroelastic modeling of pneumatic and tensioned for air-supported fabric structures.

Moreover, Huntington (1987) investigated the performance of the new materials technology used in permanent architectural fabric structures. Furthermore, Fujikake et al. (1989) have analyzed fabric structures under tension by proposed a non-linear analysis method by developing Lagrangian formulation to embrace high deformations in load simulation. Shan et al. (1993) analyzed frame-cable structures, however, the study was very wide and did not focus on fabric structures. Also, Birchall (2015) discussed the modern advances in architectural fabric structures in Europe and specifically the design and construction of the London 2012 Olympic Stadium and its context in the European fabric structures market. Besides, Stimpfle (2015) presented the recent developments in architectural fabric structures with an emphasis on Titan Plaza Shopping mall in Bogotá city in Columbia. Moreover, Heyse et al. (2015) investigated the high performance smart multifunctional technical textiles for the construction sector. Likewise, Eltahan (2018) studied how the structural parameters affect the tear strength of the fabric tents by carrying out a parametric study on tearing strength of fabric tents when induced to heavy loads. The research carried out by Eltahan (2018) has concluded that material properties are directly proportional to the right selection of the fabric texture and coating. Besides, the fabric tearing strength increases as the length of yarn float increases. Additionally, Guo et al. (2018) presented a modified material model describing the load-deflection behavior of air-supported fabric structure with decreasing stress. Finally, Shi et al. did a research on the shear behavior of architectural coated fabrics under biaxial bias-extension used two types of coatings were studied to determine the shear behavior. These are PTFE coated glass-fiber fabrics and PVDF coated polyester fabrics. Finally, Abdel Rahim (2020) has proposed Fiber Reinforced Polymers (FRP) on cold-formed structural steel elements to improve the structural thermal behavior. This idea could also be adopted and installed on fabric structures to increase the resistivity against snow and wind loads.

## 3 DISCUSSION AND CONCLUSION

The dynamic behavior of fabric structures subjected to wind and snow loads varies from deflection due to induced stress. Once the fabric material reaches its ultimate load-bearing capacity it starts to lose its tearing resistance and collapse. It is believed that the snow and wind loads eventually creates an alteration in the fabric material properties and its elasticity.

On the other hand, the tearing resistance of fabric structures varies depending on the type of fabric used. Accordingly, the tearing resistance of fabric structures could be increase by (1) using high-quality fabric material, (2) painting the fabric with adequate material, (3) fixing hydraulic system joints, and (4) installing Fiber Reinforced Polymers.

### Conclusion and recommendations for future work

As a conclusion, the behavior of fabric structures subjected to wind and snow loads could be improved as below:

- Using high tensile strength fabric material.
- Coating/painting the fabric with waterproof material.
- Installing hydraulic cables between the fabric sections to reduce the stress concentration.
- Reinforcing joints, connections, and bottom soffits with Fiber-reinforced polymers.

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