

**SURVEY OF INDIA  
PROJECT SURVEY WING  
GEODETIC & RESEARCH BRANCH**



**REPORT ON  
CRUSTAL MOVEMENT STUDIES  
FOR  
JAMRANI DAM PROJECT IN UTTARAKHAND  
SEASON 2006-07**



## SURVEY OF INDIA PROJECT SURVEY WING, G&RB

### REPORT OF ANALYSIS OF GEODETIC OBSERVATIONS FOR CRUSTAL MOVEMENT STUDIES FOR JAMRANI DAM IN NAINITAL, UTTARAKHAND DURING 2006-07.

**INTRODUCTION:** Jamrani Dam is proposed to construct 145 m high rock fill Dam on Gola River in Jamrani area of Nainital District, Uttarakhand. Krol Thrust is crossing the reservoir area of the proposed Dam. To study the crustal movement behaviour due to Krol Thrust in the vicinity of and around the Dam area, No. 14 Party (G&RB) had taken up the field observations to conduct the study during season 1981-82 on the basis of the indent sent by the Superintending Engineer of Jamrani Dam project and 1<sup>st</sup>, 2<sup>nd</sup>, 3<sup>rd</sup> and 4<sup>th</sup> epoch observations were taken up during the year 1981-82, 1986-87, 1989-90 and 1996 (Summer) respectively. At present a set of 5<sup>th</sup> epoch observation has been completed by Project Survey Wing, G&RB during season 2006-07.

**LOCATION :** The Jamrani Dam project falls in sheet No. 53 O/11 in district Nainital, Uttarakhand.

**OBSERVATIONS :** All the Geodetic observations for planimetric and height control for scheme were taken up during 2006-07 as detailed below :

- (a) **Planimetric Control :** All the crustal movement stations were connected in main scheme of observation.
- (b) **Vertical Control :** Precision levelling was carried out in Fore and Back directions by starting the work from Type 'B' at Arna and closing on Type 'B' at Barajala established during season 1981-82. All the crustal movement stations were also connected in the above closed circuit of levelling.

#### **DATA PROCESSING AND ADJUSTMENT :**

- (a) **Planimetric Control :** All the observed horizontal angles were corrected for bubble and deflection corrections. EDM bases were computed on plane of reference as per departmental procedures. The adjustment of triangulation scheme was done using Survey of India adjustment programme based on variation of co-ordinates method.

The Bhimtal H.S. and Raunshil New-1 H.S. were taken as fixed station in 1<sup>st</sup>, 2<sup>nd</sup>, 3<sup>rd</sup> and 4<sup>th</sup> epoch and for 5<sup>th</sup> epoch Biloti H.S. and Raunshil New-1 H.S. were taken fixed station for adjustment as Bhimtal H.S. was found destroyed.

The comparative statement of co-ordinates of all epochs are tabulated in – Table I & II.



- (b) **Vertical Control** : The computation of heights were done with respect to old type 'B' bench marks established during season 1981-82. All the crustal movement stations were taken into computation. The comparative statement of heights of all epochs are tabulated in table - III.

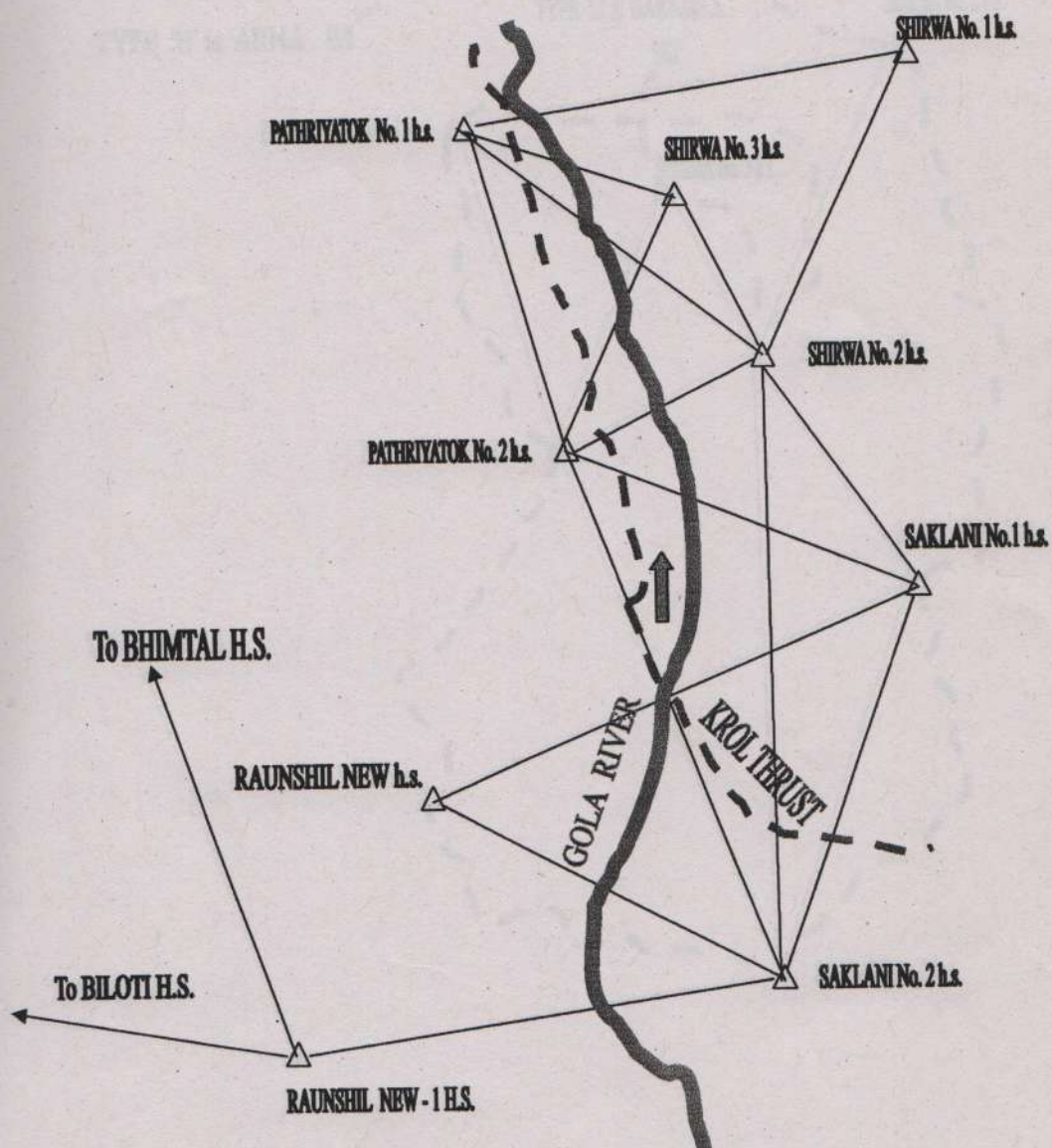
#### **ANALYSIS OF RESULTS :**

- (a) **Horizontal Movement** : By comparing and analyzing the results of all seasons w.r.t. 1981-82 it was noticed that the lateral movement is vibratory and it does not follow any particular direction. The movement is 1cm per year approximately as concluded from the study carried out in the area.
- (b) **Vertical Movement** : The vertical movement is minor and is well within the permissible limits. This shows no sinking or upheaval of the terrain during the period of study.

**INTERPRETATION OF RESULTS :** Precautions may be taken by the project authorities during the construction of Dam as found deemed fit from the engineering point of view.

# JAMRANI DAM PROJECT

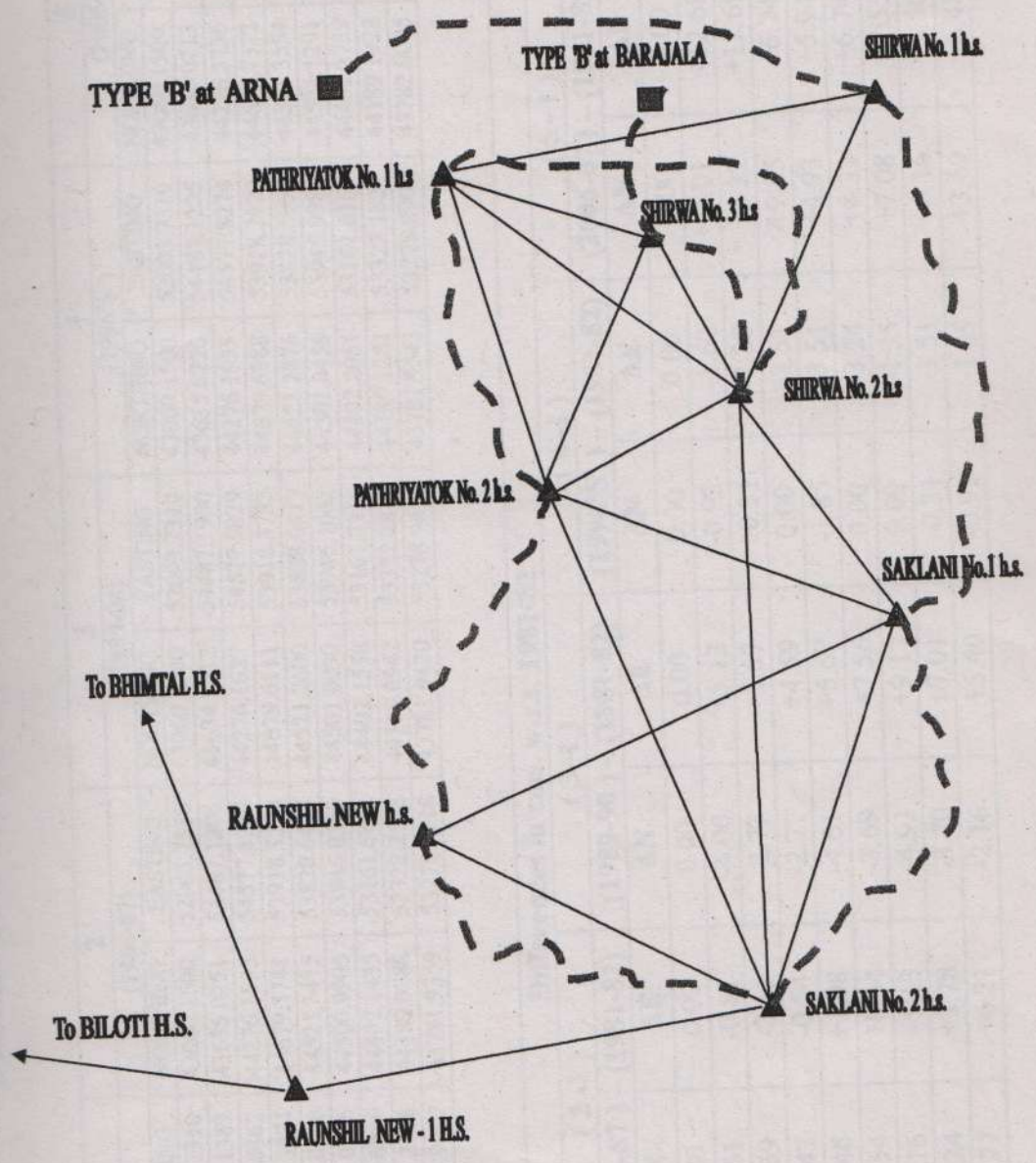
## TRIANGULATION SCHEME





# JAMRANI DAM PROJECT

## SCHEME FOR VERTICAL CONTROL





# COMPARATIVE STATEMENT OF CO-ORDINATES OF JAMRANI DAM PROJECT OBSERVED DURING DIFFERENT EPOCHS

Sl No	Name of Station	1 (1981-82)		2 (1986-87)		3 (1989-90)		4 (1996'S')		5 (2006-07)	
		NORTHING	EASTING	NORTHING	EASTING	NORTHING	EASTING	NORTHING	EASTING	NORTHING	EASTING
1.	RAUNSHIL NEW 1 H.S.	43060.1500	52003.7310	43060.1500	52003.7310	43060.1500	52003.7310	43060.1500	52003.7310	43060.1500	52003.7310
2.	SAKLANI No. 2 h.s.	43635.0312	54487.1387	43635.0251	54487.1306	43634.9912	54487.1900	43635.0220	54487.1225	43635.0713	54487.2655
3.	SAKLANI No. 1 h.s.	44276.1904	54577.8462	44276.1535	54577.8247	44276.1627	54577.9029	44276.1935	54577.8274	44276.2736	54577.9731
4.	SHIRWA No. 1 h.s.	44679.6388	53918.3274	44679.5741	53918.3220	44679.6111	53918.3733	44679.6388	53918.2923	44679.7373	53918.3948
5.	SHIRWA No. 3 h.s.	44521.3061	53828.6350	44521.2415	53828.6458	44521.2600	53828.6917	44521.2876	53828.5999	44501.1291	53946.0979
6.	SHIRWA No. 2 h.s.	44501.0459	53946.0305	44500.9905	53946.0359	44501.0090	53946.1061	44501.0459	53945.9981	44402.2759	53161.7054
7.	PATHRIYATOK No. 1 h.s.	44402.2051	53161.6299	44402.1435	53161.6812	44402.1558	53161.7216	44402.2051	53161.6164	44189.1928	53322.2528
8.	PATHRIYATOK No. 2 h.s.	44189.1312	53322.2178	44189.0788	53322.2556	44189.0942	53322.2879	44189.1281	53322.1827	43782.0005	53278.9745
9.	RAUNSHIL NEW h.s.	43781.9636	53278.9097	43781.9359	53278.9718	43781.9420	53278.9637	43781.9543	53278.8908		

Name of Station	(2-1)		(3-1)		(4-1)		(5-1)	
	(1986-87) - (1981-82)	(1989-90) - (1981-82)	(1996'S') - (1981-82)	(2006-07) - (1981-82)				
	AN	AE	AN	AE	AN	AE	AN	AE
RAUNSHIL NEW 1 H.S.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SAKLANI No. 2 h.s.	-0.61	-0.81	-4.00	+5.13	-0.92	-1.62	+4.01	+12.68
SAKLANI No. 1 h.s.	-3.69	-2.15	-2.77	+5.67	+0.31	-1.88	+8.32	+12.69
SHIRWA No. 1 h.s.	-6.47	-0.54	-2.77	+4.59	0.00	-3.51	+4.93	+5.94
SHIRWA No. 3 h.s.	-6.46	+1.08	-4.61	+5.67	-1.85	-3.51	+8.32	+6.74
SHIRWA No. 2 h.s.	-5.54	+0.54	-3.69	+7.56	0.00	-1.35	+7.08	+7.55
PATHRIYATOK No. 1 h.s.	-6.16	+5.13	-4.93	+9.17	0.00	-3.51	+6.16	+3.50
PATHRIYATOK No. 2 h.s.	-5.24	+3.78	-3.70	+7.01	-0.31	-1.89	+3.69	+6.48
RAUNSHIL NEW h.s.	-2.77	+6.21	-2.16	+5.40	-0.93	-1.89		



Differences in cms. consecutive years

Name of Station	(2-1)		(3-2)		(4-3)		(5-4)	
	(1986-87) - (1981-82)		(1989-90) - (1986-87)		(1996'S') - (1989-90)		(2006-07) - (1996'S')	
	AN	AE	AN	AE	AN	AE	AN	AE
RAUNSHIL NEW I H.S.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SAKLANI No. 2 h.s.	-0.61	-0.81	-3.39	+5.94	+3.08	-6.75	+4.93	+14.30
SAKLANI No. 1 h.s.	-3.69	-2.15	+0.92	+7.82	+3.08	-7.55	+8.01	+14.57
SHIRWA No. 1 h.s.	-6.47	-0.54	+3.70	+5.13	+2.77	-8.10	+9.85	+10.25
SHIRWA No. 3 h.s.	-6.46	+1.08	+1.85	+4.59	+2.76	-9.18	+6.78	+9.45
SHIRWA No. 2 h.s.	-5.54	+0.54	+1.85	+7.02	+3.69	-10.80	+8.32	+9.98
PATHRIVATOK No. 1 h.s.	-6.16	+5.13	+1.23	+4.04	+4.93	-10.52	+7.08	+8.90
PATHRIVATOK No. 2 h.s.	-5.24	+3.78	+1.54	+3.23	+3.39	-10.52	+6.47	+7.01
RAUNSHIL NEW h.s.	-2.77	+6.21	+0.61	-0.81	+1.23	-7.29	+4.62	+8.37

Differences in cms. of year 2006-07 with previous year

Station	(5-1)		(5-2)		(5-3)		(5-4)	
	(2006-07) - (1981-82)		(2006-07) - (1986-87)		(2006-07) - (1989-90)		(2006-07) - (1996'S')	
	AN	AE	AN	AE	AN	AE	AN	AE
RAUNSHIL NEW I H.S.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SAKLANI No. 2 h.s.	+4.01	+12.68	+4.62	+13.49	+8.01	+7.55	+4.93	+14.30
SAKLANI No. 1 h.s.	+8.32	+12.69	+12.01	+14.84	+11.09	+7.02	+8.01	+14.57
SHIRWA No. 1 h.s.	+9.85	+6.74	+16.32	+7.28	+12.62	+2.15	+9.85	+10.25
SHIRWA No. 3 h.s.	+4.93	+5.94	+11.39	+4.86	+9.54	+0.27	+6.78	+9.45
SHIRWA No. 2 h.s.	+8.32	+6.74	+13.86	+6.20	+12.01	-0.82	+8.32	+9.98
PATHRIVATOK No. 1 h.s.	+7.08	+7.55	+13.24	+2.42	+12.01	-1.62	+7.08	+8.90
PATHRIVATOK No. 2 h.s.	+6.16	+3.50	+11.40	-0.28	+9.86	-3.51	+6.47	+7.01
RAUNSHIL NEW h.s.	+3.69	+6.48	+6.46	+0.27	+5.85	+1.08	+4.62	+8.37



# COMPARATIVE STATEMENT OF HEIGHTS OF BENCH-MARKS OF JAMRANI DAM PROJECT OBSERVED DURING DIFFERENT EPOCHS

Sl. No.	Name of Station	Heights in metres					Difference of heights in centimeters			
		1	2	3	4	5	(2-1)	(3-2)	(4-3)	(5-4)
		1981-82	1986-87	1989-90	1996(S)	2006-07				
1.	SAKLANI No. 2 h.s.	818.4767	818.4826	818.4950	818.4738	818.4792	+0.59	+1.24	-2.12	+0.54
2.	SAKLANI No. 1 h.s.	834.4019	834.4072	834.4203	834.3994	834.4064	+0.53	+1.31	-2.09	+0.70
3.	SHIRWA No. 1 h.s.	798.6396	798.6414	798.6501	798.6459	798.6388	+0.18	+0.87	-0.42	-0.71
4.	SHIRWA No. 3 h.s.	683.0318	683.0287	683.0335	683.0185	683.0173	-0.31	+0.48	-1.50	-0.12
5.	SHIRWA No. 2 h.s.	701.2490	701.2488	701.2546	701.2431	701.2466	-0.02	+0.58	-1.15	+0.35
6.	PATHRIYATOK No. 1 h.s.	714.5891	714.5831	714.5805	714.5727	714.5631	-0.60	-0.26	-0.78	-0.96
7.	PATHRIYATOK No. 2 h.s.	730.3280	730.3264	730.3262	730.3215	730.3197	-0.16	-0.02	-0.47	-0.18
8.	RAUNSHIL NEW h.s.	855.2348	855.2315	855.2375	855.2193	855.2219	-0.33	+0.60	-1.82	+0.26

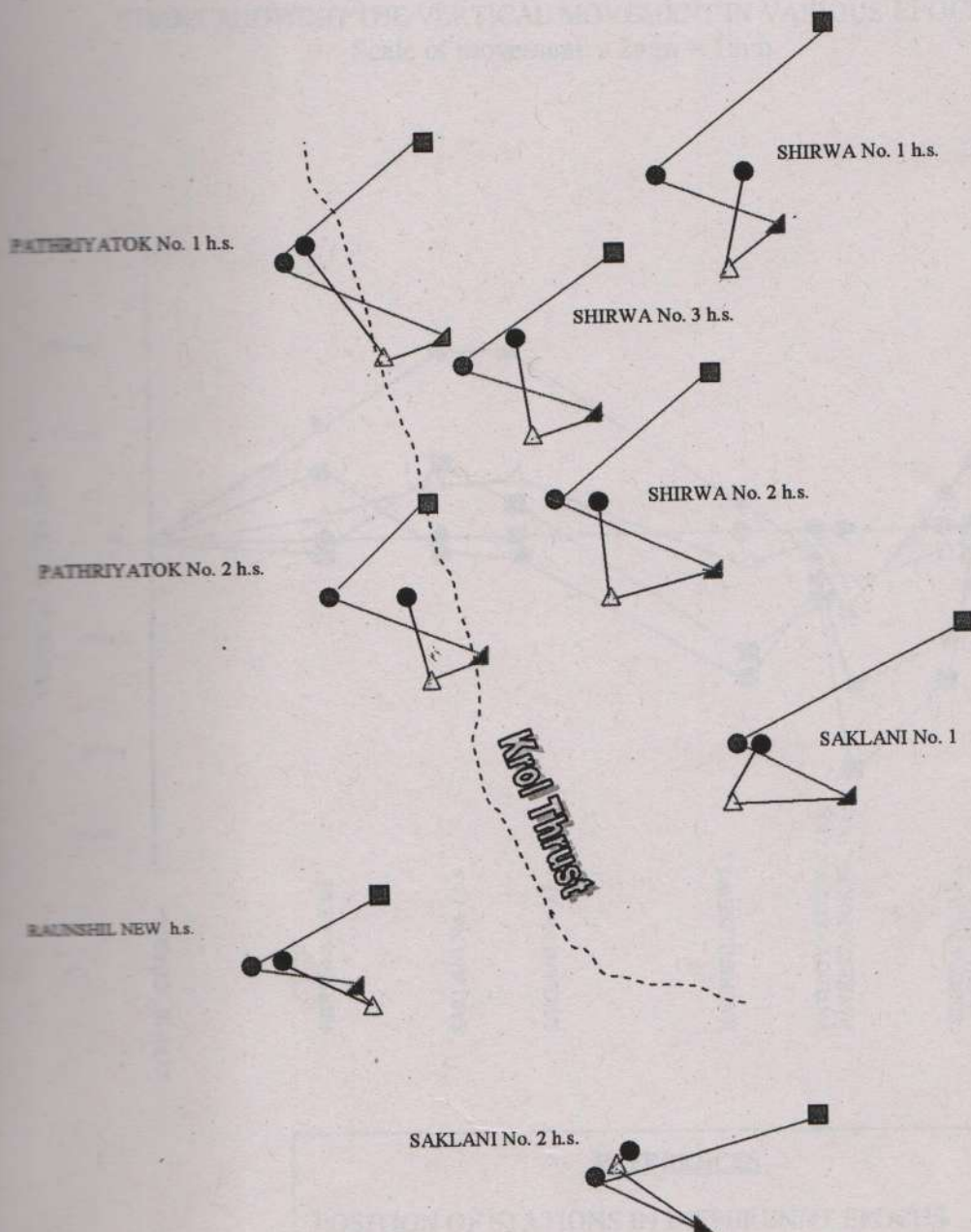
Sl. No.	Name of Station	Heights in metres					Difference of heights in centimeters			
		1	2	3	4	5	(5-1)	(5-2)	(5-3)	(5-4)
		1981-82	1986-87	1989-90	1996(S)	2006-07				
1.	SAKLANI No. 2 h.s.	818.4767	818.4826	818.4950	818.4738	818.4792	+0.25	-0.34	-1.58	+0.54
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4.	SHIRWA No. 3 h.s.	683.0318	683.0287	683.0335	683.0185	683.0173	-1.45	-1.14	-1.62	-0.12
5.	SHIRWA No. 2 h.s.	701.2490	701.2488	701.2546	701.2431	701.2466	-0.24	-0.22	-0.80	+0.35
6.	PATHRIYATOK No. 1 h.s.	714.5891	714.5831	714.5805	714.5727	714.5631	-2.60	-2.00	-1.74	-0.96
7.	PATHRIYATOK No. 2 h.s.	730.3280	730.3264	730.3262	730.3215	730.3197	-0.83	-0.67	-0.65	-0.18
8.	RAUNSHIL NEW h.s.	855.2348	855.2315	855.2375	855.2193	855.2219	-1.29	-0.96	-1.56	+0.26



# JAMRANI DAM PROJECT

CHART SHOWING THE HORIZONTAL MOVEMENT IN VARIOUS EPOCHS

Scale of movement: - 1mm = 4mm



## REFERENCES

### POSITION OF STATIONS IN DIFFERENT EPOCHS

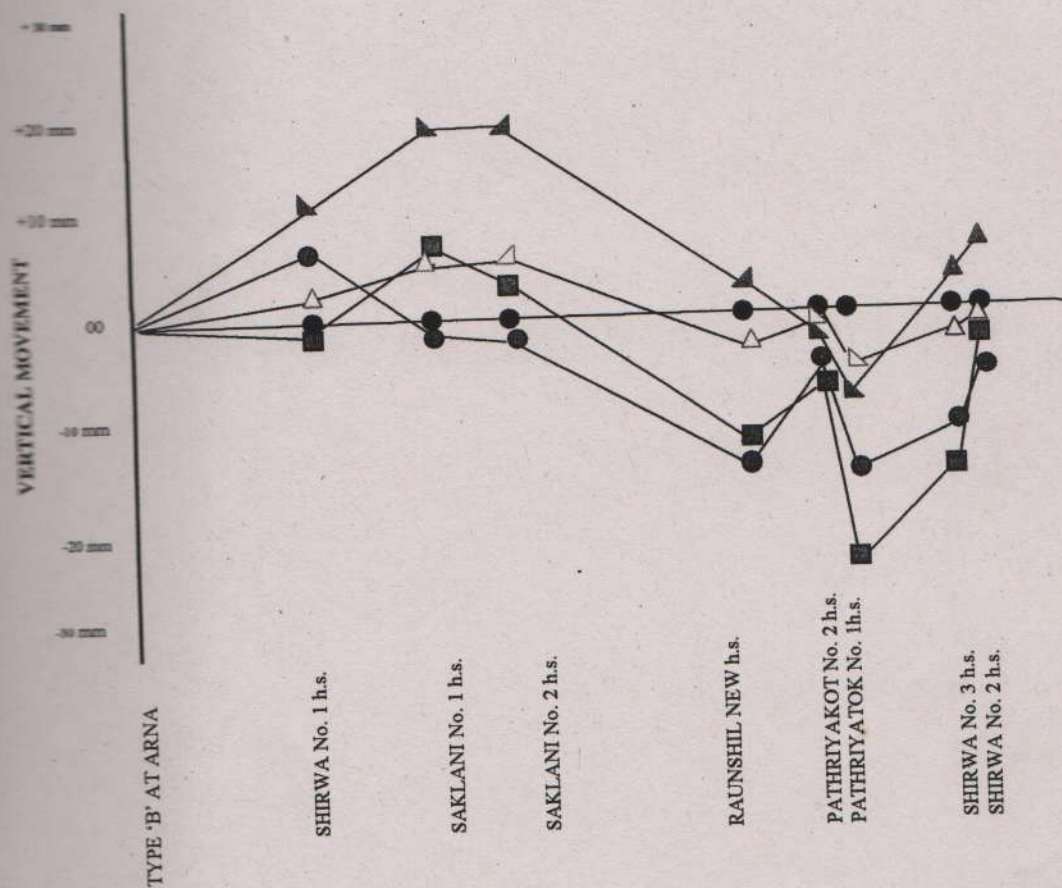
- |                    |       |   |
|--------------------|-------|---|
| 1. SEASON 1981-82  | ----- | ● |
| 2. SEASON 1986-87  | ----- | △ |
| 3. SEASON 1989-90  | ----- | ▲ |
| 4. SEASON 1996 (S) | ----- | ● |
| 5. SEASON 2006-07  | ----- | ■ |



# JAMRANI DAM PROJECT

## CHART SHOWING THE VERTICAL MOVEMENT IN VARIOUS EPOCHS

Scale of movement: - 2mm = 1mm



### REFERENCES

#### POSITION OF STATIONS IN DIFFERENT EPOCHS

- |                          |   |
|--------------------------|---|
| 1. SEASON 1981-82 -----  | ● |
| 2. SEASON 1986-87 -----  | △ |
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| 4. SEASON 1996 (S) ----- | ● |
| 5. SEASON 2006-07 -----  | ■ |



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**LOCATION :** The Jamrani Dam project falls in sheet No. 53 O/11 in district Nainital, Uttarakhand.

**OBSERVATIONS :** All the Geodetic observations for planimetric and height control for scheme were taken up during 2006-07 as detailed below :

- (a) **Planimetric Control :** All the crustal movement stations were connected in main scheme of observation.
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The comparative statement of co-ordinates of all epochs are tabulated in – Table I & II.



- (b) **Vertical Control** : The computation of heights were done with respect to old type 'B' bench marks established during season 1981-82. All the crustal movement stations were taken into computation. The comparative statement of heights of all epochs are tabulated in table - III.

### **ANALYSIS OF RESULTS :**

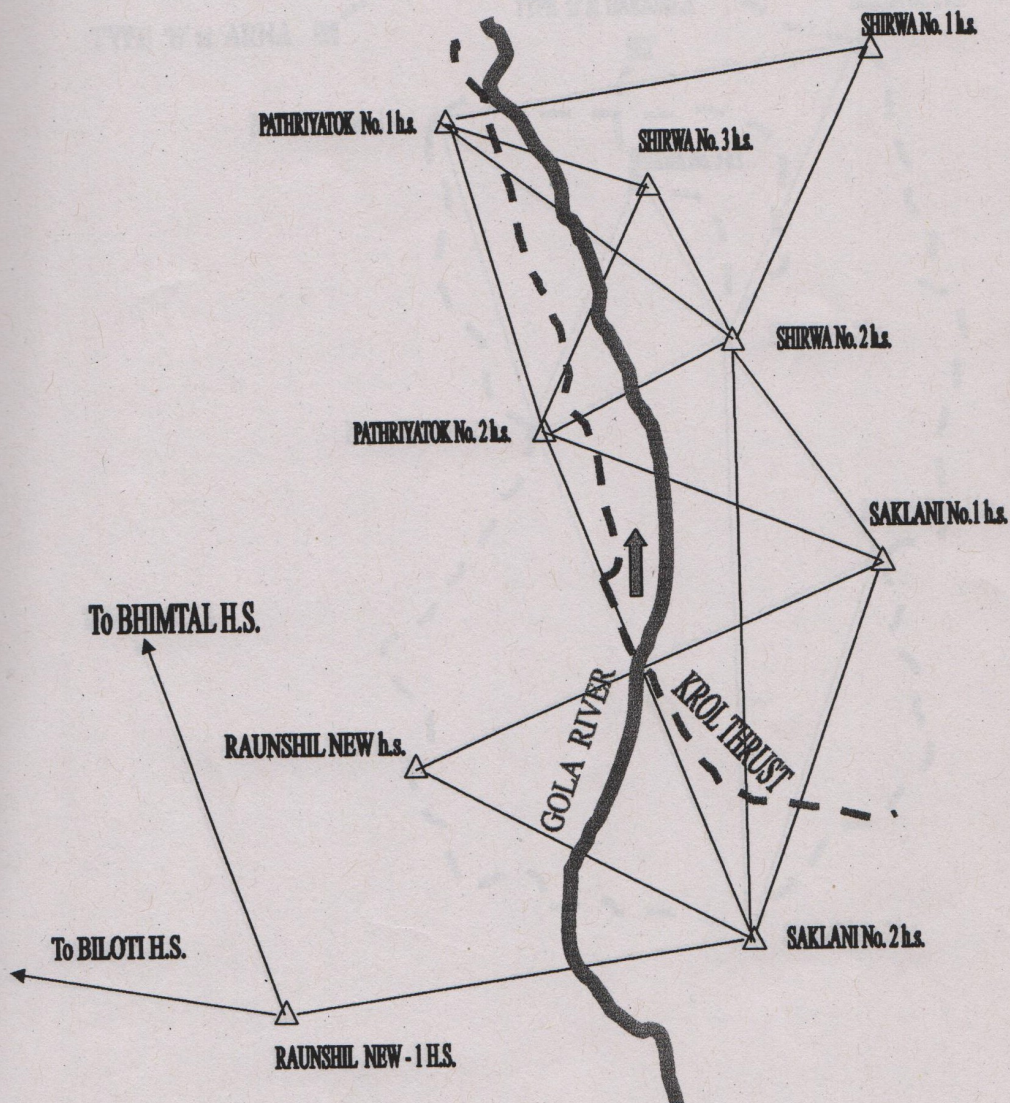
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- (b) **Vertical Movement** : The vertical movement is minor and is well within the permissible limits. This shows no sinking or upheaval of the terrain during the period of study.

**INTERPRETATION OF RESULTS :** Precautions may be taken by the project authorities during the construction of Dam as found deemed fit from the engineering point of view.



# JAMRANI DAM PROJECT

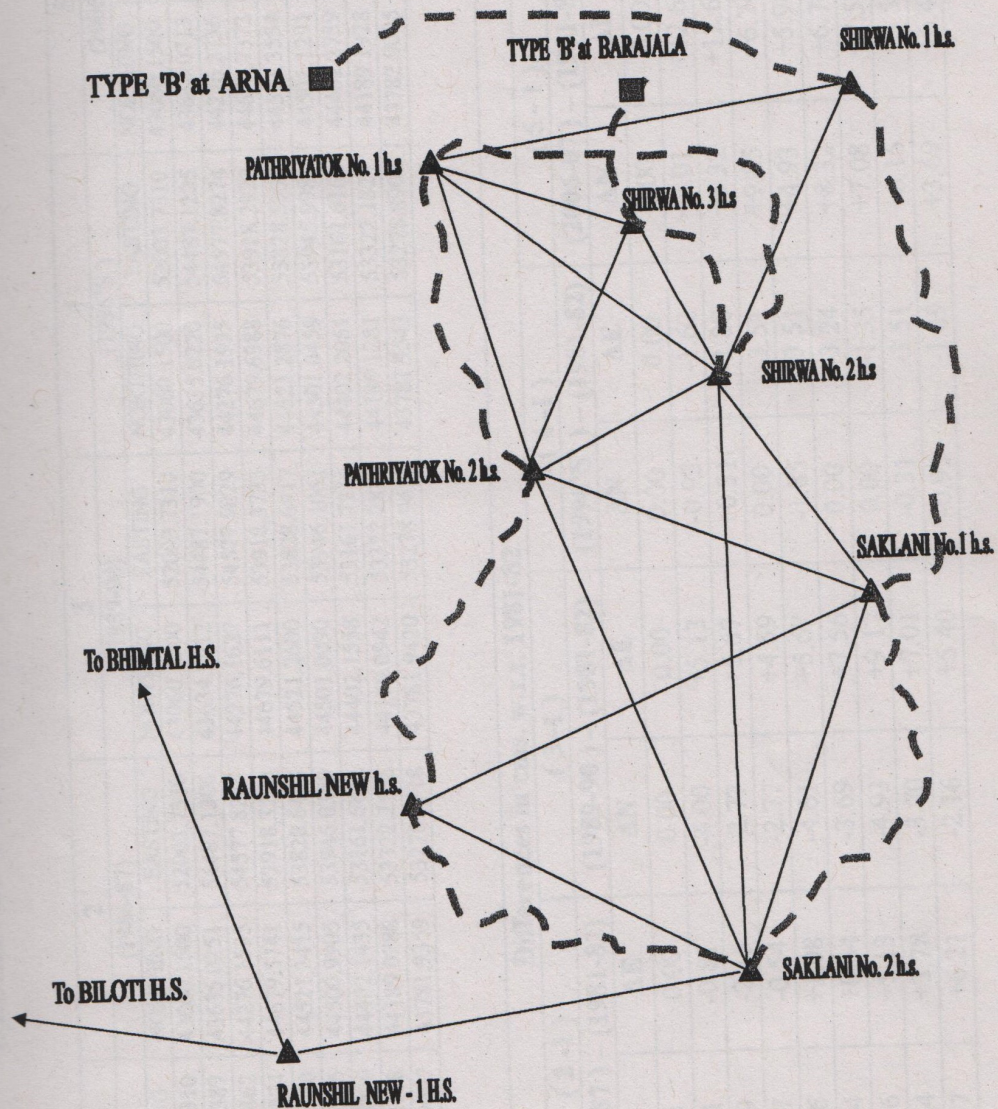
## TRIANGULATION SCHEME





# JAMRANI DAM PROJECT

## SCHEME FOR VERTICAL CONTROL





# COMPARATIVE STATEMENT OF CO-ORDINATES OF JAMRANI DAM PROJECT OBSERVED DURING DIFFERENT EPOCHS

Sl No	Name of Station	1 (1981-82)		2 (1986-87)		3 (1989-90)		4 (1996'S')		5 (2006-07)	
		NORTHING	EASTING	NORTHING	EASTING	NORTHING	EASTING	NORTHING	EASTING	NORTHING	EASTING
1.	RAUNSHIL NEW 1 H.S.	43060.1500	52003.7310	43060.1500	52003.7310	43060.1500	52003.7310	43060.1500	52003.7310	43060.1500	52003.7310
2.	SAKLANI No. 2 h.s.	43635.0312	54487.1387	43635.0251	54487.1306	43634.9912	54487.1900	43635.0220	54487.1225	43635.0713	54487.2655
3.	SAKLANI No. 1 h.s.	44276.1904	54577.8462	44276.1535	54577.8247	44276.1627	54577.9029	44276.1935	54577.8274	44276.2736	54577.9731
4.	SHIRWA No. 1 h.s.	44679.6388	53918.3274	44679.5741	53918.3220	44679.6111	53918.3733	44679.6388	53918.2923	44679.7373	53918.3948
5.	SHIRWA No. 3 h.s.	44521.3061	53828.6350	44521.2415	53828.6458	44521.2600	53828.6917	44521.2876	53828.5999	44521.3554	53828.6944
6.	SHIRWA No. 2 h.s.	44501.0459	53946.0305	44500.9905	53946.0359	44501.0090	53946.1061	44501.0459	53945.9981	44501.1291	53946.0979
7.	PATHRIYATOK No. 1 h.s.	44402.2051	53161.6299	44402.1435	53161.6812	44402.1558	53161.7216	44402.2051	53161.6164	44402.2759	53161.7054
8.	PATHRIYATOK No. 2 h.s.	44189.1312	53322.2178	44189.0788	53322.2556	44189.0942	53322.2879	44189.1281	53322.1827	44189.1928	53322.2528
9.	RAUNSHIL NEW h.s.	43781.9636	53278.9097	43781.9359	53278.9718	43781.9420	53278.9637	43781.9543	53278.8908	43782.0005	53278.9745

Name of Station	Differences in cms. w.r.t. 1981-82				(4-1)				(5-1)	
	(2-1)		(3-1)		(1996'S') - (1981-82)		(2006-07) - (1981-82)			
	(1986-87) - (1981-82)	AN	(1989-90) - (1981-82)	AN	AN	AE	AN	AE		
RAUNSHIL NEW 1 H.S.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
SAKLANI No. 2 h.s.	-0.61	-0.81	-4.00	+5.13	-0.92	-1.62	+4.01	+12.68		
SAKLANI No. 1 h.s.	-3.69	-2.15	-2.77	+5.67	+0.31	-1.88	+8.32	+12.69		
SHIRWA No. 1 h.s.	-6.47	-0.54	-2.77	+4.59	0.00	-3.51	+4.93	+5.94		
SHIRWA No. 3 h.s.	-6.46	+1.08	-4.61	+5.67	-1.85	-3.51	+4.93	+6.74		
SHIRWA No. 2 h.s.	-5.54	+0.54	-3.69	+7.56	0.00	-3.24	+8.32	+7.55		
PATHRIYATOK No. 1 h.s.	-6.16	+5.13	-4.93	+9.17	0.00	-1.35	+7.08	+7.55		
PATHRIYATOK No. 2 h.s.	-5.24	+3.78	-3.70	+7.01	-0.31	-3.51	+6.16	+3.50		
RAUNSHIL NEW h.s.	-2.77	+6.21	-2.16	+5.40	-0.93	-1.89	+3.69	+6.48		



Name of Station	Differences in cms. consecutive years							
	(2-1)		(3-2)		(4-3)		(5-4)	
	(1986-87) - (1981-82)		(1989-90) - (1986-87)		(1996'S') - (1989-90)		(2006-07) - (1996'S')	
	AN	AE	AN	AE	AN	AE	AN	AE
RAUNSHIL NEW 1 H.S.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SAKLANI No. 2 h.s.	-0.61	-0.81	-3.39	+5.94	+3.08	-6.75	+4.93	+14.30
SAKLANI No. 1 h.s.	-3.69	-2.15	+0.92	+7.82	+3.08	-7.55	+8.01	+14.57
SHIRWA No. 1 h.s.	-6.47	-0.54	+3.70	+5.13	+2.77	-8.10	+9.85	+10.25
SHIRWA No. 3 h.s.	-6.46	+1.08	+1.85	+4.59	+2.76	-9.18	+6.78	+9.45
SHIRWA No. 2 h.s.	-5.54	+0.54	+1.85	+7.02	+3.69	-10.80	+8.32	+9.98
PATHRIYATOK No. 1 h.s.	-6.16	+5.13	+1.23	+4.04	+4.93	-10.52	+7.08	+8.90
PATHRIYATOK No. 2 h.s.	-5.24	+3.78	+1.54	+3.23	+3.39	-10.52	+6.47	+7.01
RAUNSHIL NEW h.s.	-2.77	+6.21	+0.61	-0.81	+1.23	-7.29	+4.62	+8.37

Station	Differences in cms. of year 2006-07 with previous year							
	(5-1)		(5-2)		(5-3)		(5-4)	
	(2006-07) - (1981-82)		(2006-07) - (1986-87)		(2006-07) - (1989-90)		(2006-07) - (1996'S')	
	AN	AE	AN	AE	AN	AE	AN	AE
RAUNSHIL NEW 1 H.S.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SAKLANI No. 2 h.s.	+4.01	+12.68	+4.62	+13.49	+8.01	+7.55	+4.93	+14.30
SAKLANI No. 1 h.s.	+8.32	+12.69	+12.01	+14.84	+11.09	+7.02	+8.01	+14.57
SHIRWA No. 1 h.s.	+9.85	+6.74	+16.32	+7.28	+12.62	+2.15	+9.85	+10.25
SHIRWA No. 3 h.s.	+4.93	+5.94	+11.39	+4.86	+9.54	+0.27	+6.78	+9.45
SHIRWA No. 2 h.s.	+8.32	+6.74	+13.86	+6.20	+12.01	-0.82	+8.32	+9.98
PATHRIYATOK No. 1 h.s.	+7.08	+7.55	+13.24	+2.42	+12.01	-1.62	+7.08	+8.90
PATHRIYATOK No. 2 h.s.	+6.16	+3.50	+11.40	-0.28	+9.86	-3.51	+6.47	+7.01
RAUNSHIL NEW h.s.	+3.69	+6.48	+6.46	+0.27	+5.85	+1.08	+4.62	+8.37



# COMPARATIVE STATEMENT OF HEIGHTS OF BENCH-MARKS OF JAMRANI DAM PROJECT OBSERVED DURING DIFFERENT EPOCHS

Sl. No.	Name of Station	Heights in metres					Difference of heights in centimeters				
		1	2	3	4	5	(2-1)	(3-2)	(4-3)	(5-4)	
		1981-82	1986-87	1989-90	1996(S)	2006-07					
1.	SAKLANI No. 2 h.s.	818.4767	818.4826	818.4950	818.4738	818.4792	+0.59	+1.24	-2.12	+0.54	
2.	SAKLANI No. 1 h.s.	834.4019	834.4072	834.4203	834.3994	834.4064	+0.53	+1.31	-2.09	+0.70	
3.	SHIRWA No. 1 h.s.	798.6396	798.6414	798.6501	798.6459	798.6388	+0.18	+0.87	-0.42	-0.71	
4.	SHIRWA No. 3 h.s.	683.0318	683.0287	683.0335	683.0185	683.0173	-0.31	+0.48	-1.50	-0.12	
5.	SHIRWA No. 2 h.s.	701.2490	701.2488	701.2546	701.2431	701.2466	-0.02	+0.58	-1.15	+0.35	
6.	PATHRIYATOK No. 1 h.s.	714.5891	714.5831	714.5805	714.5727	714.5631	-0.60	-0.26	-0.78	-0.96	
7.	PATHRIYATOK No. 2 h.s.	730.3280	730.3264	730.3262	730.3215	730.3197	-0.16	-0.02	-0.47	-0.18	
8.	RAUNSHIL NEW h.s.	855.2348	855.2315	855.2375	855.2193	855.2219	-0.33	+0.60	-1.82	+0.26	

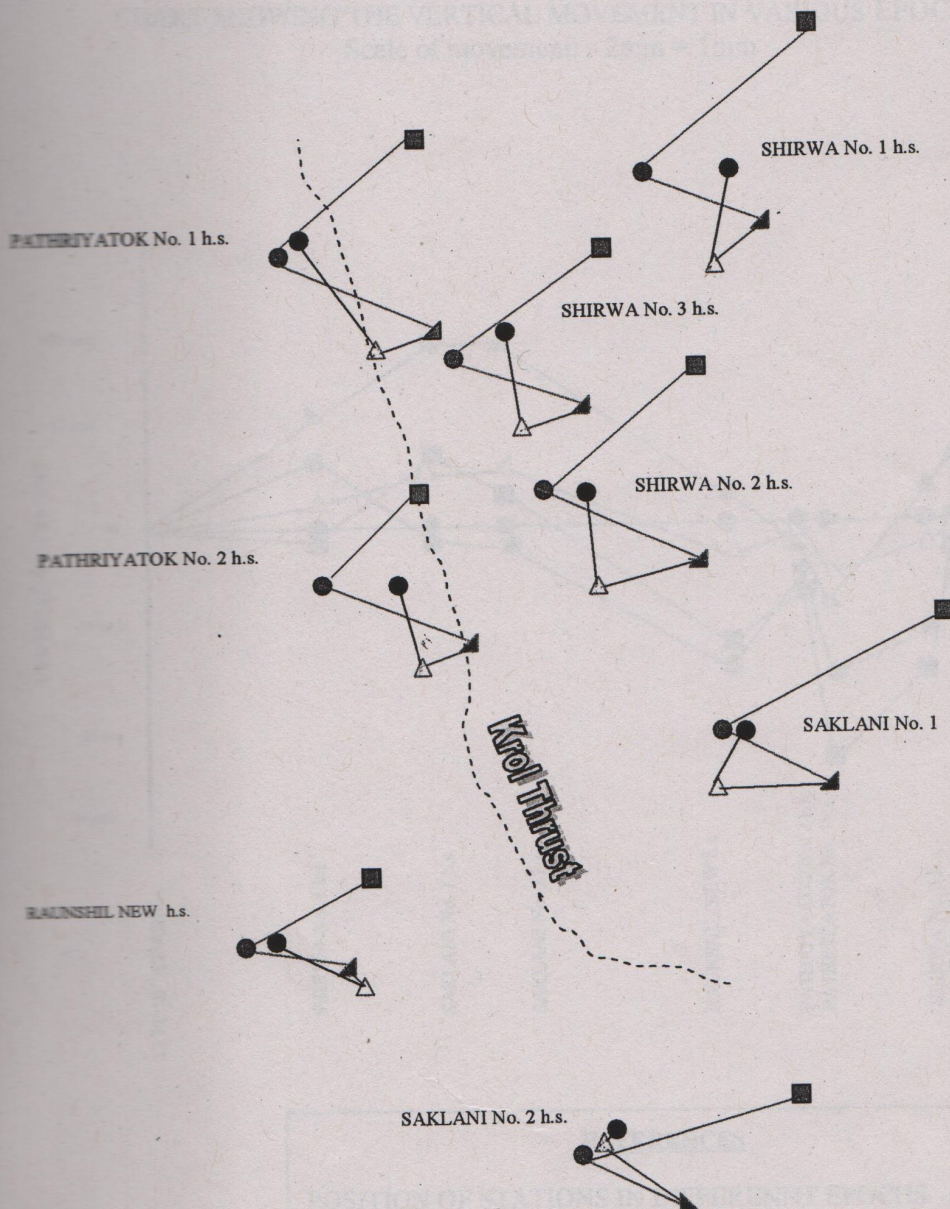
Sl. No.	Name of Station	Heights in metres					Difference of heights in centimeters			
		1	2	3	4	5	(5-1)	(5-2)	(5-3)	(5-4)
		1981-82	1986-87	1989-90	1996(S)	2006-07				
1.	SAKLANI No. 2 h.s.	818.4767	818.4826	818.4950	818.4738	818.4792	+0.25	-0.34	-1.58	+0.54
2.	SAKLANI No. 1 h.s.	834.4019	834.4072	834.4203	834.3994	834.4064	+0.45	-0.08	-1.39	+0.70
3.	SHIRWA No. 1 h.s.	798.6396	798.6414	798.6501	798.6459	798.6388	-0.08	-0.26	-1.13	-0.71
4.	SHIRWA No. 3 h.s.	683.0318	683.0287	683.0335	683.0185	683.0173	-1.45	-1.14	-1.62	-0.12
5.	SHIRWA No. 2 h.s.	701.2490	701.2488	701.2546	701.2431	701.2466	-0.24	-0.22	-0.80	+0.35
6.	PATHRIYATOK No. 1 h.s.	714.5891	714.5831	714.5805	714.5727	714.5631	-2.60	-2.00	-1.74	-0.96
7.	PATHRIYATOK No. 2 h.s.	730.3280	730.3264	730.3262	730.3215	730.3197	-0.83	-0.67	-0.65	-0.18
8.	RAUNSHIL NEW h.s.	855.2348	855.2315	855.2375	855.2193	855.2219	-1.29	-0.96	-1.56	+0.26



# JAMRANI DAM PROJECT

CHART SHOWING THE HORIZONTAL MOVEMENT IN VARIOUS EPOCHS

Scale of movement: - 1mm = 4mm



## REFERENCES

### POSITION OF STATIONS IN DIFFERENT EPOCHS

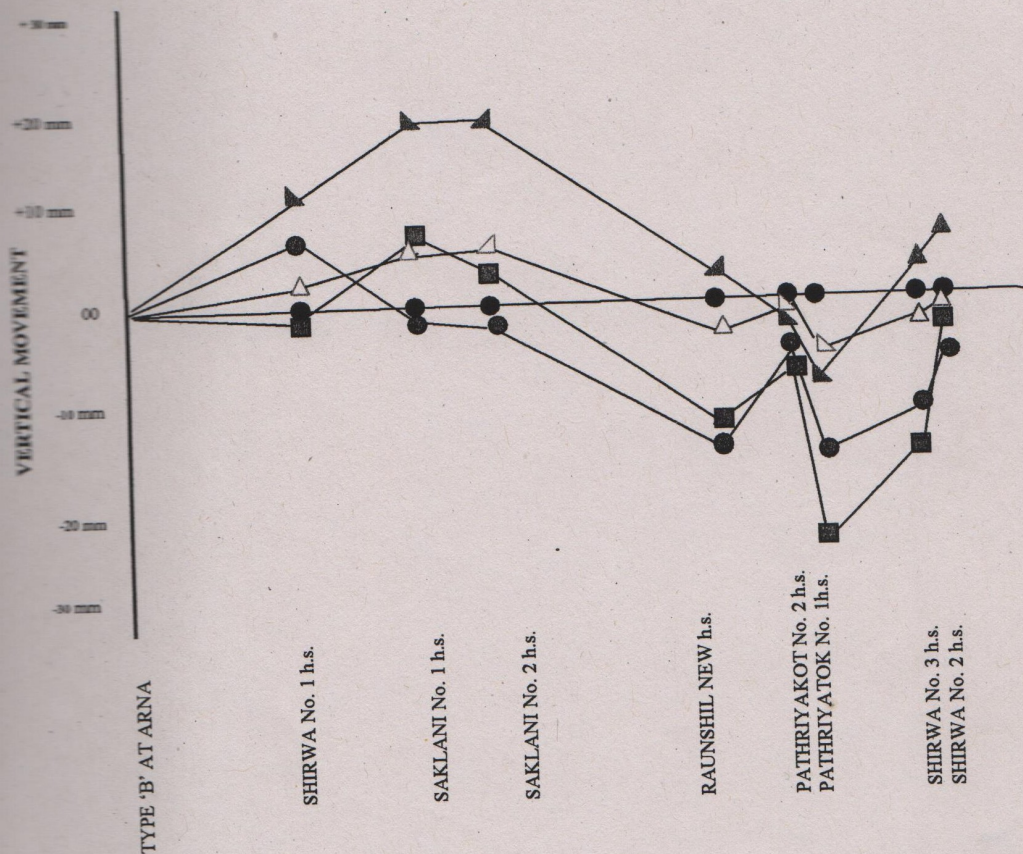
- |                    |       |   |
|--------------------|-------|---|
| 1. SEASON 1981-82  | ----- | ● |
| 2. SEASON 1986-87  | ----- | △ |
| 3. SEASON 1989-90  | ----- | ▲ |
| 4. SEASON 1996 (S) | ----- | ● |
| 5. SEASON 2006-07  | ----- | ■ |



# JAMRANI DAM PROJECT

## CHART SHOWING THE VERTICAL MOVEMENT IN VARIOUS EPOCHS

Scale of movement: - 2mm = 1mm



### REFERENCES

#### POSITION OF STATIONS IN DIFFERENT EPOCHS

- |                          |   |
|--------------------------|---|
| 1. SEASON 1981-82 -----  | ● |
| 2. SEASON 1986-87 -----  | △ |
| 3. SEASON 1989-90 -----  | ▲ |
| 4. SEASON 1996 (S) ----- | ● |
| 5. SEASON 2006-07 -----  | ■ |