

# Need to Review the West Seti Dam Design



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**Abstract:** The proposed 195 meter high concrete faced rockfill dam (one of the highest of its kind) in West Seti Hydroelectric Project in Nepal will impound 1,500 million cubic meters of water. High CFRD dams were only recently constructed since 1980s. Nepal's Ministry of Energy must constitute a panel of experts of high standing in the field of dam/river engineering to seek their advice on the West Seti Project. Engineering aspects of the project must be reviewed before taking the final decision to implement the project. Similarly, the growing concerns echoed through the media about the sharing of downstream benefits and problems of submergence of Nepalese territory resulting from the Laxmanpur barrage, which is a direct extension of the West Seti Project, must also be properly addressed.

**Key words:** West Seti Hydroelectric Project, CFRD dam design, Nepal

## Introduction

**I**t appears that the government of Nepal is determined to grant final permission to the private company to build the 195 meter high West Seti Dam, which is going to be one of the world's highest concrete faced rockfill dams ( CFRD), totally disregarding the necessity to conduct from the government side the review of critical aspects of the project design, like the dam safety. The dam will impound a vast storage reservoir. It will be about 1,500 million cubic meters in volume. The failure of the West Seti Dam would have terrible consequences on our country, resulting in a colossal loss of life and property. Despite such grave danger, many of us might not fully realize how disastrous a large storage dam failure can be. We can easily be convinced of this type of risk if we turn our attention towards China, which is a country greatly suffering from the vagaries of its mighty rivers. China was struck by Banquiu Dam disaster in 1975. It is reported that two hundred and thirty thousand people died when the Banquiu Dam collapsed.

## A panel of experts

The technology of building very high concrete faced rockfill dams is still at its infancy. It has not yet been extensively tested. The Water and Energy Commission Secretariat (WECS) of Nepal had strongly recommended the then Water Resources Ministry to constitute a panel of leading dam experts of high standing in the international community of river engineering to seek their opinion on the West Seti Project. The WECS had stressed that any further action in the direction of taking the decision to award the project to the private developer should be deferred until the panel gives its absolutely positive view. Unfortunately, it appears that the WECS's recommendation has remained completely ignored.

The WECS has pointed out the great danger to CFRD at the time of big earthquakes. The 1988 meeting of the International Commission on Large Dams (ICOLD) also recommended conducting further research works on the performance of CFRDs at the time of big earthquakes. On May 12, 2007, China was hit by a big earthquake. The 158 meters high Zipingpu CFRD Dam located 18 km away from the epicenter of the earthquake was severely damaged, whereas the 132 meters high RCC (roller compacted concrete) Shapai Dam located

only 12 kilometers away from the epicenter of the earthquake remained intact. This incident sent shock waves through the dam engineering community across five continents.

## Why West Seti Dam could be unsafe?

The West Seti Project will have a 195 m high concrete faced rockfill dam (CFRD ). This type of dam is found to be very competitive in cost, but until recently it was considered risky for heights above 150 meters. This type of dam had also been considered as one of the alternatives in selection of the high dam for the Kankai Project. The French expert called in by the German Government to advise on the Kankai Dam dissuaded the German study team from considering the CFRD as a viable option, although the height of the Kankai high dam is only 85 meters, and, as a result, an embankment type dam with asphaltic concrete face was selected.

The CFRD is very sensitive to settlement and deformation of the rock-fill supporting the upstream face. The advent of the vibratory roller compacted rockfill in early 1960s had helped to generate some interest in this type of dams. The deformations of rockfill produce movements of the concrete slab joints by opening them, and if the movements exceed certain limits then the resulting leakage is difficult to control. It would be a horrendous task to stop the leakage by repairing the concrete slab joints at depths where the ambient pressure could reach, in the West Seti Project case, up to 20 times the atmospheric pressure at sea level. Such repair would only be possible by applying under water advanced caisson technology.

## There is no precedent

Needless to say that there is a need for great caution in adopting very high CFRD. According to J. Barry Cooks (1997), this type of dams is of empirical design and based on precedent design and experience. Experience has been the basis for continuing progress in maximum heights and design aspects, and also in construction methods. Unfortunately, relatively high CFRDs have been introduced only very recently.

The proposed developer of the West Seti Project appears to have cited as precedent in their report two CFRDs close in height to proposed the West Seti Dam. It is claimed that they are already in good service for a long time. They are

China's Tiensingquiao Dam with a height of 180 meters and Mexico's Aguamilpa Dam with a height of 185.5 meters. Unfortunately neither of these CFRDs can be considered suitable examples to justify the selection of CFRD for the West Seti Project. The Tiensingquiao Dam might have been only recently constructed. According to the original schedule the dam was not expected to be completed before the 2000. So, it is not well known yet how the dam will perform over a reasonable length of time. The Aguamilpa reservoir was first filled in August 1993. Since then two abnormal peak seepage values have been observed. Those events were of great concern, and several hypothesis were made to explain this behavior, although none is satisfactory. Some years back underwater inspections were made to investigate the cause of the leakage.

### Prevention of Kulekhani Dam disaster

We should not forget how the Kulekhani High Dam was on the verge of collapse through an unfortunate minor oversight. A few years after construction of the Kulekhani Dam it was at risk of being washed away. It was feared that at any time in immediate future a very big portion of the right bank terrace along with the intake structure could plunge into the reservoir setting in motion a huge mass of the reservoir water to overtop the dam. In a similar type of Vajont dam incident in Italy, the loss of life was significant even though the dam was left standing after the overtopping because it was a concrete dam. The whole project was rendered useless, however, after that incident. In case of the Kulekhani Dam, made of earthen core, the whole dam body would have been completely washed away after an overtopping.

Leading experts from the USA, Australia and Japan were called in for consultation shortly thereafter. On their recommendation works such as the clearing of large volume of weathered materials, anchor bolting of huge masses of rocks to prevent sliding into the reservoir, and provision of an underground drainage system were carried out. It was feared that the Kulekhani Dam could be completely washed away during the coming monsoon season. It was a sheer chance that a renowned Japanese contractor engaged in the construction of Kulekhani-2 project could be quickly mobilized to carry out the extensive protection works within a very short period before the onset of the monsoon rains. Thus, the timely intervention helped to preclude the possibility of Nepal being hit by a big dam disaster.

### Insensitivity to advice

Insensitivity to advice from outsiders could have terrible consequences. A case in point could be the Malpasset Dam near Frejus in Southern France. It is reported that the decision makers were cautioned ahead of time that the dam site was not suitable. It was recommended that the dam be built elsewhere. For reasons of engineering convenience, however, the advice was disregarded. The dam failed on December 2, 1959, causing the death of a large number of people.

Construction of the high dam without full study covering the whole reservoir area led to the catastrophe of the Vajont Dam in Italy. The Vajont Dam is 261 meters high and the

volume of the water contained in its reservoir is 150 million cubic meters. (By comparison, the volume of the West Seti reservoir would be about 1,500 million cubic meters). In September 1963 the reservoir level reached a height of 180 meters, and an earth movement started along the slope of Mont Toc. That movement accelerated in October and caused a landslide which gave rise to a giant wave that flooded the valley beneath, wiping out several villages and killing many people.

Shoddy workmanship and poor quality of materials are often the prime cause of dam failures. The failure of St. Francis Dam in California has been attributed to faulty foundations. Design errors were apparently largely responsible for the collapse of the Teton Dam. Over-topping occurred with the Machau-II Dam in India in 1979 and caused the death of a large number of people downstream. In this case, the malfunctioning of equipment contributed to the failure, as the spillway gates could not be opened in time. The failure of spillways to function properly also led to the near failure of the 140 m high Tarbela Dam in Pakistan in 1975-6. It is reported that in this case design errors and possible poor construction materials were also involved.

### Performance of government institutions

Nepal's laissez-faire hydropower development policy could have adverse effect on dam safety. Until now the Nepal Government's performance in handling private developers of hydropower projects has not been satisfactory. The government endorsed whatever the private developers proposed. There is nobody from the government side to check the works of the private developers at the site. As a result, in case of the Bhotekosi Project of Nepal the concerned department and ministry came to know that the installed capacity of that hydropower project had been raised from 36 MW to 45 MW, completely defying the power purchase agreement only after the completion of the construction works. The government learnt about it when a claim was lodged by the developer with the government to request the NEA to buy extra power.

### Full scope of review

The engineering design and all other important aspects of the project must be reviewed before finally deciding to implement the West Seti Project. Similarly, the growing concerns echoed through the media about the sharing of downstream benefits and submergence problems of Nepalese territory resulting from the Laxmanpur barrage, which is a direct extension of the West Seti Project, must also be properly addressed.

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