

A close-up photograph of a hand touching a dark, textured fabric formwork structure. Several white ropes are draped over the fabric, creating a series of loops and shadows. The lighting is dramatic, with strong highlights and deep shadows, emphasizing the textures of the fabric and the hand.

Mark West

the fabric formwork book

methods for building
new architectural
and structural forms
in concrete

The Fabric Formwork Book
*Methods for Building New
Architectural and Structural
Forms in Concrete*

Mark West

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The Fabric Formwork Book

Concrete is the most used man-made material in the world and is the fundamental physical medium for most of the world's architecture and construction. The character of concrete is largely the product of the rigid moulds that have shaped it since its invention in antiquity. The advent of flexible moulds, however, marks a radical break from conventional practice – and conventional concrete architecture. *The Fabric Formwork Book* provides the first comprehensive handbook on the emerging technology of flexible moulds for reinforced concrete architecture.

Written by the foremost expert in the field, this book takes a comprehensive and generous approach that includes technical, historical and theoretical aspects of the subject. The book:

- concentrates on simple flat-sheet formworks
- contains detailed technical descriptions of how to construct a wide range of formworks for various applications
- features case studies from around the world
- critiques the difficulties and advantages in each case it covers
- provides instruction and guidance on how to model and design fabric-formed structures
- includes the most comprehensive history of fabric formwork yet published
- features essays from guest expert authors, which explore the theoretical, historical, and poetic significance of flexibly formed architecture and structures
- discusses fabric formwork as an exemplary approach to sustainable construction through its simplicity and efficiency.

Beautifully designed and illustrated with a superb range of images, diagrams and technical drawings, the book both informs and inspires. Speaking directly and plainly to professionals, students and academics, the language used is both clear and precise, and care is taken to avoid opaque technical or academic jargon. Technical terms, when used, are clearly described and a special glossary is included to make the book as widely accessible as possible.

Mark West is an artist, builder, professor of architecture, and inventor of numerous flexible mould techniques for concrete construction. He was the founding Director of the Centre for Architectural Structures and Technology (CAST) at the University of Manitoba, and is currently a visiting professor at the Massachusetts Institute of Technology, as well as teaching at other schools of architecture and engineering internationally.



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"*Fabric Formwork* inspires us to seek poetry in the practical. With this beautiful book, Mark West demonstrates an original, magical, and sustainable approach to shaping one of the world's oldest man-made building materials. He and his co-authors offer an encyclopedic introduction to the counterintuitive, yet persuasively sensible, use of fabric to shape concrete."

Kim Tanzer, FAIA, Professor Emerita of Architecture, University of Virginia

"With research becoming central to many emerging architectural practices, Mark West represents one of the few academics with decades of accomplished work bridging design with material sciences. *The Fabric Formwork Book* radicalizes our conception of what architecture can become."

Nader Tehrani, Principal of NADAAA, and Dean of the Irwin S. Chanin School of Architecture

To Nada for everything

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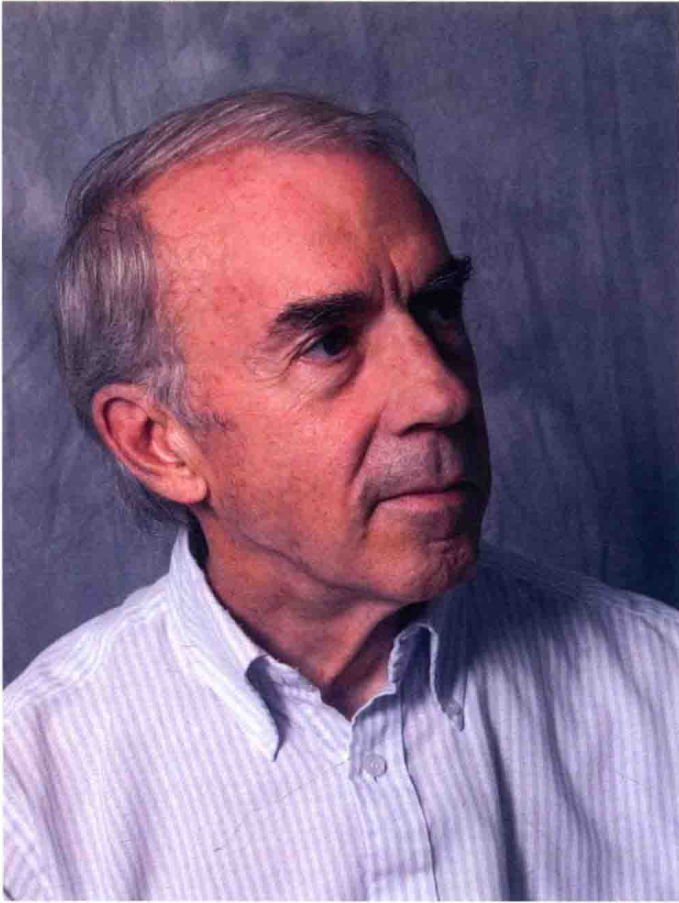
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Mark West is an artist, builder, professor of architecture and inventor of numerous flexible mould techniques for concrete construction. He was the founding Director of the Centre for Architectural Structures and Technology (CAST) at the University of Manitoba – the first academic laboratory dedicated to fabric formwork research and development. He currently teaches at the Massachusetts Institute of Technology (USA) and as a visitor at other schools of architecture and engineering internationally.



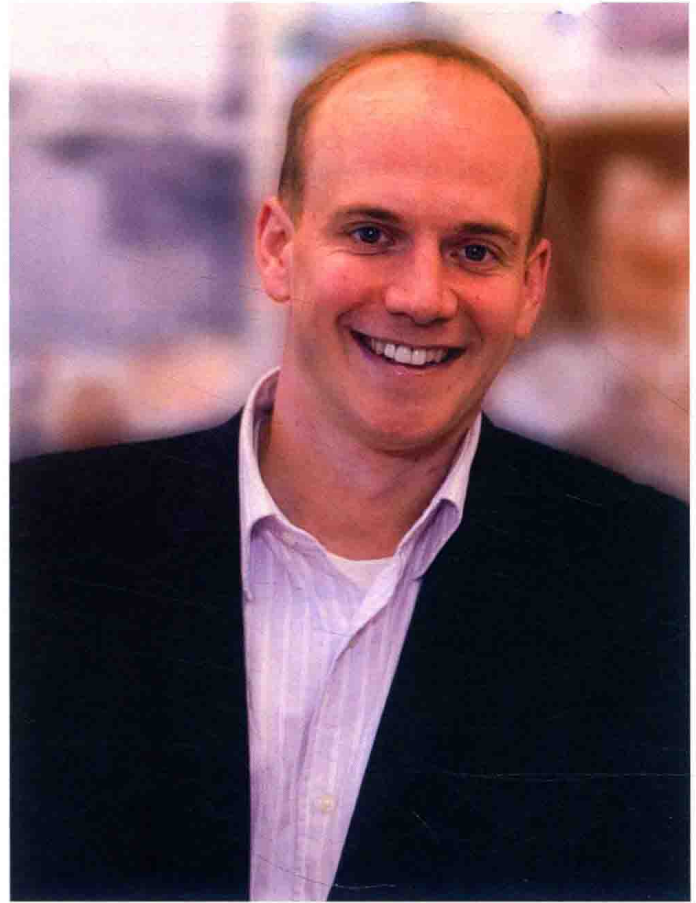
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(Co-author of Chapter 6 *Connections*, and Chapter 11 *Non-Pressurized Moulds*, and this book's web-based resource on Fabric Formwork Models)

Ronnie Araya is a Chilean architect, educator and designer, now working in Montreal, Canada. He studied architecture at Pontificia Universidad Catolica de Valparaiso, and post-professionally as a member of the "Open City Group" of architects in Ritoque Chile. He is a leading researcher in fabric formworks. In his many years as a Research Associate of the Centre for Architectural Structures and Technology (CAST) he has invented numerous fabric formwork techniques and designs, and is actively engaged in fabric formwork research, and construction projects internationally.

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INTRODUCTION

The use of flexible moulds for concrete construction represents a very simple technical change – one common material (plywood, for example) is replaced with another (a plastic tarp, for example). Yet the results of changing rigid panels for flexible membranes have profound repercussions for sculptural, architectural, and structural form, as well as for construction logistics and economy.

While most technical advances occur at the outer “leading” edges of a field – what we might call the “branch” or “twig” level of things – the introduction of flexibility into concrete formwork represents a deep, simple, and fundamental change at the “trunk” level. That is to say that this simple change demands a re-thinking of the entire “tree” of concrete architecture. The hard, flat, prismatic, world of cast concrete is suddenly, and effortlessly, transformed into soft and sensual curvatures that love the play of light. Heavy, expensive, rigid moulds, destined for the pyre or landfill, become light, efficient, inexpensive, and reusable membranes. Utility and beauty are met in the same body. The introduction of flexible moulds also presents the designer and builder with some unexpected and provocative questions about their own potential roles in the design and construction process.

As the first comprehensive book on fabric formworks, this volume attempts many things. It does not, however, cover all aspects of flexible moulds. This book is built to provide practical knowledge that can be used directly by designers, builders, and artists, and as such tries to avoid spreading itself too thin. Conspicuously missing are any chapters on inflatable moulds, or underwater and geotechnical applications of flexible moulds – both important and interesting subjects, but consciously left outside the scope of this work. Instead, this book concentrates exclusively on flat-sheet moulds. There is plenty to choose from within this concentration, as it covers a very broad range of architectural and structural engineering applications, including the full array of reinforced concrete structural members and components, for both cast-in-place and precast construction. While mostly focused on reinforced concrete constructions, many of these techniques can be used for other kinds of moulds, including purely sculptural constructions.

Finally, because this book is fundamentally about mould-making, the otherwise important subjects of reinforcing design, and concrete mix design are not included. In any event, the change of mould materials from rigid to flexible does not affect either reinforcing or concrete mix design. These remain the same as in conventional practice, although mention is made of these topics, here and there, with respect to certain details peculiar to their use in flexible moulds.

How to use this book

The book's structure

There are two main parts to the book:

Part 1, ABOUT FLEXIBLE FORMWORKS consists of three chapters each taking a broad view of the subject. First is an opening essay On Flexibility, followed by The History of Fabric Formwork by Diederik Veenendaal, and finally a chapter on Structural Intelligence in Flexible Materials by Edward Allen, John Ochsendorf, and myself.

Part 2, CONSTRUCTION begins with its own separate introduction, followed by nine practice-based chapters. The first two chapters of this section contain information on Textiles and Concrete respectively. These are followed by seven "How-To" chapters focusing on how to construct a full range of fabric formworks.

You will find that the information contained throughout the book is often interlaced with cross-references to different sections and chapters. This is because knowledge in one area is often important to several other aspects or applications. These cross-references (which are highlighted in blue) can be treated like hyperlinks in digital media, making this book partly non-linear in its structure. You may need to visit two, or more, locations in the book to get the full description of a particular subject. For example, different parts of a specific construction may be used in multiple places to illustrate/demonstrate several different aspects of mould-making. Images and descriptions of that single construction will, therefore, be distributed here and there as needed. This interlacing of information, while perhaps a bit awkward at times, reflects the way in which material, technical, design, and aesthetic concerns in this field are mutually dependent. The book is dense with information, and a full description of a particular thing you might be interested in may require piecing together multiple discussions.

Nomenclature

Every effort has been made to make the text clear and understandable to novice and experienced builders/designers alike. Many technical terms used are part of a builder's or engineer's normal vocabulary, while others are unique to flexible fabric mould-making. If you do not recognize or understand a particular term used in the book, try the glossary – chances are you'll find definitions for your mystery words listed there.

Certain terms are used interchangeably: for example, there is no difference in meaning between Fabric, Textile and Cloth. Likewise Formwork and Mould mean exactly the same thing, as do "fabric mould", "membrane mould", and "flexible mould". These synonyms are used strictly to avoid monotony and repetition in the text (thinking of you, dear reader). Other, more technical terms that are used interchangeably, are noted at the start of individual chapters.

Specific project locations, dates, authors, etc. are not included in the body of the text, but can be found noted in image captions.

Finally, the methods and details revealed here, describe only the shoreline of a much larger, unexplored, continent. A great deal remains to be invented and discovered at your hands. Despite its multitude of "How-To" pages, this is not a cookbook. It is, instead, made as a toolbox. It is yours to dump out, re-organize, and deploy, according to your own lights (and likes).