

# AN EXPERIMENTAL STUDY ON LEGO-INSPIRED BLOCKS: A REVIEW

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**Abstract** - Concrete is one of the most broadly utilized item on the planet and utilized for substantial Infrastructure improvement of every nation. Because of this high demand there is consistently an approach to improve the concrete. A concrete masonry block (CMU) is a rectangular block of masonry that is used in the construction of buildings. Because of the great range of aesthetics that may be created using CMUs, they are considered to be among the most adaptable construction components now available. The blocks, which can be stacked like giant Legos, may be used to form sturdy, poster putty walls and building structures. Concrete Lego bricks are created by pouring the concrete in steel moulds and setting them aside to dry. Clutch power is generated by the interlocking mechanism, which includes (male) studs & (female) recesses. A few of these materials is the Lego brick, which would be a high-quality product that is produced by hyper pressing rather than via the use of heat. An examination of the benefits of the Lego piece in contemporary building, as well as the technology that goes into its manufacture and, in particular, its use in masonry. It is explained what raw materials are utilised in the manufacturing process, as well as the characteristics of the form and structure of the product.

**Key Words:** Lego Blocks, Interlocking, Concrete

## 1. INTRODUCTION

According to the McKinsey Global Institute's 2017 Construction Report, labour productivity in the United States fell by more than half between 1968 and 2010. This is in line with the global trend of Construction productivity is falling. The United States and a number of other developed countries that have negative construction productivity growth despite maintaining economic development have been labelled as "declining leaders. "Overall production is high. Construction productivity is lagging. The US economy loses roughly 0.6 trillion dollars every year, and the world economy is worth 1.6 trillion dollars. Because of the low productivity as a result of a range of issues, such as a skilled labour scarcity Building workers are less willing to work on construction sites, have a slower adaptability to new technologies, and are increasingly concerned about the harmful effects of construction activities on the

environment. During the process of emergence Digital manufacturing methods have been used in a variety of applications. Construction remains one of the few businesses that has not drastically modernised its operations. one of the most stalled industries, employing technologies created almost a hundred years ago. While the construction industry is full of exceedingly predictable procedures, the widely held of building projects are still considered as never-to-be-repeated prototypes, which means they must be started from scratch manually, wasting time as well as cost savings.[1]

Automatic Brick Laying was the term given to Lego brick construction in Denmark in 1949. In 1951, the phrase "Automatic Brick Laying" was changed and given its ultimate name: "Lego brick," which was first commercially commercialised in 1958. Since the 1970s, pressed cement-sand brick has expanded throughout Africa, Canada, the Middle East, and India, starting in Africa.[1]

Despite their effectiveness, precast building techniques now in use have limits. The efficiency of building is limited by the structures' designs. Most prefabricated pieces are now joined with damp joints (fresh grouts) that need period to cure. Limited construction efficiency in the framework of transportation infrastructure, such as bridges, increases downtime and exacerbates traffic congestion, jeopardising suppleness, monetary advantages, and eminence of life. Without factoring the negative consequences on the milieu and human health, traffic delays cost billions of dollar bill in lost petrol and person hours each year. Because existing structures cannot be reprocessed, a substantial amount of creation and demolition (C&D) trash is generated [1]

### 1.1 Need of Lego-Inspired blocks

Inspire by Legos that can be constructed with dry joints and dismantled for use with different things, this work proposes blocks made of concrete which can be assembled with dry joints to form a variety of different constructions.

Ecological purity due to the composition of the Lego brick, in which there are predominantly natural components. Ease of processing; - Ease of installation due to the presence of the interlocking joints in the modules and the straightening of the geometric shapes of bricks

## 1.2 Objective of Study

The objectives of the study are listed below:

1. To Study the utilisation of Lego similar cement bricks as a contemporary building technology.
2. To analyse the mechanical characteristics of the blocks and impact of containing steel slag.
3. With the dry connections, the constructed created with the blocks may be removed, and the pieces could be used to build new structures with varied configurations.
4. The suggested Lego inspired building is capable to considerably increase the construction proficiency, lessen the detrimental effects on the accepted surroundings triggered by traditional edifice ways and developing it as a low - cost houses method.
5. To promote the usage of both in Slums Upgradation Projects, AFH Projects.
6. To minimise the total cost to build construction.

## 2. Literature Review

By studying literature review from various authors some were concluded which are follows

### 2.1 Lego Blocks

**Ahmad, Sajad. (2014)** stated the term "masonry" refers to the use of hand-placed clay units, material structural clay tile, glass lump, natural stones, and other similar materials in building. The components themselves are also referred to as masonry. Bricks, stones, marbles, limestone, dolomite, acrylic, plaster, and tiles are popular masonry unit materials. Masonry units are often constructed in a very durable manner. The ingredients used, the quality of the mortar and workmanship, and the pattern in which the units are constructed, all have an impact on the overall masonry construction's longevity. The mortar joint is the weakest portion of a brickwork wall because the use of lime instead of aggregate affects the inclusive stability of the junction. The necessity for expert masons to carefully and precisely fit each block demands the utilisation of highly paid masons. [2]

**Shankar Rao BSanthosh JTalluri R (2015)** stated that for many years, problems linked with building sites have been recognised. The construction sector must be able to sustain a globe that is experiencing continued population increase and economic progress. For easier laying, superior appearance and finish, interlocked standard concrete blocks are appropriate materials for walkways, parking lots, gardens, and other locations. However, it is now generally used in a variety of submissions where old-style pavement construction utilising hot bituminous mix or cement concrete expertise is neither possible nor acceptable. Alternative building processes and materials are being explored due to increased construction material prices and the requirement to adhere to sustainability. Greater

knowledge of products made using locally accessible materials in addition indigenously generated mineral intermixtures is required to expand the uses of concrete paving blocks. Masons.[3]

**Vianna Bahiense, Alexandre. (2020)** stated a dose up process meant for concrete paving pavements that include decorative rock surplus, with the goal of achieving mechanical and moulding standards while also ensuring the mineral industry's long-term viability, despite environmental concerns about waste creation. The minimal void ratio is used to determine the concentration of the sand, coarse aggregate, and waste fines. [4]

**Bao, Yi. (2020)** stated analyses the possibility of a new building paradigm — Lego-inspired construction. This study proposes blocks constructed of flexible concrete that can be situated built with dry joints and dismantled for dissimilar items, inspired by Lego bricks that can be constructed and dismantled for different applications. The bricks are utilised to create a prototype footbridge in order to show the assembly method, which is suitable with robotic construction systems. Mechanical tests revealed that the footbridge can handle a considerable amount of weight.[1]

**Jenson J (2021)** stated the emphasis of many social policy communities these days is on 'new social hazards.' Despite a strong preference for fiscal restraint, they believe that these dangers need "social expenditures." The focus on investments, activation, and the future is seen to be the best anchor for reforming national welfare systems. We may talk of a transition toward that LEGOTM paradigm because of convergence around three ideas: life-long learning, a future orientation, and the social advantages of an engaged society. However, much as when Keynesianism was paradigmatic, we recognize that there are differences in how the paradigm is applied.[5]

### 2.2 Compressive strength

**Akeem \*Raheem A. (2012)** The emphasis of many social policy communities these days is scheduled 'new social hazards.' In spite of a strong preference for fiscal restraint, they believe that these dangers need "social expenditures." The focus on investments, activation, and the future is seen to be the best anchor for reforming national welfare systems. We may talk of a transition toward that LEGOTM paradigm because of convergence around three ideas: life-long learning, a future positioning, and the social advantages of an engaged civilization. However, much as when Keynesianism was definitive, we recognise that there are differences in how the archtype is applied.[6]

**Shaari S. (2014)** stated that in practical building, an interlocking block beam may take the role of a traditional beam as a lintel. Although the interlocking block approach may not eliminate all building challenges, it does alleviate

many of the problems associated with traditional methods of construction. The interlocking block's fundamental characteristic is that it replaces the mortar layers normally employed in joined brickwork by interconnecting key (S. F. Omar, 2009). The goal of this investigate is to decide the maximum tensile strong point of interconnecting block beams made with two types of filler particles, cement paste and mortar with superplasticizer, as well as the best interlocking block arrangement in the creation of beam samples by comparing them to standard concrete beams. All 5 beam samples are put through a four-point bending assessment to assess their attributes, such as strength, deflection, and strain. Except for one of the masonry beam samples, all of the main structural beam samples exhibit greater flexural strength readings than the reference beam sample. Based on the findings, mortar with superplasticizer is the optimum filler for the main structural beam. In this work, both experimental and theoretical outcomes were addressed. [7]

**Joyklad, Panuwat. (2018)** gathered the results of an investigational examination taking place cement-clay interconnecting (CCI) hollow bricks prepared by the traditional technique are presented in this article. CCI bricks are created in Thailand in various places utilising far away available clay, and there is on no account uniform mix design for preparing bricks. As a result, CCI bricks illustrations were gathered from three distinct locations of Thailand in order to investigate the impact of locally accessible clay in addition mix composition ratio on CCI brick mechanical qualities. The compressive, split tensile, modulus of estrangement, and water absorption of the material were all resolute.[8]

### 2.3 Durability

**Ahmad S (2014)** stated the term "masonry" refers to the use of hand-placed clay units, concrete operational clay tile, glass block, natural stones, and other similar materials in building. The components themselves are also referred to as masonry. Bricks, stones, marbles, limestone, dolomite, acrylic, plaster, and tiles are popular masonry unit materials. Masonry units are often constructed in a very durable manner. The materials rummage-sale, the quality of the mortar and craftsmanship, and the outline in which the units are constructed, all have an impression on the overall masonry construction's longevity. The mortar joint is the weakest portion of a masonry wall because the use of lime instead of aggregate affects the overall stability of the junction. The necessity for expert masons to carefully and precisely fit each block demands the utilisation of highly paid masons. [2]

**Al-Fakih, Amin. (2020)** Masonry goods are made from waste and industrial byproducts like recycled aggregate & fly ash. Rigid cement interlocking bricks (RIB), which comprise 10% crumb rubber as sand replacement and 56.6% fly ash as cement replacement, are an entirely new product that has

just been developed. The goal of this study was to better understand the response of masonry walls made of rubberized interlocking bricks beneath out-of-plane stress, with or without pre-compression force. Compressive strength of the load-bearing RIB is 18.4 MPa.[9]

### 2.4 Fire Resistance

**Balázs GLublóy É (2017)** Material properties and structural performance deterioration is largely dependent on ingredients and temperature history. The composition of a material may have a significant impact on the structural behaviour of an element. For high temperatures, web thickness is important. Interjoistelements (cement or bricks) among precast roof girders are in the same position. The first component of our research was to see whether structural elements with a typical thin web might increase fire resistance. Fire experiments on various concrete mixtures and fire tests of the girder with concurrent application of load were included in our experimental investigation. The second phase of our research examined at how actual firecases for support beam systems with masonry or brick interjoists fared.[10]

**Aldefae A, Essa A, Edan A. (2020)** The impact of firing temperature on clay bricks and cubic concrete specimens was investigated in this research at a temperature of 600 °C to determine how these commonly used building materials respond during fire catastrophes. At 7 and 28 days, extensive examinations are carried out on brick specimens taken from various locations around the governorate of Wait, as well as multiple groups of concrete cubic examples. The outcome of high-temperature burning taking place the concrete compressive strength and clay bricks was studied experimentally. Also, using combination of all three and water absorption experiments on clay bricks, investigate the influence of fire temperature on clay bricks. The researchers discovered that the firing temperature has a considerable impact on clay bricks and concrete, making them less effective in load resisting capacity under compression. In addition, there has been an increase in the efflorescence of bricks and a drop in the average of water absorption by bricks.[11]

**Selvaratnam A, Arachchi K. (2021)** In the Civil Engineering Industry, EPS (Increased Polystyrene) is a very well insulating material. This research offers an experimental and computational study of cementitious insulation for Carbon Fiber Reinforce Polymer (CFRP) - Concrete composites made using EPS. The CFRP/Concretecomposites were insulated with an EPS mix and tested at extreme temperatures. Under normal fire circumstances, a computational model was built to predict the heat exchange behaviour of CFRP/Concrete composite with the created insulation.[12]

## 2.5 Low Cost

**Kamel B. (2015)** When it comes to Egypt's growth strategy, there is a specific language and pattern of urban development to be found. The years after 1952, which were defined by the privatisation of farmland and a population explosion, were known as the "urban disaster." Buildings sprung up everywhere to meet the requirements of the rising population, burying agricultural regions behind a forest of red bricks and blurring the borders among urban and rural life. Ashwa'eeyator informal communities have sprung up all throughout the nation as a result of the informal growth phenomena. These may be distinguished in Egypt by a uniform building approach that consists of concrete skeleton structures consisting of concrete slabs and beams, as well as simple red brick walls; a look that does not reflect or throw light on Egyptian society or environmental concerns. [13]

**Jenson J. (2016)** stated that the emphasis of many social policy communities these days is on 'new community hazards.' Scorn a strong preference for fiscal restraint, they have faith in that these dangers need "social expenditures." The focus on investments, activation, and the future is seen to be the best anchor for reforming national welfare systems. We may talk of a transition toward that LEGOTM paradigm because of convergence around three ideas: life-long learning, a future alignment, and the social advantages of an engaged the world. We recognise, just as we did when Keynesianism was stock, that there are differences in how the paradigm is applied.[5]

**Chheda R (2020)** As a result of the country's rapid population expansion and migration from rural areas to urban areas, Indonesia has a housing problem (11.44 million in 2015), environmental degradation, & poor living circumstances, according to the report. Buildings account for roughly 60% of global CO2 emissions, therefore addressing the housing shortage must include a focus on environmentally friendly construction practises.[14]

## 3. Lego-Inspired Blocks

Laying. Automatic Brick Laying was the term applied to the Lego brickwork that was first employed in Denmark in 1949. In 1951, the term "Automatic Brick Laying" was changed and given its ultimate name: "Lego Brick," which was first commercially marketed in 1958. Since the 1970s, compressed cement-sand brick has gained popularity in Africa, Canada, the Middle East, and India.

Concrete is a strong material. Lego bricks is sometimes used as a temporary retaining wall or a wall divider between various materials like sand, salt, compost, and so on. The advantage of employing interlocked blocks is that they may be used as a temporary solution for projects since they can be moved or expanded without the need for casting between

the blocks. Waste is created in large quantities all around the globe.



Fig -1: Lego Cement Blocks



Fig -2: Lego Cement Blocks

Various varieties of interconnecting blocks and brick have been manufactured in recent years, with substantial composition, dimensions, and form altering according on the needed strong point and use."Sparlock systems, Meccano scheme, Sparfil system, Haener scheme, Putra block arrangement, and the Solid Interlock block (SIB) or else Hydraform blocks" are examples of these alternatives to traditional bricks and blocks. "Soil-cement blocks, rice quiet ash concrete blocks, and concrete blocks" are among the numerous interlocking blocks depending on materials, according to reports. The cement-to-soil ratio in soil cement blocks is normally flanked by 1:6 too 1:10 by volume, but in rice hush ash (RHA) masonry, the cement-to-rice hush ashes proportion is 1:4. In addition, the proportion of cement, sand, and gravel in the concrete blocks is 1:5:3. [15]

## 3.1 Bendable Concrete

In a previous research, Cement Composites Composites (ECC), also known as malleable concrete, was created. The combination was made by means of ASTM Type I Cement, Class F ashes, dry powder quarry dust, polyvinyl alcohol

(PVA) fibbers, plus spring water. The quartz sand measured 75 metres in diameter and weighed 2.63 grams per cubic metre. The PVA fibres were 8 mm in span, 39 m in diameter, then 1300 kg/m<sup>3</sup> in density; their tensile strength, Elastic modulus, with last elongation have been 1.6 GPa, 43 GPa, & 6%–8%, correspondingly. [1]

PVA fibre volume percent in concrete is 2 percent by volume in the combination of water-to-binder ratio of 0.25, sand-to-binder ratio of 0.36, and PVA fibre volume percent. By weight, the binder included 30% concrete and 70% fly ash. To make the combination self-consolidating, a 0.1 volume percent binder dose of a good variety water reducer might be utilised. 60 quarts of Hobart mixer were used to combine all of the contents. After 5 minutes of mixing at 60 rpm, the dry mixture of cement, fly ash, and quartz sands was ready for use. It was then combined for five min at 120 RPM with the high-range reducing water in water and dissolved in water.[1]

Lastly, the PVA fibres are introduced at 60 rpm / min before being blended at 120 rpm for 3 minutes. After the mixture had completed mixing, it was checked by hand for fibre agglomeration, which was found to be absent. Flexible concrete is made using Engineered Cementitious Composites (ECC) using high tensile ductility. The tensile strain associated with highest tensile stress is frequently higher over 4%, and is more than 400 times larger than normal concrete. Normal concrete loses its capacity to sustain tensile strain when it fractures, while ECC does not. ECC features distinct fracture patterns and endurance in calculation to its exceptional stiffness confrontation. ECC has regulated narrow fracture widths (60 m) because to the associating action of chopped fibres scattered in ECC matrix. In terms of transport qualities, the regulated crack thickness declares that cracked ECC functions correspondingly to uncracked ECC. Even more intriguing, the tight fracture may self-heal in the presence of moisture in the air.[16]

### 3.2 COMPARISON BETWEEN TRADITIONAL AND LEGO CONCRETE BLOCK

No	Parameters	TRADITIONAL	Lego Concrete Block
1.	Raw Materials	Ordinary Portland Cement, Sand, Gravel, Water	ASTM Type I Portland cement, Class F fly ash, finely ground quartz sand, polyvinyl alcohol (PVA) fibers, Steel slag tap water
2.	Environmental Impact	carbon dioxide emission	Less Carbon dioxide emission,

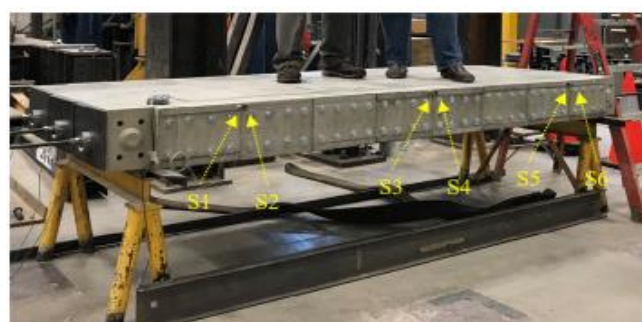
			Reusable
3.	Motor consumption	Used for joints	Not used due to presence of interlocking Joints.
4.	Cost	Cost High as individual	Cost high as individual but uses no motor which makes it more efficient.

**Table-1:** Comparison between Traditional and Lego Concrete Block

### 4. CASE STUDY

To examine the effectiveness of the Lego-inspired block, the four kinds of blocks are utilised to create a footbridge. The footbridge is generally supported on inflexible support with a main span of 2.8 m. The footbridge is meant to withstand own self-weight and the motion of two individuals walking over the bridge. Structural study of the bridge was done utilizing finite element models.

The blocks from footbridge were repurposed to create a down-scaled frame. The frame is composed of 2 column and one beam, resembling a section of a beam-column structure of a building. Comparing with footbridge, the frame employed the same blocks joined by the shearing keys and steel bolts. More blocks may be added to the frame using the same assembly method to build up and around the frame also create the primary framework of the framework for just a multi-story structure.



**Fig-3:** Lego Bridge

### 5. CONCLUSIONS

This study introduces a new-fangled archetype of building – Lego-inspired \creation, and proves its practicality through a footbridge and \frame created via RecoBlox™ bricks composed of flexible concrete:

1. Lego-Inspired Concrete blocks are the new method with the advancement in the construction techniques.
2. The reusable properties of this block and the motor less interlocking mechanism will play important role in the low-housing schemes.
3. These will play as a blessing in the slums upgradation projects as well as AFH projects also in the community centres,
4. Potentially revolutionary is the proposed notion of designing and constructing Lego-style structures, which would give an alternative to the current structural design and construction paradigm.
5. Building building efficiency, productivity, safety, environmental protection, and economic benefits may all be improved thanks to the new paradigm. It can also promote electronic manufacturing techniques such as 3D printing.

## ACKNOWLEDGEMENT

I express sincere and wholehearted thanks to Prof. **(Dr.) Indrajit N. Patel**, Principal, Birla Vishwakarma Mahavidyalaya Engineering College, Vallabh Vidyanagar, **Prof. (Dr.) L. B. Zala**, Head and Professor Civil Engineering Department, Birla Vishwakarma Mahavidyalaya Engineering College, **Dr. Jayeshkumar Pitroda**, Associate Professor, PG Coordinator of MTech. Construction Engineering and Management, Civil Engineering Department, Birla Vishwakarma Mahavidyalaya Engineering College (An Autonomous Institution), Vallabh Vidyanagar for allowing me to pursue this topic as part of my research. I am also grateful to **lecturer A.D. Raval** Civil Engineering Department, B&B Institute of Technology Engineering College, Vallabh Vidyanagar, Gujarat for his constant constructive support, continuous encouragement, coaching, and pushing of my efforts in the right path. I'd like to express my gratitude to my family and friends for allowing me to reach my full potential. All of their support throughout the years has been the best present anyone has ever given me.

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