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Comparative Cost Study of Shaft over the RCC ESR in Rural Water Supply Scheme

Mr. Rahul D. Shinde[1], Mr. Vinayak N. Giram[2]
[1]*Asst. Professor Department of Civil Engineering Rasiklal M. Dhariwal Sinhgad Technical Institutes Campus, Warje, Pune*
[2]*M.E Construction and management, Rasiklal M. Dhariwal Sinhgad Technical Institutes Campus, Warje, Pune*

Abstract: ***RCC (Reinforced Cement Concrete) Elevated Service Reservoirs (ESRs) are commonly used in rural water supply schemes for storing and distributing water. However, there are several challenges associated with their use in rural setting such as High Initial Cost, Long Construction Time, Maintenance and Repair Challenges, Structural Integrity Issues, Land Acquisition Issues, Water Losses, Vulnerability to Natural Disasters. The main objective of the study is to study the problems faced in running rural water supply scheme, to understand the application of shaft in rural water supply scheme over the RCC ESR, to carry out the cost analysis of shaft over the RCC ESR, to compare the shaft and RCC ESR based on the performance and its lifecycle. with the help of case studies. Thus the aim of following study is to minimize the cost of water supply projects also reduce the wok completion time and to minimize the operational and Maintenance cost of project in future.***
Keywords: RCC, ESR, SHAFT, Maintenance, performance

I. INTRODUCTION

A. RCC ESR

The rural water supply scheme in India plays a crucial role in ensuring access to safe and clean drinking water for the rural population. India, with its vast rural expanse, faces significant challenges in providing clean water to its people, especially in remote and underserved areas. Over the years, various policies, programs, and initiatives have been launched to address these challenges and improve water accessibility in rural areas.

Fig. 1 RCC ESR

B. Shaft

In rural water supply schemes in India, an RCC ESR (Reinforced Cement Concrete Elevated Storage Reservoir) plays a crucial role in ensuring the efficient distribution of water to rural communities. It is a type of storage tank built above the ground on a raised platform to store water at a height, allowing for gravity-based distribution to homes or other areas.

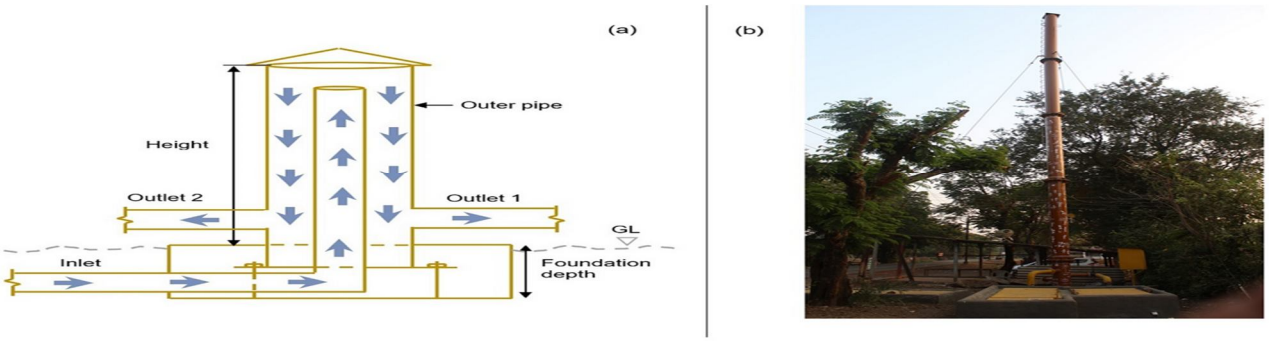

FIG. 2 CROSS-SECTION OF A SHAFT (A) SHAFT AT SAPHALE, PALGHAR, MAHARASHTRA, INDIA (B) ,

II. LITERATURE REVIEW

A. kumar Sinha, and P. Kalbar et al. [1] In this literature paper we studied the application of Shaft in WTN has operational benefits like minimizing the effect of water hammer, thus reducing the operation and maintenance cost of the pipelines. Also, Shaft reduces the extra static head over the pipeline, improving the performance of the system. The Shaft acts as a hydraulic isolation structure, separating the hydraulics of the upstream and downstream network. The hydraulic separation, helps in conversion of the RWPM into RWGM. Overall, use of Shaft at appropriate location in the WTN will substantially improve the efficiency of the system.

P. F. Boulos, B. W. Karney, D. J. Wood et al. [2] In this literature paper we studied the hydraulic transient, also called pressure surge or water hammer, is the means by which a change in steady-state flow and pressure is achieved. When conditions in a water distribution network changed, such as by closing a pump or a valve or starting a pump, a series of pressure waves generated. These disturbances prop-of sound within the medium until gate with the velocity of sour dissipated down to the level of the new steady state by the action of some form of damping or friction.

P. Kalbar and P. Gokhale et al. [3] In this literature paper we studied the the design and operational practice of water supply schemes (WSSs) in India is discussed in the context of the prevailing performance of the systems. Issues such as the tremendous gap in design and operation, unskilled manpower, and unmanageably large operation zones are identified as the main causes of the failure of WSSs in India.

A. kumar Sinha, and P. Kalbar et al. [4] In this literature paper we studied the there is a need to create a WSS that delivers water with good pressure with expected liters per capita per day, and there should not be inequality in the distribution. Several solutions such as multi-outlet tanks, shafts, manifolds, and masterpiece introduced in this paper can help alleviate the current situation.

III.METHODOLOGY

Limala is a Village in Purna Taluka in Parbhani District of Maharashtra State, India. It belongs to Marathwada region. It belongs to Aurangabad Division. It is located 31 KM towards East from District headquarters Parbhani. 512 KM from State capital Mumbai Limala Pin code is 431402 and postal head office is Parbhani. Limala is surrounded by Palam Taluka towards South, Loha Taluka towards South, Basmat Taluka towards North, Parbhani Taluka towards west.

Under Bharat Nirman scheme one percolation well constructed near village around 2.1 km away from village near local nala from this well currently 1,30,000 Lit. , one RCC ESR constructed of 30,000 Lits. Capacity with 12.0 m. stagging height completed in 2009.

Now the existing RCC ESR having capacity 30,000 Lits. is not full field the demand of current population by considering the existing RCC ESR we need the additional 46,000 Lits. RCC ESR To fulfil the demand of next 30 years with demand 55.0 Lits/Person also the existing percolation well is also not full field the demand so we assume the new percolation well having yield 1,50,000 Lits. but the problem is the near existing ESR there is no open space for constructing new RCC ESR so to tackle this problem by using the case studies by application of shaft we can distribute the water to distribution line.

In this study we made the comparative analysis of RCC ESR over the Shaft its application, Limitation, Cost reduction, Future Scope etc.

FIG. 3 (CASE STUDY LOCATION IN GOOGLE WARTH)

By using available population census of 5 decades from (1971-2011) we calculated the population for coming 30 years of 5 years gap by using Arithmetical increase method, Incremental Increase method, Geometric progression method by taking the average of this methods we get the average population for the correspondence years as shown in table no. 1 and Daily demand for this 30 years as shown in below table No.2

TABLE NO. 1 (POPULATION FORECASTING)

POPULATION - FORECAST

Village:- LIMLA

Taluka:- PURNA

DISTRICT:- PARBHANI

YEAR	POPULATION	INCREASE IN DECADE	INCREMENTAL INCREASE IN DECADE	RATE OF GROWTH PER DECADE
1971	829			
		0		0.0000
1981	808		371	
		371		0.4592
1991	1179		0	
		246		0.2087
2001	1425		0	
		169		0.1186
2011	1594			
TOTAL	5835	786	371	Rg =
AVERAGE :-	1167	197	124	0.0000

YEAR	ARITHMETICAL METHOD	INCREMENTAL INCREASE METHOD	GEOMETRIC PROGRESSION METHOD	AVERAGE OF I. I. & G. P.
2025	1870	2078	1594	1847
2040	2165	2865	1594	2208
2055	2461	3930	1594	2662

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TABLE NO. 2 (DAILY DEMAND)

DAILY DEMAND

Village:- LIMLA
Taluka:- PURNA
DISTRICT:- PARBHANI

		Present stage 2025	Immediate stage2040	Ultimate limited stage 2055
A)	Domestic Water Demand			
	1. Population (Souls)	1847	2208	2662
	2. Rate of Water Supply(L.P.C.D.)	55	55	55
	4. Daily Demand (Liter . per Day)	101592	121439	146387
	3. Daily Demand (M.L. per Day)	0.102	0.121	0.146
B)	Other Water Demand			
	1. Demand for floating Population (MLD)	0	0	0
	2. Instituional Demond (LTR)	0	0	0
	3. Floting Population (LTR)	0	0	0
	4 For Cattle	13395	13395	13395
	5. Total Demond (LTR)	114987	134834	159782
	6. Supply Available from exisiting sources	0	0	0
	7. Net Demand Requried (5-6)	114987	134834	159782
C)	Demand Considerring the Looses as Below			
	1. Demand at ESR with 15% Losses in Distribuction system (MLD)	: 17248	20225	23967
	Gross Demand (Liter)	: 132235	155059	183750
	Gross Demand (MLD	: 0.1322	0.1551	0.1837
	For Pumping Machinary/ Rising Main	Total Deamand In	=	183750 Liter

	Water available from exisiting source is		130000		
1)	Exisitng Water	:	0.1300	0.1300	0.1300
	For Desing purpose				
2)	Gross Demand (MLD	:	0.1322	0.1551	0.1837
3)	60 % Water available from exisiting Source	:	0.0793	0.0930	0.1102
4)	40 % Water available from New Source	:	0.0529	0.0620	0.0735

To pump the water we calculated the pumping machinery for lifting the water from source to ESR/ Shaft.

DESIGN OF PUMPING MACHINARY

Village:- LIMLA
Taluka:- PURNA
DISTRICT:- PARBHANI

1)	Daily demand FOR 2035	:	0.0620	MLD
2)	Pumping Hours	:	12	Hrs.
3)	Rate of pumping	:	5169	Lit/Hrs.
4)	STATIC HEAD			
	a) F.S.L. of Reservoir	:	404.10	M
	b) Lowest Suction level in the well	:	362.71	M
	c) Velocity head / Residual head	:	3	M
	D) Heance Static head	:	44.39	M
5)	FRICTIONAL HEAD			
	a) Designed discharge in MLD LPH X 24	:	0.1240	MLD
	b) Length of Main	:	2.1540	KM
	c) Diameter , Type & class of pipe	:	90.00 mm Dia. PVC 6 Kgf. / Sq.cm.	
	d) Hazen williams constant	:	140	
	e) Rate of Frictional loss	:	1.48	M
	f) Total Frictional losse(b x f)	:	3.18	M
	g) Add for losses in bends/ valve etc.10 % of above f	:	0.32	M
	h) Total frictional Head (f + g)	:	3.50	M
6)	TOTAL HEAD ON PUMP	:	50.89	M

7) B.H.P. REQURIED

$$\frac{5169 \times 50.89 \times 1.20}{75 \times 3600 \times 0.60} = 1.95 \text{ Bhp}$$

= 1.95 Bhp

8) Total H.P. Proposed = 5.00 Bhp

9) Provide duplicate set of submerssible pumps capable of 5169 lit./ hours against total head 50.89 M be driven by 5.00 H.P. electrical motar directely coupled to it.on pump will be in operation and one will be stand by .

Required RCC ESR Design.

Village:- LIMLA
Taluka:- PURNA

DISTRICT:- PARBHANI

CAPICITY OF STORAGE RESERVOIR

1)	Total requriment of water per day	:	155059	Litrs
2)	Distribuction of water twice per day	:	77529	Litrs
3)	Exisiting E.S.R. Capicity	:	30000	Litrs.
4)	Proposed E.S.R.	:	46000	Litrs.

By using the MJP SSR 2023-24 and PWD SSR 2022-23 we make the estimate the of RCC ESR 46,000 Lits. and Shaft of outer dia. 508 mm 7.9 mm thick with 12.0 m stagging height from G.L. as shown in below table No.3&4

TABLE NO. 3 (RCC ESR 0.46 LAKH LIT. 12 M STAGGING HEIGHT ESTIMATE)

ELEVATED STORAGE RESERVOIR ESTIMATE					
I.No.	Description	Quantity	Unit	Rate	Amount
1	For 0.46 Lakh Lits. ref. as per MJP SSR 2023-24 I. No. 8 Page No. 271	1	Nos	1403655	1403655
				Total (Rs.)	14,03,655

TABLE NO. 4 (SHAFT / BPT ESTIMATE)

SHAFT					
I. No.	Description	Quantity	Unit	Rate	Amount
1	Providing and laying in situ, cement concrete of trap /granite / quartzite / gneiss metal for PCC work below foundation and footing including normal dewatering, plywood formwork, compaction finishing and curing, etc. complete.	0.18	Cum	5881	1059.00
2	Manufacturing providing and supply spirally welded/ ERW /SAW/ fabricated M.S. pipe (commercial Quality) including procurements of plates, gas cutting to required size rolling, tack welding, assembling in suitable lengths to form pipes, welding on automatic welding machine and forming 'V' edge on both ends of pipes including all taxes (central and local), railway freight, insurance, unloading from railway wagon, loading into truck, transport to stores / site, unloading, stacking, etc. complete as per IS-5504 as applicable as per specification (No negative tolerance in thickness is permissible) 508 mm Dia (OD) MS Pipe 7.9 mm Thick	4	RMT	9164	36656
	219.10 mm Dia MS Pipe 7.9 mm Thick	7	RMT	3870	27090

3	Providing and supplying ISI Standards M.S specials of required thickness with 3 coats of approved make epoxy paint (Shalimar, Iba or Mahindra & Mahindra make) from octroi, inspection charges, transportation to stores/site, and stacking etc. complete Double flanged MS specials	300	Kg	95	28500
4	Providing and laying in situ Cement Concrete. Of Trap / Granite Quartzite / Gneiss Metal for RCC work in foundation like rafts, grillage, strip foundation and footing of RCC columns and steel stanchions including normal dewatering, plywood form work, compaction, finishing and curing etc. complete. (By weigh bashing and mix design for M-250 and M 300 only. Use of L & t , A.C.C, Ambuja, Birla Gold, Manik gad, Rajashree, etc. cement in permitted.)	1.44	Cum	9910	14270
5	Providing and fixing in position for steel bar reinforcement of various diameters for RCC piles, caps, footings, foundations, slabs, beams, columns canopies, stair cases, newels, chajjas, lintels, parties, copings, fins, arches, etc. as per detailed designs, drawings and schedules including cutting, bending, hooking the bars, binding with wires, or tack welding and supporting as required etc. complete(including cost of binding wire)Stee bar reinforcement 0.5% of concrete qty.	0.057	MT	84020	4789
6.	Providing & laying epoxy paint inner side of Brake pressure shaft Epoxy paint -2 coats inner side of shaft 500 mm Dia MS pipe	6.284	Sqmt	695	4367
7.	Providing & laying gray graphite paint outer side of Break pressure shaft Gray Graphite epoxy paint -outer side of shaft 508 mm dia MS pipe	6.385	Sqmt	450	2873
				Total	1,19,604.00

Saving in Cost
= Cost of ESR – Cost of Shaft
=1403655-119604
=1284051 (91.48 %) Cost Reduction

IV. CONCLUSIONS

The study done over here is related to comparative study for use of SHAFT over the RCC ESR in Rural water supply scheme. The observations and remark shows that the cost of project will be saved upto (91.48%). The use of RCC ESR or SHAFT will be used as per site condition, soil bearing capacity of soil, availibity of skilled labours, pipe type will be used, budget etc.

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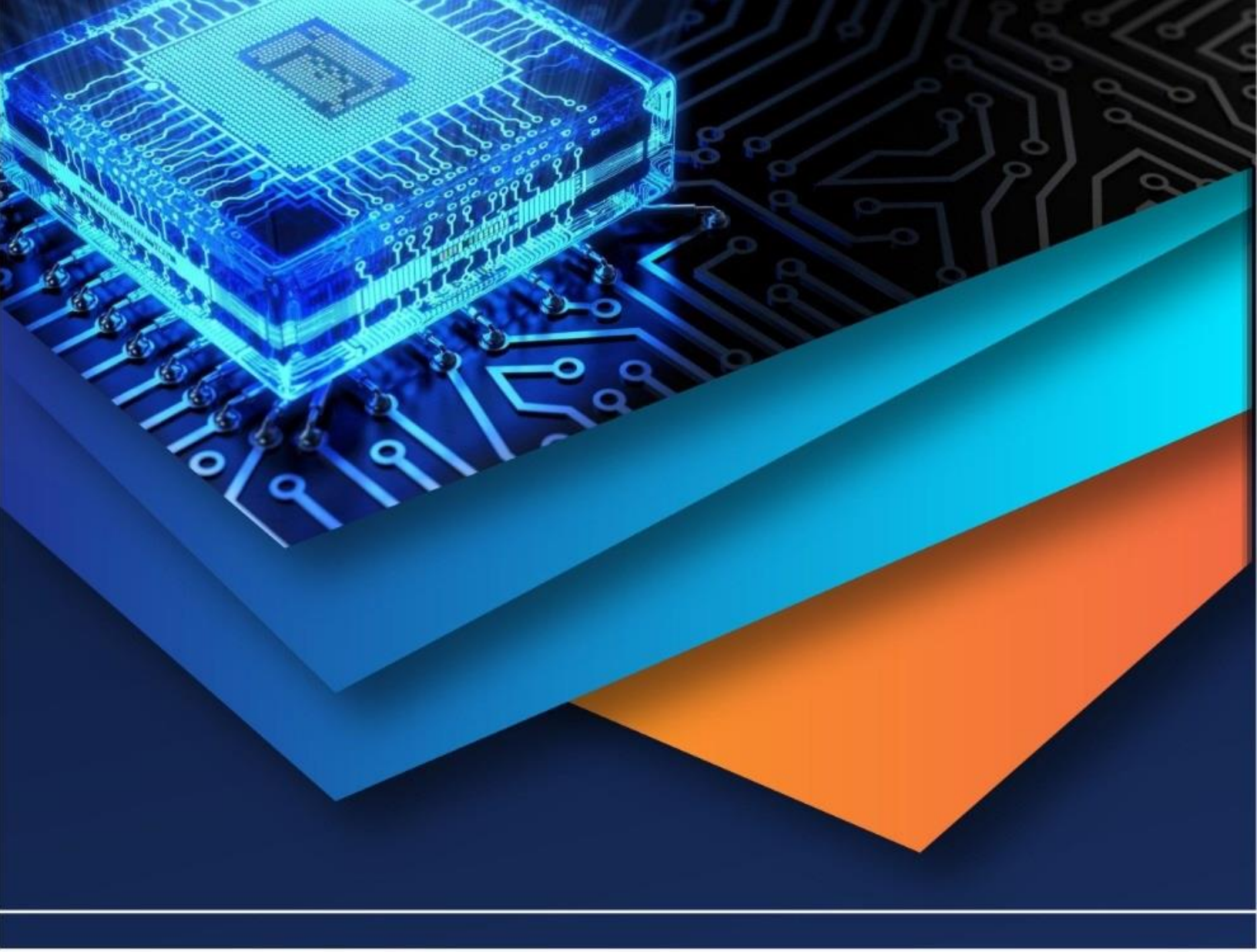

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