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Shveta Mohan · Vijayalaxmi J.

Embodied and Operational Carbon in Buildings

Strategies to Decarbonize

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Ms. Shveta Mohan dedicates the Book to her grandfathers.
Dr. Vijayalaxmi J. dedicates the Book to all her students.

Foreword

The book *Embodied and Operational Carbon in Buildings* by Ms. Shveta Mohan and Prof. Vijayalaxmi J., is a must-read book recommended to all building, energy, and environmental professionals, decision-makers, and students. It addresses and provides insights and useful scientific and engineering solutions for a very important problem in the built environment: 'Embodied and Operational Carbon and Emissions'. Considering that the energy efficiency of buildings is improving fast, and the operation energy consumption of the building sector is expected to decrease significantly soon, embodied energy and embodied carbon will be one of the principal terms in the energy and environmental balance of buildings. It is, therefore, necessary to understand the science and engineering related to the embodied and operational carbon, to develop methodologies to assess its magnitude, to evaluate its impact under various local and regional conditions, and most importantly to develop, implement, and assess appropriate solutions to minimize or at least reduce significantly its impact. The present book is among the very few documents that address the problem. It provides comprehensive and well-organized knowledge and information and succeeds in informing and educating the reader on almost all important aspects of the problem and finally offering a complete picture of the necessary scientific background including both the existing knowledge and future scientific developments.

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Preface

The Emissions Gap Report 2023 states that temperature records have escalated and climate impacts are to intensify as greenhouse gas emissions hit new high. The SDG 13 seeks to take urgent action to combat climate change and its impacts. Concentrations of greenhouse gases continued to increase in 2020, reaching new record highs. It was one of the three warmest years on record, with the global average temperature about 1.2 °C above the 1850–1900 baseline. It is imperative for all countries to do their part to meet the commitments to reduce carbon emissions. India is committed to reducing CO_2 emissions by 1 billion tons by 2030; reducing carbon intensity below 45% by 2030; and finally achieve a Net-Zero emission target by 2070. In the building sector, energy consumption and carbon emissions in the built environment are largely born out of the use of electricity and building materials. In India, under the current scenario, embodied and operational emissions have a share of 40% and 60%, respectively. India's total building floor area is predicted to be around 57.6 billion m^2 by 2050 from 15.8 billion in 2015. With the conventional building systems, this will escalate the demand for construction materials like cement, steel, bricks, glass- and all of these are energy and emissions intensive materials. Hence, there is a need to reduce the use of carbon intensive materials and adopt low carbon emitting materials.

This book offers the basics of embodied and operational carbon while discussing the inclusion of carbon emission in the GBRS at global and national level. This book also critically explores the important topic of embodied and operational carbon of buildings with insights on the strategies to measure and reduce embodied carbon in buildings through a case study and application approach. This approach assesses the impact of embodied carbon on the choice of structural systems, alternate building materials, alternate building technologies, and air conditioning system. The impact of these alternate measures in reducing embodied and operational carbon is analyzed by demonstrating its use on a base case building.

This book is written with a hope that architects, construction engineers, interior designers, architecture students, civil engineering students and all those associated

with the construction industry gain an insight into their roles in reducing carbon emissions in order to achieve the National and International commitments.

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Contents

Abbreviations

AAC	Autoclaved Aerated Concrete
ASHRAE	American Society of Heating, Refrigerating, and Air Conditioning Engineers
BIM	Building Information Modelling
BLA	Bamboo Leaf Ash
BREEAM	Building Research Establishment Environment Assessment Methodology
BUA	Built Up Area
CBAM	Carbon Border Adjustment Mechanism
CF	Carbon Footprint
CFC	Chloro-Fluoro Carbons
COP	Coefficient of Performance
CoP	Conference of Parties
CSEB	Compressed Stabilized Earth Blocks
DGU	Double Glazed Unit
EAC	Energy Attribute Certificate
EC	Embodied Carbon
EC3	Embodied Carbon Calculator
EC3	Embodied Carbon in Construction Calculator
ECBC	Energy Conservation Building Code
EE	Embodied Energy
EOL	End of Life
EPD	Environmental Product Declaration
EPI	Energy Performance Index
EPI	Energy Power Intensity
EUI	Energy Use Index
FaL-G	Fly Ash Lime Gypsum Blocks
FSC	Forest Stewardship Council
GBRS	Green Building Rating Systems
GGBS	Grund Granulated Blast-furnace Slag
GHG	Greenhouse Gas