

c. Gharats of Uttarakhand: Harnessing Natural Energy

Anyone living in the hills of the state of Uttarakhand in India would know what a gharat is. The somewhat subdued rolling sound of a continuous friction between heavy stones near the river betrays the presence of a gharat nearby. These gharats have a momentous role in utilization of mechanical power from water streams mainly for grinding purpose.⁹

There are three distinct types of water mills. The simplest and probably the earliest was a vertical wheel with paddles on which the force of the stream acted. Next was the horizontal wheel, with a vertical shaft attached directly to the wheel used for driving a millstone. Third was the geared mill, driven by a vertical waterwheel with a horizontal shaft. This required more knowledge and engineering skill than the first two, but it shows greater potential. Vertical waterwheels are also distinguished by the location of water contact with the wheel, as the undershot wheel, the breast wheel, the overshot wheel and the Baker wheel. These waterwheels generally use the energy of moving streams. Each type of mill has its particular advantages and disadvantages. Relatively little is known of their development before the middle Ages.⁹

The traditional Himalayan water mill or the gharat is of the vertical shaft type. The gharats in Uttarakhand can be found alongside the rivers. To run these mills a channel is dug along the river to carry the water up to the mill-house. The gradient of the channel for the flow of the diverted water is less than the gradient of the river. With this, after several hundred meters from the diversion, a fall of 2 to 6 meters is achieved for the water. In this manner water from the stream is tapped and routed through the chute, which then falls on the flat blades. The water chute consists of an open channel either made from wooden planks or carved from a large tree trunk. The chute is narrowed down towards the lower end forming a nozzle. The force of the water let through the chute with a head of 2 to 6 meters strikes the blades and rotates the wheel, which in turn, rotates the metal shaft. The head of the water varies from place to place depending upon the availability of the fall.⁹

The wooden blades are fitted to a thick vertical wooden shaft, tapering at both ends. Two round millstones, hewn locally, are fitted at the top of the shaft to act as the grinding mill. The wooden shaft of the turbine is supported on a stone pivot through a steel pin and held in the sliding bearing at the top. The sliding bearing is a wooden bush fixed in the lower stationary grinding stone. The top-grinding wheel rests on the lower stone and is rotated by the turbine shaft through a straight slot coupling. The gap between the stone is adjusted by lifting the upper stone with the help of a mechanical lever. The blades vary in number in different gharats from 11 to 21, which is fixed lengthwise at the axis to transmit the entire load to an iron base. At opposite end from the cylindrical axis, a long shaft connects it to the upper part of the grinder stone. It is interesting to note that the fitness and quality of grain can be determined even in this nature-run process for which a groove is made into the upper grinder to set a tapered iron piece that holds the shaft and grinder simultaneously. An

iron base bears the load of the system that in turn diffuses it over the horizontally laid plank. One end of the plank is attached to an adjusting lever, which moves upward and downward. The lever governs the distance between the moving and the stationary part of the grinder. An upward movement of the lever allows for coarse grinding while the downward is for fine grinding. Traditionally, channels divert the water from stream/ river to the mill. A device is also incorporated in the channel to divert the water if the water mill is not in operation. This device redirects water. It's a simple but an ingenious construction and can be maintained with simple understanding of the principles involved.

9. Source: http://www.infinityfoundation.com/mandala/t_es/t_es_shah_m_gharats_frameset.htm

The components of a gharat may be listed as follows:

1. Flume or chute: A wooden drain kind of thing that routes and rushes the water from the diverted channel to the rotor blades attached to the vertical shaft.
2. Grain Feeder: A bag or funnel, which feeds grains to the grinding millstones.
3. Bearing: That helps the upper grinding stone to rotate freely.
4. Upper Grinding or milling stones: The circular Upper grinding stone of the mill that is directly attached to the shaft and rotates with it.
5. Lower Grinding or milling stones: The circular lower grinding mill stone through the middle of which the shaft rod passes to support the upper grinding stone. This lower grinding stone remains stationary.
6. Bush: A round wooden or a leather piece fitted to the hole in the lower grinding stone through which the shaft rod passes.
7. The vertical shaft: The wooden or iron rod that connects the rotating fan down below with the upper grinding stone.
8. Runner with hub: The thick wooden portion to which the fans are fitted and which determines the speed of the rotation of the shaft.
9. Lifting mechanism lever: A wooden mechanism that determines the coarseness or the fineness of the grains being ground.
10. Bearing: The point at which the pin of the shaft rests giving free rotation.

These gharats are constructed from locally available material such as wood, stones, bamboo, and reeds. Apart from the technological aspect. These gharats also have an important sociological dimension. Socially, they have been the meeting points for villagers to get together. The widespread use of gharats and its popularity owe much to its simple and cost effective mechanism. It is important to note the advantages inherent in the indigenous watermill technology, in particular:

- Simple technology
- Locally designed and built
- Involving mainly local materials
- Low capital cost
- Almost no running costs
- Easily managed and maintained
- Better taste of the ground material

9. Source: http://www.infinityfoundation.com/mandala/t_es/t_es_shah_m_gharats_frameset.htm