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Research Article

The adaptation and implementation of ancient construction

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ABSTRACT

In this article we came across some of the mysterious and majestic ancient constructions all over the world with the methods used in it. We gave more importance to The Grand Anicut which was built by the King Karikala Cholan and the Brihadeeshwara Temple by Raja Raja Cholan, we tried to figure out some the mysterious methods used by them during the construction of this great dam and we have found a solution for a budget friendly house construction by implementing the methods used in Grand Anicut and Brihadeeshwara temple, along with the dam construction we have also implemented the interlocking method which has been used in the construction of Brihadeeshwara Temple, Indus valley civilization, keezhadi and in most of the Japanese civilization. We have also promoted these methodologies with artificial intelligence by using robots and drones in the field of construction works to avoid death and man power during the construction progress.

Key words: Ancient Construction, Modern Construction, The Grand Anicut, The Brihadeeshwara Temple, Functions, Interlocking Construction

INTRODUCTION

One of the most visible differences between the ancient buildings and the modern ones is the use of materials. In the older times, stone and its derivatives were the only material used. In the present world there are so many new materials that were used for the construction but will not last forever when compared to the ancient construction. Here we have used some of the methods involved in the ancient construction with the advancement of technology in the modern construction.

METHODS

Tangent, Mysterious Clay, Functions and Golden Ratio, Critical Path Analysis, Interlocking Construction.

Ancient constructions

Over 2000 years ago, King Kari Kala Cholan was reining Southern India. Agriculture was prosperous in his period. The reason for the prosperity is the River Cauvery. King Kari Kala Cholan wanted to build a Dam across the River. It results in the Iconic Architecture of Tamil Nadu, The Grand Anicut (the Kallanai). Today it is very easy to build a Dam with Modern Equipment but 2000 years ago it is very difficult to lay the foundation across The River because at that time 2,00,000 cubic feet of water would flow in Cauvery. We are going to see how the King overcame the challenge and build the dam with the help of “Tangent” and “Functions”.

Rock cutting

Punching hole, Inserting Wooden Wedge, Adding Water, Breaking

Mysterious mud clay

It is still a mystery for the great scholars and the engineers over 2000 years mud used to stick the rocks at the Kallanai were still strong with the same firm. The paste that will be used to adhere two or more rocks together will be made in such a way that two stones can be readily merged (Atin & Lubis, 2019). The mix that was made that day was so good that the ancient architectures are still keeping the rocks in that place.

Functions

One day The King was walking by the seashore of Kaveripoombattinam. Then he noticed that as soon as the sea wave hit his foot he buried his foot in the soil. If we put a particle (stone) on the soil’s surface, it will stay in the same place. When water flows over a particle (stone), it buries itself in the soil. It’s known as soil erosion. (Figure 1 & 2)

The King wanted to use this idea to lay the foundation for the Dam that he wanted to build. To make the foundation stronger, The King decided to bury the rock from 15,000 cm to 30,000 cm deeper. He started his mission. He put a 10g stone at the riverbank it went 2cm deeper, then he put 30g stone at the same place it went 6cm in Table 1.

Input (X- Mass)	Output (Y-Depth)
10	2
30	6

By using this concept, he found the Mass of the Rock which would bury up to 30,000cm deeper. To know how he found the mass, we should study the concept of Function.

Function

A Relation between two non-empty sets X and Y is called a function.

F	X	Y
Function	Input	Output

When we give an Input, it will give an Output by a relation. We can see the mass is 5 times the depth. The function for the data is

$$Y=X/5\ldots (1)$$

The Mass is 5 times the Depth that is we know how deeper the rock should bury but we don't know the mass of the rock. By using the above data, The King wanted to find the mass of the rock which would bury 30,000cm deeper.

Y=X/5		Y=30,000	
X=5Y	X=?	X=5,30,000	X=1,50,000g

Now, the King found the mass of the Rock to be buried.

Representation of function

Set of ordered pairs

f = {(10, 2), (30, 6)… (150k, 30k)} K-1,000

Arrow Diagram

Input	Output	X-Input
(X-Mass)	(Y-Depth)	Y-Output

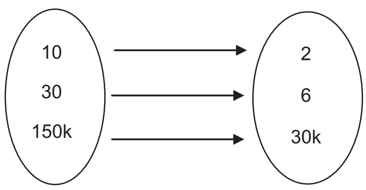


Table form:

(Table1) K-1,000

Graph Form

We will plot the above data (values) in a graph (Figure 3).

The King wanted to start the construction work for the dam. But later he came to know this data could be applicable at the riverbank only. Since, the speed of the water is very slow at the riverbank but the speed will be slowly increased to the middle of the river. If we place a 1, 50,000g rock at the riverbank it will bury exactly 30,000cm deeper. If we use the same rock in the middle of the river it will sink because the speed of the river will be high in the middle (Miller, 1985). Then he placed a 10g stone at the riverbank it went 2cm deeper and he took the same stone and placed it at the inside of the river it went 5cm deeper. It became a challenge to the king. Then he realized that soil erosion was not only about the mass of the stone but also depends on the speed of the water. Then we will also plot the values which the King collected from inside the river. (Figure 4)

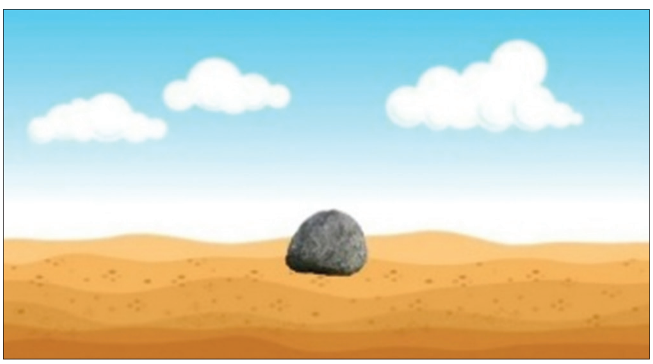


Figure 1: Stone on the soil's surface.

	Input	Output
	X- Mass	Y-Depth
Riverbank	10g	2cm
Inside the river	10g	5cm

Condition for testing function

We will check whether it is a function or not by the Vertical line test (Figure 5).

It doesn't represent a function as the vertical lines meet the curve in two points. We can see the input 10 has two outputs so it cannot be a function. The King went to the river and placed a 10g stone at the riverbank, inside the river and

Table 1: Representation of function in table form

X- Mass	10	30	150k
Y-Depth	2	6	30k

Figure 2: Stone buried in the soil.

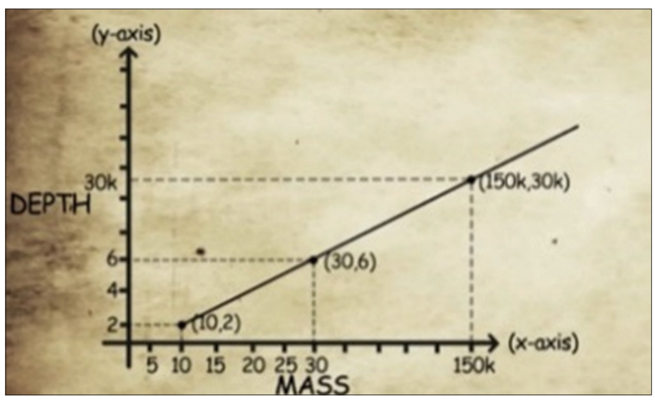
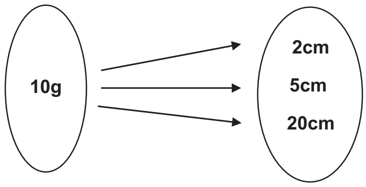


Figure 3: Representation of function in graph form

middle of the river the stone it buried to 2cm, 5cm and 20cm respectively.

Input	Output	X-Input
(X-Mass)	(Y-Depth)	Y-Output



As the same input has more than an output, it is not a function.

Types of function

To make the above diagram as a function we will change and write it as,

Input	Output	X-Input
(X-Mass)	(Y-Depth)	Y-Output

Function at Riverbank

10g → 2cm

The mass is 5 times the depth so the equation will become Y=X/5 … (2)

Function at Inside the river

10g → 5cm

The mass is 2 times the depth so the equation will become Y=X/2 … (3)

Function at Middle of the river

10g → 20cm

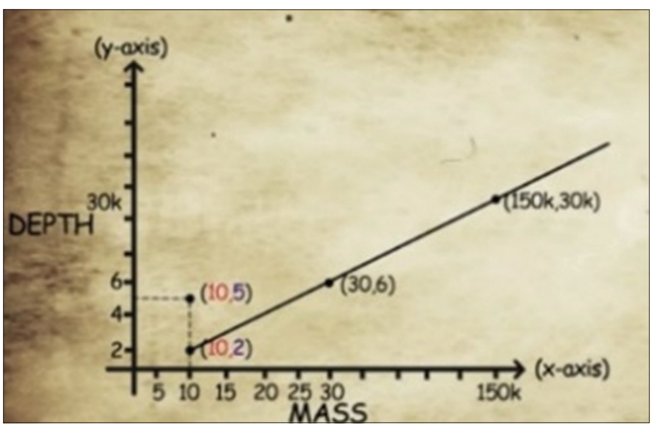


Figure 4: Graph for same input gets two outputs.

The depth is 2 times the mass so the equation will become Y=2X … (4)

The above diagrams are representing the one-one function.

One-one function

A function f: X Y is called a one-one function if distinct elements of X have distinct images in Y

We need the mass of the rock ie., X so we will interchange the function. If we interchange the Input and Output, it will become an inverse function. The interchanged function can be represented as follows.

F	Y	X
Function	Input	Output

This is called the Inverse function. It will be represented as $f^{-1}(x)$

Input	Output	Y-Input
(Y-Depth)	(X-Mass)	X-Output

Inverse function of Riverbank

2cm → 10g

The inverse function for (2) equation is X=5Y … (5)

Inverse function of Inside the river

5cm → 10g

The inverse function for (3) equation is X=2Y … (6)

Inverse function of Middle of the river

20cm → 10g

The inverse function for (4) equation is X=Y/2 … (7)

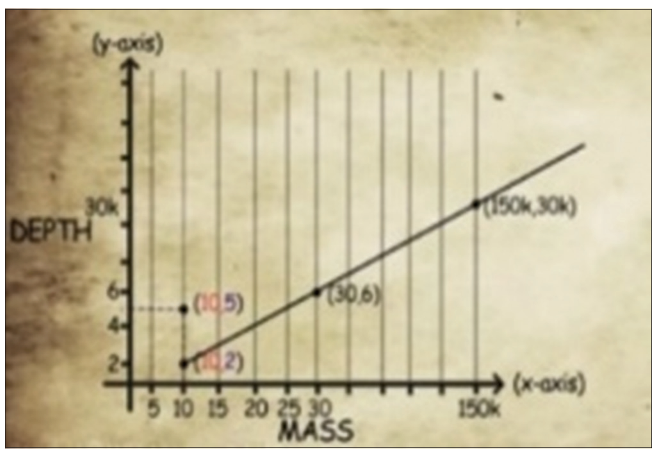


Figure 5: Vertical line test.

Now King Karikalan used the data and found the mass of the rocks.

We know how deep the rock should bury ie., Y= 30,000cm.

Riverbank	X=5Y i.e., X=5*30,000	X=1, 50,000g rock
Inside the river	X=2Y i.e., X= 2* 30,000	X= 60,000g rock
Middle of the river	X=Y/2 i.e., X= 30,000/2	X= 15,000g rock

By using this mathematical concept King Karikalan laid a strong foundation for the Dam, The Grand Anicut. The Dam still stands firm after 2000 years. Its glory has not diminished to this day (National Council of Teachers of Mathematics, 1998).

Brihadeeshwara temple

The same rock cutting and tangent plays a very important role in the construction of The Great Brihadeeshwara temple.

Interlocking in Brihadeeshwara temple

Some of the temples were built in such a terrible manner by specific Kings that recent troubles have arisen as a result of the fact that the temple's Gopuram needs to be restored, and the Gopuram has even fallen down due to the major damage that occurred in the Gopuram due to natural catastrophes. Brihadeeshwara temple was built by the interlocking method and it remains strong (Bala, 2020). The value of the Gopuram's interlocking feature becomes clear here. The interlocking of the rocks of the Gopurams and other shrines of the Tamil Nadu temple is done in such a way the rocks hold one other very strongly. Interlocking is also used to strengthen two or more rocks that are connected together. The interlocking feature was mostly used by the Chola in the temples they built. (Figure 6)

The lime mortar that used in Kallanai was also used in Indus Valley Civilization and Keezhadi (Petty, 2020). The ancient method of constructions challenges us now in the architecture field by its unique use of materials during their period. It wonders us by its majestic archeological discoveries.

Figure 6: Interlocking in the Temple.

Japanese civilization

The interlocking method used in The Brihadeeshwara Temple was also used in Japanese Civilization. It is known for the wonderful architectural idea which gives more advantages in the field of construction.

Modern construction

We want to implement the above Ancient Construction Method in our Modern Constructions.

Modern building

Before planning a bungalow/individual construction unit, one must be aware of the quantities and Cost of Building Materials, as they account for approximately 55-60% of the total construction cost of a house. While conducting a personal tour of the nearby market, one should also seek the services of construction turnkey solution providers and then make an informed decision before beginning construction. Refer to the info graphic for the consumption of building materials and their costs for a 1000 Sq. ft budget house construction. The material quantities can be extrapolated based on the built-up area of the construction.

The following are the major raw materials, intermediate materials, and finished construction materials that contribute significantly to overall material costs (Kelley Jr & Walker, 1959). Cement and Sand, Aggregate, Reinforcement Steel,

Table 2: Materials Required for the House

Material Required For House Construction	Quantity Required For 1 Sq Ft House	Quantity Required For 1000 Sq Ft House
Cement	0.4 Bag	400 Bag
Sand	1.8 C.ft	1800 C.ft
Aggregate	1.35 C.ft	1350 C.ft
Steel	4.0 Kg	4000 Kg
Paint	0.18 Ltr	180 Ltr
Bricks	1.45 Sq.ft	1450 Sq.ft
Tiles	1.3 Sq.ft	1300 Sq.ft

Figure 7: Interlocking house.

Table 3: Budget for interlocking house

S.No	Item Name	Quantity	Rate Per Sq.Ft	Total Amount
1	Full constructions (Belt Beam, lintel, rcc concrete roof, roof top plastering, interlocking bricks wall, wall water proofing, wall joint pasting, wall decorating, wall edge plastering)	1000	Rs. 985	Rs. 985,000.00
2	Flooring tiles work, Electric works, Plumbing work, Door and windows, Kitchen table slab, Kitchen wall tiles, painting works, etc.,	1000	Rs. 420	Rs. 4,20,000.00
	TOTAL			Rs. 14,05,000.00 Fourteen lakh and five thousand only

Paint and Tiles, Bricks, Other Fittings Materials required for building a 1000 sq. ft. house construction (Table 2)

Interlocking construction

Interlocking houses will be a revelation to those who want to build a dream home without spending your entire life's savings. When you choose an interlock brick house, you can keep the amount of cement used to a minimum. When the amount of cement and sand used is reduced, the savings will be approximately 30% of the total costs. The only catch is that you'll need to find skilled workers who are familiar with interlocking bricks. (Figure 7).

Advantages of Interlocking house

- Minimal Material Cost
- Reduced Transportation Costs
- Faster Construction
- Versatile Construction Technique
- Simple To Learn and Implement
- Eco-Friendly Construction
- Load Bearing and Framed Structures
- Budgets

In addition to estimating the cost and quantity of construction materials, one should be aware of current labour costs in local markets. This is because the labour component accounts for 40-45 percent of the total cost of building a house. Unskilled labour costs between Rs. 450 and 500 per day, whereas skilled labour, such as masons, carpenters, painters, electricians, and so on, costs between Rs. 800 and 1000 per day. The total cost of construction (including design, materials, and labour) per square foot can range between Rs.1350 and Rs.2500 per square foot, depending on the specifications of the building materials you select for your home. Now that you know the total cost of construction, you can begin raising funds for the project. Your source could be personal savings or a loan from a bank or a friend. Although this appears to be a naive step, a lack of resources during construction may cause the budget to be exceeded at times.

Critical path analysis

There are three phases of critical path analysis that is implemented in our construction.

- Scheduling, Planning, Controlling.

Two unique features of our construction progress

- DRONES: This is going to be the best alternative for supervising and reduces upto 10% in our budget (Table 3).
- ROBOTS: Labour charges of up to 30% can be reduced by robots and modern 3D machines.

CONCLUSION

We tried our best to the level of our knowledge to give an idea about the most important methods used during the majestic ancient constructions such as the tangent, golden ratio, functions, interlocking methods, and using lime as a mortar we gave the budget friendly constructions by using all these methods used in ancient construction and again we tried to reduce the cost by implementing the artificial intelligence by implementing the drones and robots during the construction progress which reduces the man power and reduces the death and disasters that occurs during the constructions.

REFERENCES

Atin, S., & Lubis, R. (2019), Implementation of Critical Path Method in Project Planning and Scheduling. *IOP Conference Series: Materials Science and Engineering*, 662(2), 022031. https://doi.org/10.1088/1757-899X/662/2/022031

Bala.(2020). *Interlocking Rocks feature of Tamil Nadu Temple Gopurams.*

Jamshidi, A., Kurumisawa, K., White, G., Nishizawa, T., Igarashi, T., Nawa, T., & Mao, J. (2019). State-of-the-art of interlocking concrete block pavement technology in Japan as a post-modern pavement. *Construction and Building Materials,* 200, 713-755. https://doi.org/10.1016/j.conbuildmat.2018.11.286

Kelley Jr, J. E., & Walker, M. R. (1959). Critical Path Planning and Scheduling. Proceedings of the Eastern Joint Computer Conference.

Miller, D. (1985), Ideology and the Harappan Civilization. *Journal of Anthropological Archeology, 4(1), 34-71.* https://doi.org/10.1016/0278-4165(85)90013-3

National Council of Teachers of Mathematics. (1998). Principles and standards for school Mathematics, 1906 Association Drive, Reston, VA. 20191-9988.

Petty, W. (2020). Educational World.