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# A Review Paper on Fabric Formwork

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**Abstract:** *Fabric formwork is constructed using textile sheets (usually porous) made of synthetic fibers (typically nylon, polyesters, polypropylene) that are fabricated into containers to contain concrete during its placement and curing. The form takes the designed shape under the pressure of the wet concrete. Because concrete is the most widely used construction material in the world, improvements in the economy and durability of concrete structures has significant implications worldwide. Thus, there has been increasing interest in the use of fabric formwork as an alternative to the conventional steel, aluminium or timber formwork. It can be used effectively in geotechnical, civil engineering, architectural and under-water constructions. It can be also used in both cast-in-place and precast applications, and offers several advantages over conventional formwork technology as well as providing opportunities for innovations in architectural and structural concrete members. The present paper offers a brief history of fabric formwork, as well as a review of the types, applications, raw materials, and problems remaining to be solved.*

**Keywords:** Fabric formwork, Architectural, Structural concrete members, Geotechnical.

## I. INTRODUCTION

As many decisions in daily life just make sense, they also do in architectural practice. Unknowingly, which experience or knowledge exactly lies at the base of it. Even if the decision is substantiated with sketches or calculations, a vast amount of possibilities is unconsciously filtered away merely by the choice of method. This is because behind our strategies and tactics lie our assumptions and intuition1. They are not often argued, but have great influence on our way of researching and decision making. The course is interesting because it's not leading an investigation towards a design solution, but rather towards an investigation method itself. Fabric formwork is constructed using textile sheets (usually porous) made of synthetic fibers (typically nylon, polyesters, polypropylene) that are fabricated into containers to contain concrete during its placement and curing. The form takes the designed shape under the pressure of the wet concrete. Fabric formwork offers a fundamentally different approach to forming cast concrete because, unlike conventional formwork systems, these molds are flexible. They also offer a porous wall to the fresh concrete, improving the concrete's strength, durability and finish quality.

Further, the flexibility of the formwork membrane allows simple methods of forming structurally efficient variable section members, thus offering reductions in concrete volumes and dead weight of the cast structure. Per-square-foot material costs for fabric formwork are significantly less than most conventional formwork materials, and their low weight and volume significantly reduce storage, transport, and disposal costs (see for example [1] and [2]). This is where the course, the gained knowledge and deeper understanding of heuristics come into practice. By knowing what the assumptions, purpose and questions are, the best strategy and tactics for the thesis research, but also for the guidance tool, can be determined. The method is selected during the thesis research rather than before. Creating an overview and testing a guidance tool, with both items variable, follows an iterative process. This causes the researcher to keep an open mind, which led to a very interesting result. With this new experience and insight, the next research will be conveyed even more structurally and open minded. It will let the research method be investigated in an iterative way, parallel to the research question itself. This is the most valuable skill to be gained from this course.

## II. FABRIC FORMWORK ADVANTAGES

### 2.1 Improved Strength, Durability and Sustainability.

Studies of the properties of concrete [5] have indicated that the common use of excess mix water to achieve workability is a serious threat to concrete quality if this excess water remains in the hardened concrete, thus reducing strength and

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durability. Evacuation of excess mix water, after the concrete has been placed, can be achieved successfully by the use of porous fabric formwork, by forcing excess mix water through the porous membrane by the pumping pressure and/or the weight of the concrete itself. The consequent result is the production of high quality concrete with increased compressive strength and high durability at the casting surface, which in turn increases the strength and service life of a structure, resulting in a more sustainable construction. In terms of whole-life cost accounting, fabric formwork will always offer the most cost-effective solution if the cost of repairs and maintenance of the structure is taken into account.

### 2.2 Improved Surface Quality

Along with excess mix water, air bubbles are also forced outside through a porous fabric formwork membrane. This results in a very high quality surface finish that is visually more aesthetically pleasing than concrete cast in conventional water-tight forms. This bug hole-free finish also reduces or eliminates the labor costs of patching or otherwise finishing exposed concrete surfaces. Additionally, since the surface shapes and textures produced in fabric-cast concrete are visually indistinguishable from the textiles that formed them, they present architecturally "softer" and more appealing surfaces and shapes [6] [7]. This aesthetic advantage can eliminate the substantial costs associated with the architectural sheathing of concrete structures with veneers or other covering materials.

**Structural and architectural shape formatting.**

Simple methods of forming curved structurally efficient shapes have recently been developed [3] offering significant reductions in materials and dead weight. Architecturally and sculpturally interesting shapes, unavailable from conventional forming techniques, can also be achieved.

**Lower formwork material and storage costs.**

In many countries around the world, including most of the Middle East, wood is scarce, requiring formwork timber to be imported great distances. In tropical climates wood quickly decays, severely limiting the multiple use of wooden formwork materials. Even in North America where wood is readily available, formwork fabrics are approximate 1/10th the cost of formwork plywood and their extremely low weight and volume significantly reduces or eliminates formwork storage and disposal costs.

**Labour savings**

Labor costs associated with the assembly and stripping of formwork can be significantly reduced (by 27% according to [1]), with consequent improvements in work cycle times. The Fab-Form company claims even higher labor savings for their "Fast Tube" column form [8]. Some fabric formworks, such as pile jacket forms and fabric strip and point footing products eliminate stripping cost completely because the low-cost formwork remains with the casting.

**Protection from "Rising Damp".**

Fabric-cast footings that retain their waterproof formwork protect the foundation structures they support from moisture penetration from below [8].

**Adaptable to uneven ground conditions.**

When used to form foundation footings, fabric forms adapt to uneven or rocky ground with minimal labour compared to traditional methods

## III. HISTORICAL BACKGROUND

In Mexico in 1951, the Spanish architect Felix Candela draped burlap fabric between timber arches to form corrugated parabolic concrete shell structures [19]. In the 1970's, the first strictly architectural use of flexible formworks was done by Spanish architect Miguel Fisac, who used polyethylene film sheets as formwork for precast textured wall panels [20]. Structural, architectural, and building applications have been invented and developed since the 1980's: fabric formed walls by Japanese architect K. Unno ([15] fabric foundation footing formwork and column forms by R. Fearn (Fastfoot Industries Ltd.) [8], and systems for casting columns, slabs, panels, and beams by M. West ([3, 4, 6, 7] and]. Also during

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the 1980's, the first engineering studies of increased concrete strength and durability in concrete cast in permeable fabric molds were begun ([13] In Japan, silk fabrics have been applied as a lining with timber formwork to achieve a high fair-face finish and durable concrete

## IV. RESEARCH-METHODOLOGICAL REFLECTION

However, with the rise of digital technology mathematical argumentation gained more attention. Interest have moved a bit from discursive to mathematical on the spectrum of logical argumentation by Groat and Wang7. Whereas Brand worked out and connected literature and experience, computers can now make numerical models with vast amounts of calculations in a short time. This has created new opportunities over the last 30 years. One example is Building Information Modelling and Computer Aided Design, also known as BIM and CAD. As Aksamija and Iordanova state: CAD and BIM have changed architectural practice tremendously and created a paradigm shift8. Certain aspects of designs can now be expressed in numbers and formulas, and thus studied more mathematically. This gives way for new logical frameworks and treatises to be developed in a new architectural field. An example of such method is to use a rule-based construct for analysis of a space or form, like the one of Hillier and Hanson in The Social Logic of Space9. The architectural floor plan is reduced to an abstract map with numerical quantities attached to it for analysis. They found that although many residential floor plans in England are different, the hierarchy of different relations between the rooms stay the same. And so, they managed to shed light on a social or cultural aspect in architecture through a abstract model with numerical values. This also accounts for the thesis study in which numerical values are added to a comprehensive compendium, so that the options may be comparable and thus suited for a guidance tool. The big importance of these researches is the understanding of research methods and methodologies. They are extremely influential for the outcome of the research, since with the translation of qualitative to quantitative values a lot of information is filtered. The numerical values will only show one isolated aspect of the object they represent. However, it makes qualitative topics much more comparable. Therefore, this method is very useful, but should be used with caution.

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