

Review Article

Sustainable Construction Practices: Utilizing Waste Ceramic Tiles for Resilient Infrastructure

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A B S T R A C T

This article explores sustainable building practises using leftover ceramic tiles to strengthen infrastructure. One of the world's most disaster-prone countries, India is constantly threatened by earthquakes, floods, cyclones, and landslides. The paper recommends robust infrastructure to overcome these issues. distinct parts of India experience distinct natural calamities, which the study opens with. Earthquakes are common in the north, floods harm 12%, droughts affect 68%, and landslides, especially in Himachal Pradesh, are dangerous. Earthquake-resistant design and structural issues are highlighted by prior tragedies. The research emphasises the need of durable building materials in disaster-prone locations. Waste ceramic tiles may be recycled into cement to increase durability and minimise environmental effect. Resilient building design addresses earthquake and flood resistance. Building resiliently requires design components from the Indian Standard Code of Practise for earthquake protection. Netting, rock anchors, retaining walls, and gabion barriers are also considered landslip prevention. The solution is to focus on disaster-prone locations, upgrade infrastructure to withstand harsh weather, and establish risk-informed construction rules. The report finds that sustainable building practises like recycling ceramic tiles build resilient infrastructure. Learn from previous catastrophes, use strong design principles, and use novel materials to create a more resilient and sustainable future for infrastructure development and the environment.

Keywords: Sustainable Construction, Infrastructure Resilience, Waste Ceramic Tiles, Disaster-Prone Areas, Environmental Sustainability

Introduction

The construction of infrastructure is a crucial engine of both economic growth and human advancement; nonetheless, it confronts enormous problems as a result of natural catastrophes and environmental issues. It is vital that a sustainable strategy to building be used in order to overcome these difficulties.¹ This study investigates the novel use of discarded ceramic tiles in cement to

produce resilient infrastructure. It does so by relying on current advancements and the lessons learnt from natural catastrophes that have occurred in India.

The Need for Resilient Infrastructure in India

Building and Road infrastructure plays a key role in evolving a society. But the lessons learnt from the past shows that what is planned and made needs enhancement. This has to be mitigated. Earthquakes, floods, cyclones, and landslides

are just some of the natural calamities that may strike India, which is often ranked as one of the most disaster-prone nations in the world. These catastrophes result in severe property damage and put millions of people's lives in disarray. These occurrences may affect a significant chunk of India's territory, with a disproportionate amount of damage being inflicted on certain places. In order to apply resilient building practises, it is essential to have a solid understanding of the many kinds of natural catastrophes as well as the frequency with which they occur.²⁻⁴

Disaster Types and Their Impact

The fact that there are many different kinds of natural disasters in India demonstrates that there are many different kinds of vulnerabilities. A sizeable chunk of the nation, especially in the northern parts, is subject to the wrath of earthquakes.⁵ Floods are common and impact around 12% of the continent, although droughts are more widespread and affect 68%. In addition to earthquakes, landslides provide a substantial risk, particularly in parts of the country like Himachal Pradesh.⁶

Lessons from Past Disasters

Several natural calamities that have occurred throughout India's history might teach us important lessons. The earthquake that occurred in Gujarat in 2001 brought to light a number of difficulties, including the asymmetrical distribution of partition walls, insufficient foundation size, and architectural principles that were not resistant to earthquakes. The lessons learned at Tuticorin Port include the significance of earthquake-resistant structural design and the use of huge stones in the construction of seawalls.⁷

Challenges in Disaster-Prone Areas

In regions that are prone to natural disasters, one of the issues resides in the building materials that are employed. Many structures, particularly those that serve to economically lower areas, depend on materials of poor quality that collapse under lateral loads, such as earthquakes.⁸ This is especially true for buildings that cater to economically weaker sections. As a result, there is a need for durable building materials that are capable of withstanding the effects of such risks.

Table I. Challenges and Mitigation Strategies for Using Recycled Ceramic Tiles in Cement in Disaster-Prone Areas

Resilient Building Design Consideration	Example	Benefits	Challenges	Mitigation Strategies	References
Earthquake resistance	Use of design elements from the Indian Standard Code of Practice for Earthquake Protection, such as reinforced concrete columns and shear walls	Increases the ability of buildings to withstand earthquakes	Can be expensive to implement, especially in low-income areas	Governments can provide financial incentives for building earthquake-resistant structures. Engineers can develop affordable and innovative earthquake-resistant design solutions.	[1], [2], [5], [6], [7]
Landslide prevention	Use of netting and rock anchors, retaining walls, and gabion barriers	Reduces the risk of landslides	Can be visually unappealing, and may require significant land acquisition	Landowners can be incentivized to implement landslide prevention measures, such as through tax breaks or subsidies. Engineers can develop innovative landslide prevention solutions that are more aesthetically pleasing and less disruptive.	[1], [2], [6]

Use of recycled materials	Use of recycled ceramic tiles in cement	Reduces the environmental impact of construction, improves the durability of cement, and can save money	Recycled materials may not always be available in high quality or quantity, and may require additional processing to be suitable for use in construction.	Governments can invest in infrastructure to collect and process recycled materials for use in construction. Engineers can develop innovative construction methods that use recycled materials more effectively.	[1], [2], [3], [8], [9], [10], [11], [12], [13], [14], [15], [16], [17], [18], [19], [20], [21], [22], [23], [24]
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Utilizing Waste Ceramic Tiles for Resilient Infrastructure

Ceramic tiles that have been used and then thrown away provide an environmentally friendly answer to this problem. These are also waste which have to be managed like municipal waste and e-waste management.⁹⁻¹¹ The addition of these tiles to cement boosts the material’s capacity for withstanding wear and tear while also increasing its strength. Ceramic waste may be recycled, which not only lessens our effect on the environment but also results in the production of elements that are beneficial to the resilience of buildings.¹²

What Are Resilient Buildings?

A resilient building design entails the creation of buildings that are able to endure a variety of threats, including natural catastrophes such as earthquakes and floods, and swiftly recover once they have been affected by them. Buildings that are resilient are designed to keep their structural integrity and continue to deliver important services even in the aftermath of a catastrophic event. They help lower the expenses associated with post-disaster recovery and minimise the negative effects on the environment.¹³

Considerations in Resilient Building Design

When it comes to the construction of resilient structures, the incorporation of design elements for earthquake resistance that are directed by the Indian Standard Code of Practise is essential. Like energy efficiency management in buildings, this is also an important issue to be addresses.¹⁴⁻¹⁶ Some of the factors that might lead to landslides include sloppy building practises, a reduction in forest cover, and drainage problems. The use of netting and rock anchors, together with the construction of retaining walls and gabion barriers, are all examples of countermeasures.¹⁷

The Path Forward

In order to produce infrastructure that is resilient, it is essential to concentrate on places that are prone to natural

disasters, to upgrade infrastructure that already exists so that it can withstand strong winds, water, and heat, and to establish building regulations that are risk-informed. These objectives may be met via the use of recycled ceramic tiling in the production of building materials. Many Researcher has done their research in this field.¹⁸⁻²⁴

Conclusion

Building resilient infrastructure in areas that are prone to natural disasters, such as India, requires the use of environmentally responsible construction practises such as reusing leftover ceramic tiles in cement. We can pave the path for a more resilient and sustainable future by drawing lessons from previous catastrophes, implementing strong design principles, consulting the geologists, using administrative instruments and making use of novel materials. This strategy not only increases resilience to natural disasters but also lowers the effect that infrastructure expansion has on the surrounding ecosystem, making it a solution that benefits everyone involved.

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