Refurbishing of Karez System

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Abstract— One of the most unique features of Bidar is the historic 'Karez' system (also known as Qanat) which is a water harnessing technolog . The 'Karez' system in Naubad village, Bidar is of great historic significance dating back to almost 500 years. The karez technology basically taps into the ground water sources (or natural springs) and transports it through an underground tunnel to the settlement, ending in surface canal and/or pools in the village for various uses like drinking, washing, ablution, watering livestock, and also further used for irrigating fields, orchards and gardens.

Key words: Karez, Qanat System, Mother well

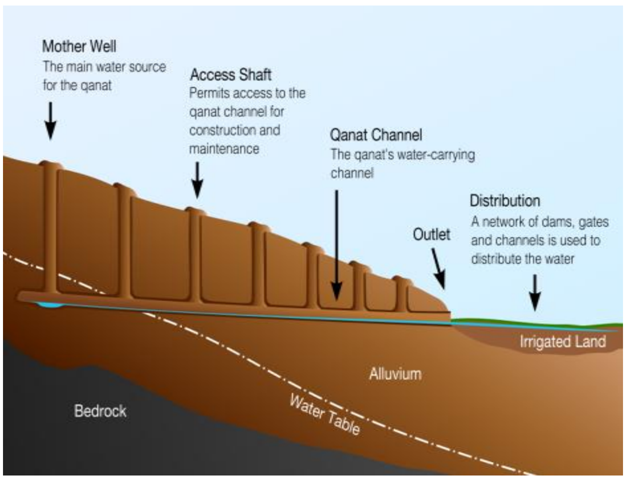
I. Introduction

Bidar is a historic city having a history of more than 700 years or more. It has been declared as one of the heritage cities of Karnataka State. Very recently Bidar has been listed under World Heritage Watch List by World Monument Fund.

The Historical or cultural landscape in Bidar is very closely associated to the natural resources of the region. The Karez systems are one of the best examples for this. The Karez systems were the lifeline of Bidar's historical period providing water for various purposes within and outside the fort enclosures. The karez systems in Bidar are still functional, being used for irrigation and potable water.

A. *What is Karez or Qanat or Surang-Bawi System?*

Scientifically, Karez or Qanat is a sub-surface aqueduct or tunnel that cut the water table and has many vertical shafts connecting to the surface. It normally runs from a higher elevation to a place with lesser elevation. The first shaft that is sunk in higher elevation at source point of water is called 'mother well'. The underground tunnel or aqueduct can run several kilometres to open at lower elevation. The opening of the Karez is called 'mouth'. General cross section of karez given in figure 1, Illustrates its various sections. The Karez gallery cuts the water table and allows groundwater to get accumulated and carried down slope. Though there are distribution mechanisms do existing at mouth for various purposes, the vents themselves acted as wells for extraction of water.



II. Literature Review

A. *Author: V. Govindankutty, Assistant Professor in Geography. Kerela*

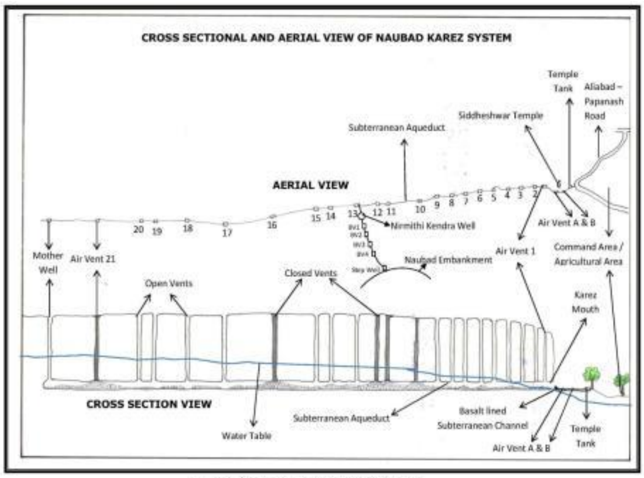


Figure 1: Cross Sectional and Aerial View of Karez System

B. *Karez Systems of Bidar*

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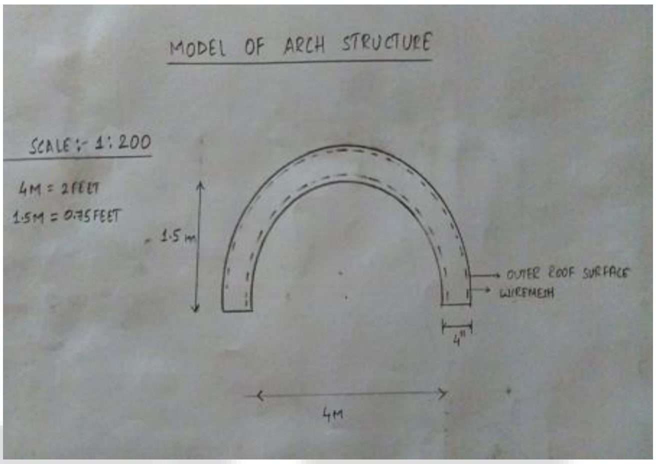
III. Materials Used

- Cement
- Aggregates
  - Fine Aggregates
  - Coarse Aggregates
- Water
- Fly ash

A. Welded wire mesh

B. Measurement of the mouth's Karez System

C. Dimensions of the Karez system after measurements



IV. RESULT

The bulk density is recorded in kg/m3 to the nearest 0.01 kg

A. Specific Gravity for Cement

1) Weight of empty density bottle (w1) = 77.6grms
2) Weight of empty density bottle + water (w2) = 176.8grms
3) Weight of empty density bottle + kerosene (w3) = 156.7grms
4) Cement + Density bottle (w4) = 96.8grms
5) Cement+ Density bottle + kerosene (w5) = 171grms

Specific gravity of kerosene $=\frac{w3-w1}{w2-w1}=\frac{156.7-77.6}{176.8-77.6}$

Specific gravity of kerosene = 0.8

Specific gravity of cement

$$=\frac{w4-w1}{(w3-w1)-(w5-w4)}*0.8$$

$$=\frac{96.8-77.6}{(156.7-77.6)-(171-96.8)}*0.8$$

Specific gravity of cement = 3.15

B. Test for Specific Gravity of Fine Aggregate and Moisture Content

1) Mass of empty pycnometer (M1) = 659.5grms
2) Mass of pycnometer + given sample (M2) = 1461.98grms

3) Mass of pycnometer + given sample + water (M3) = 2053grms
4) Mass of pycnometer + water (m4) = 1548.4grms

Specific gravity = $\frac{M2-M1}{(M4-M1)-(M3-M2)}$ = $\frac{1461.98-659.5}{(1548.4-659.5)-(2053-1461.98)}$

Specific gravity = 2.605

Percentage of water absorption = $\frac{M2-M1*(G-1)}{(M3-M4)-G}$ = $\frac{(1461.98-659.5)*(2.605-1)}{(2053-1548.4)-2.605}$*100

Percentage of water absorption = 1.23%

C. Preparation of Mix Design for M15 Grade Concrete

1) Stipulations for proportioning

1) Type of the cement used: OPC 53 grade conforming to IS 8112
2) Maximum nominal aggregate size: 20 mm
3) Minimum cement content: 320 kg/m3
4) Maximum water-cement ratio: 0.45
5) Workability: 100 (slump)
6) Exposure conditions: Normal
7) Method of placing concrete:Hand placed
8) Degree of supervision: Good
9) Type of aggregate: Crushed angular aggregate
10) Type of mineral admixture: fly ash
11) Maximum cement content 450kg/m3

2) Test data for materials

No.	Physical properties	Coarse aggregate	Fine aggregate
1	Specific gravity	2.88	2.605
2	Water absorption	0.97%	1.23%
3	Sieve analysis	Zone I	Zone II

Specific gravity of cement=3.15

3) Target strength for mix proportioning

f'ck = fck + 1.65 *s*

Where,

f'ck = target average compressive strength at 28 days,

fck = characteristic compressive strength at 28 days, and

s = standard deviation.

From Table I of IS 10262: 2009,

Standard deviation, *s* =3.5 N/mm2

Therefore,

Target strength = 15 + 1.65 x 3.5 = 20.77 N/mm2

4) Selection of water-cement ratio

From the graph, page 8 of IS 10262: 1982

Water-cement ratio as 0.40

0.45 < 0.40, hence OK.

5) Selection of water content

From Table 2,

Maximum water content =208liter (for 25 to 50 mm slump range) for 10 mm aggregate.

Therefore,

Water content = 220liters

Based on the these trails the superplasticizers water content reduced 29% hence the arrived water content= 220*0.71= 156 liters

6) Calculation of cement & fly ash content

Water-cement ratio = 0.40

Cementitious material (cement+flyash) =140/.40 = 350 kg/m3

From Table 5 of IS 456, minimum cement content for 'moderate' exposure = 240 kg/m3

350 kg/m3 > 240 kg/m3, hence, O.K

Now proportions are mixed containing fly ash and the following steps are suggested

Decoide the percentage to be used based on the project requirement and quality of requirement in certain situations increase the cementitious material .

Cementatious material content = 350*1.1 = 385kg/m3

Water content = 156kg/m3

Water cement ratio = 156/385 = 0.405

Fly ash at 25% = 96.25kg/m3

Cement = 385 – 96.25 =288.75kg/m3

Saving of cement while using flyash = 350-288.75 =61.25kg/m3

7) Volume of coarse aggregate and fine aggregate

From Table 3 of IS 10262: 1982, for 10 mm aggregate and water-cement ration of 0.5 volume of coarse aggregate is 0.46

For water-cement ratio of 0.4, volume of coarse aggregate is 0.48

(As the water-cement ratio is lower by 0.10. the proportion of volume of coarse aggregate is increased by 0.02 (at the rate of -/+ 0.01 for every ± 0.05 change in water-cement ratio).

Volume of fine aggregate=1-0.43 = 0.57

Volume of course aggregate = 0.48*0.9 = 0.43

8) Mix calculations

a) Volume of concrete = 1 m^3

b) Volume of cement = $\frac{massofcement}{specificgravityofcement} \times \frac{1}{1000}$

$= \frac{288.75}{3.14} \times \frac{1}{1000}$

= 0.092m^3

c) Volume of flyash = $\frac{massof\ flyash}{specificgravityofcement} \times \frac{1}{1000}$

$= \frac{96.25}{3.14} \times \frac{1}{1000}$

= 0.031m^3

d) Volume of water = $\frac{massofwater}{specificgravityofwater} \times \frac{1}{1000}$

$= \frac{156}{1} \times \frac{1}{1000}$

= 0.1560 m^3

e) Volume of chemical admixture takes as 0.5% by mass of cement

$= \frac{massofadmixture}{specificgravityofadmixture} \times \frac{1}{1000}$

$= \frac{1.9}{1.45} \times \frac{1}{1000}$

= 0.00165m^3

f) Volume of all in aggregate = [a-(b+c+d+e)]

= [1-(0.092+0.031+0.1560+0.00165)]

= 0.719 m3

g) Mass of fine aggregate

= e× Volume of fine aggregate × Specific gravity of fine aggregate × 1000

= 0.712 × 057 ×2.884* 1000

= 1170.0kg/m3

h) Mass of coarse aggregate
= f × Volume of coarse aggregate × Specific gravity of coarse aggregate × 1000
= 0.712 × 0.43× 2.884 × 1000
= 882.9 kg/m3

9) Mix proportion

Cement = 288.75kg/m3
Water = 156kg/m3
Fine aggregate = 1170kg/m3
Coarse aggregate = 882kg/m3
Admixture = 1.9 kg/m3
Water-cement ratio = 0.40
Fly ash =96.25kg/m3

10) Mix ratio

Cement	Fine Aggregate	Coarse Aggregate
1	4	3

D. Steps to be followed to cast the samples

1) Preparation of moulds:
   The Arch mould (made of cast iron plates) should be tightened and oiled well in advance before pouring the concrete into the arch mould.

2) Mixing of materials:
   The required quantity of materials as calculated in the mix design is mixed according to the mix proportion arrived in the mixer.
3) Placing and compacting of the concrete:
   The mixed concrete is poured into the moulds in 3 subsequent layer, every layer is tamped 25 times to attain good compaction.
4) Demoulding and curing:
   The compacted samples are allowed to set for 24 hours after which the arch is detached from arch mould and put into water for essential amount of curing.

V. RESULTS AND DISCUSSIONS

A. Properties of cement

The following table shows the physical characteristics of cement used:

Sl no.	Properties	Results
1	Specific gravity	3.15
2	Fineness	3%
3	Normal consistency	31%

B. Properties of coarse aggregate

The following table shows the physical characteristics of coarse aggregate used:

Sl no.	Properties	Values
1	Specificgravity	2.884
2	Water absorption	0.97%
3	Bulk density (compacted)	1760 kg/m3

C. Properties of fine aggregate

The following table shows the physical characteristics of fine aggregate used:

Sl no.	Properties	Results
1	Specific gravity	2.605
2	Water absorption	1.23%
3	Bulk density (compacted)	1653 kg/m3

D. Sieve analysis

The following table shows the gradation of the aggregates used:

Coarse aggregate		Fine aggregate	
Sieve size in mm	% passing	Sieve size in mm	% passing
12.50	99.10	4.75	99.93
10.00	87.79	2.36	95.02
6.35	35.31	1.18	78.48
4.75	16.57	0.60	49.48
-	-	0.30	7.28
-	-	0.15	0.07
Fineness modulus = 6.61		Fineness modulus = 3.31	

E. Test results for conventional M15,M20, & M25Archs

The following table shows the various strength parameters of conventional M35 concrete (i.e. 0% replacement) samples.

7 days results	Strength in kN/mm2		
Arch loading	40	45	50

VI. CONCLUSIONS

The following conclusions would be drawn from the be study: The existing load in the Karez system in 35.52KN/m, the obtained strength from the above experiment conducted is 40,45 and 50kn/m which is greater than existing dead load. Hence the Struture is safe.

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