

CHAPTER 7

KOYANA DAM AND THE EARTHQUAKES

1. INTRODUCTION:

The big dams are said to have several side effects on environment and people. They can be enumerated as follows: degradation of soil in the command areas of irrigation projects due to increase in soil salinity and water logging, destruction of habitat, dam diseases like malaria, destruction of ecosystem and the earthquake. The present chapter deals with the construction of Koyana dam and the phenomenon of earthquakes.

The scientific research conducted at several large reservoirs has revealed "the possibilities of earthquakes being triggered off due to the impounding of massive amounts of water in them. Seismic tremors have been recorded at all these reservoirs. Earthquakes can also occur due to the existence of active faults or discontinuities in the underground rocks, along which movement may take place or due to the existence of fissures through water seepage into the earth" ¹ It will be appropriate to observe the Koyana Dam situation on this background.

2. KOYANA DAM AND THE EARTHQUAKES: The details regarding the Koyana dam and its influence have been noted as follows, "the Koyana Dam is 103 meters high and its reservoir has a maximum volume of 2780 million cubic meters (Mm³).

Filling started in 1962 and ended in 1964 when the reservoir was a little less than half filled. In 1963, the frequency of the shocks increased greatly and their epicentres were all found to be either in the neighbourhood of the dam or under the reservoir. In 1964, the volume of the water in the reservoir was brought upto 2000 Mm³. In the next few years, there was little seismic activity. Indeed by the summer of 1967, it was assumed that everything had settled down and that tremors would no longer occur. Thus P.M. Mane, the Chief Engineer at Koyana argued at the IX Congress on Large Dams, held that year in Istanbul that the tremors were probably due to crystal adjustments taking place in and around the lake. He went on to tell the delegates to the conference: "It is gathered that such tremors gradually decrease over a period of some years and stop completely. It is hoped that it will be so at Koyana also" 2

However, this expectation did not hold true for many days as, "the devastating earthquake of the magnitude of 6.5 struck Koyananagar on 10th December 1967. This region had long been recognized as the non-seismic one, however, it started experiencing a series of tremors after the impounding of waters in Koyana dam reservoir in 1962. In the 1967 earthquake nearly 200 lives were lost, 1500 people were injured and thousands were rendered homeless. More than 80 percent of the houses at Koyananagar were either completely destroyed or became uninhabitable. The

generation of electricity from Koyana hydel works was badly affected paralysing Bombay's industry." ³ On this background the details regarding reservoir-induced changes in seismicity have been presented in Table 7.1

TABLE 7.1

RESERVOIR-INDUCED CHANGES IN SEISMICITY

Dam Name	Location	Height of dam (m).	Volume of res- ervoir (10 ⁶ m ³)	Year of impoun- ding.	Year of large- st earth quake.	Magni- tude or Inten- sity.
Major induced earthquakes						
Koyana	India	103	2780	1964	1967	6.5
Kremasta	Greece	165	4750	1965	1966	6.3
Hsinfengkiang	China	105	10500	1959	1962	6.1
Oroville*	U.S.A. (Calif)	236	4295	1968	1975	5.9
Kariba	Rhodesia	128	160368	1959	1963	5.8
Hoover	U.S.A. (Ariz)	221	36703	1936	1939	5.0
Marathon	Greece	63	41	1930	1938	5.0

* The relationship between the Oroville earthquake and the filling of the reservoir is not as clear as for the other major induced earthquakes.

(Source: Goldsmith E. and Hildyard N.: "The Social and Environmental Effects of Large Dams, P.114).

The data from the above table show that, compared to other dams in the world the magnitude of the Koyana earthquake was much higher than any other dams though these have higher volume of reservoir (exception Marathon).

On this background it will be appropriate to observe the situation regarding reservoirs with greater than 100 m height in India. The details in this connection have been presented in Table 7.2.

TABLE 7.2

RESERVOIRS WITH GREATER THAN 100 m HEIGHT (INDIA)

Date	Dam Name	River	Type	Dam Height m.	Res. Vol. m ³ x 10 ³	Dam Vol. m ³ x 10 ³
1963	Bhakra	Sutlej	PG	226	9868	4130
1964	Koyana	Koyana	PG	103	2780	1300
1966	Kakki Cam.	Kakki	PG	114	447	725
1971	Snoliar	Snoliar	TE	105	157	640
C	Beas	Beas	TE	133	8141	32310
C	Cheruthoni	Cheruthoni.	PG	136	-	1699
C	Idukki	Penyar	VA	171	1459	466
C	Nagarjuna-Sagar.	Krishna	TE	124	11315	56250
C	Ranganga	Ranganga	TE	126	2369	13507
C	Srisaillam	Narmada	-	167	27	-

Legend: Type- TE : Earthfill
 PG : Gravity
 VA : Arch.

Date : Year completed.

C : Under Construction.

(Source: Goldsmith E and Hildyard: "The Social and Environmental Effects of large Dams." - Appendix one.)

When one looks at the names of these dams, it becomes clear that the Koyana is the only dam with which the series of earthquakes is related.

The position regarding earthquakes in 1984 is presented in Table 7.3.

TABLE 7.3

EARTHQUAKES AT KOYANA IN 1984

<u>Date</u>	<u>Remarks</u>
25th September 1984	5 to 7 seconds Emerging Point: 10 Km. from Koyananagar.
27th September 1984	Area 140 Km.
14th November 1984	Emerging Point: 24 Km. from Koyananagar.
21st December 1984	5 to 6 seconds.

The table prepared on the basis of newsitem from local newspaper indicates that the minor quakes are still going on and the emerging point for these is located in and around Koyananagar.

The "Government of Maharashtra disbursed a loan of Rs.21.17 lakh for house construction to the quake affected farmers. They also waived the interest of Rs.27/-lakh, which would benefit 1459 farmers." 4

3. FACTORS RESPONSIBLE FOR EARTHQUAKE: Thus this was one of the tragic points for the people who were rehabilitated in the Koyana Dam area. On this background, one must examine the factors responsible for earthquakes. These may be noted as "according to two scientists of the National Geophysical Research Institute, both the Koyana earthquake and the Bhatsa tremors (in Thane District of Maharashtra) were caused by the reactivization of rift valleys, deep geological faults beneath the Deccan trap." 5

The observations from other scientists and organizations are as follows." the area in which the Koyana dam was built, the Deccan plateau, is uniformly covered by Basaltic rocks. According to Rothe this shield is one of the least seismic of the pre-cambrian areas of the world, there are no known faults. In spite of that, a number of geologists

: and geophysicists insist that the earthquakes were unrelated to the building of the dam and reservoir. A UNESCO Study also denied that the filling of the reservoir was responsible for the two major shocks of September and December 1967. Other experts maintained that although small shocks could be attributed to the reservoir, the two important shocks could not - an argument which does not appear very convincing."6

In the case of Koyana, soon after the first shocks were felt, "a world renowned seismologist from Japan was invited to give his opinion. After examining the data, he said that shocks were infact welcome as the built-up stress was being released slowly and ultimately they would die out. However the Japanese expert was proved wrong by the disaster that followed. This example is given not to question the expertise of the seismologist but to show how difficult it is to predict an earthquake even today. Irrespective of the views expressed at home, the Koyana earthquake has come to be described by the international scientific community as a classic example of RIS. (Reservoir Induced Seismicity). Koyana has shown for the first time how totally aseismic zone could turn out to be a killer quake, observed a British scientist in an article in the magazine "Nature".⁷

There has been a direct relationship between the water level and the frequency of the earthquakes. "The relationship between the reservoir water level and weekly frequency of earthquakes prior to the earthquake of 10th December 1967 shows that there is a time-lag between peak water load and the number of tremors. It is significant that seismic activity increased considerably after the lake level reached 650 metres height above MSL and was retained there for a fairly long time. The relationship between the lake level, rate of change of lake level (dl/dT) and the magnitude of the earthquakes at Koyana during the period 1964-1981

reveals an interesting relationship in terms of time-lag between peak reservoir load and strong seismic events. It has also been observed that the strong seismic events follow rapid rise in lake level." 8

Thus the reasons behind the earthquake at Koyana cannot be attributed to a single factor alone, however, the fact remains that the two shocks in 1967 did cause great disturbances to the people who were resettled in this location just 2 to 3 years ago and even today the series of tremors continue to occur on and often.

The displaced families constructed their houses in the plains but the earthquakes have caused a great damage to their habitat and once again they have to rebuilt their houses due to earthquake. In this process the displaced families have suffered a lot and they were unable to built up their houses as good as they were able to duilt up earlier.

R E F E R E N C E S

1. Centre for Science and Environment. : "The State of India's Environment: Centre For Science and Environment, New Delhi, 1982, P.65.
2. Goldsmith E. and Hildyard N. : "The Social and Environmental Effects of Large Dams," Wadebridge Ecological Centre, Camelford, Vol.1 P.109-110.
3. Centre for Science and Environment. : Op. Cit. P.65.
4. News-item : Daily Sakal, Kolhapur, 23rd May 1985.
5. Centre for Science and Environment. : The State of India's Environment, Centre for Science and Environment, New Delhi, 1985, P.115.
6. Goldsmith E. and Hildyard N. : Op. Cit. P.110
7. Kumar S. : Quake and The Dammed," The Illustrated Weekly of India, December 11, 1983, P.35.
8. Patil D.N. and Guha S.K. : Impoundment of Large Water Reservoirs And Seismic Hazards: A Global Assessment, Journal of Engineering Geology, Vol.XVII, Nos. 3 and 4, September 1988, PP.9-11.

.....