WATER MILLS AND ASSEMBLAGE OF MILLS OF MAYMAND IN KERMAN

Sharareh Poormojdehi[1]

ABSTRACT

The vital role of watermills in the past, have had so wealthy value for the rural society which any possibility were used for constructing this kind of structure, although they are rarely in use, now a days those machines are replaced with new electronic systems, it could be seen that these new systems are functionally derived some how from those simple and small but efficient, scientific carefully designed and well performed plants.

Watermills are the best evidences that illustrate how the man utilizes the natural energies for their needs.

According to the climate, availability and existence of water, in Iran the fact is that watermills have been used in different geographical areas, but their importances and values, have not been considered, examined and studied worthily.

The main and most important reasons for this research is to introduce some part of our national heritage, ways for rehabilitation, conservation, innovation these efficient systems using to produce flour as an indigenous significant technical structure even more scientific base systems. You could see our ancestors, as an example, standpoint for the next generations a sample to study the revolution of machines and for them to know how the primitive and supposedly simple but efficient Mechanical systems were. Evolved from the modern and ever sophisticated today plants and also to remember this fact that despite their undeniable role they have played in emergence of more complicated machines, how gradually they are going to be for gotten and declined.

For a better understanding and appreciation of watermills functions, it has been applied a close local survey or site examination in different geographical areas systems to prepare plans of mechanical and hydraulic components, structural details, materials, water discharges, energy dissipating etc.

After studying various kind of watermill, founded that they utilize the energy of water and it ways, functions, mechanisms and know how they are built.

1 - Master of conservation and restoration of historic buildings, Email: shpm500@yahoo.com

All studies and investigation on watermills have been done over one of the existing in Meymand region in Kerman province to understand plan, remediation procedure, necessary actions for rehabilitation of this kind ground pressurized hydraulic systems.

INTRODUCTION

Engineering and technique are forms which have knowledge and art in themselves and show their characteristics in the form of it.

Many tools that human create for he is representative of its maker's art, tought and mind.

The composing of technique and engineering with art are visible in historical works of Iran.

The short history of making mills is an example in which this harmony of technique and art is completely obvious, that human knew at the beginning of evolution that how use the energies and materials of surrounding world for improving his life and little by little increase his technique and art.

This paper introduces the types of water mills and humans exploitation of potential energy, with attention to this point that mills had an important role in humans life in past and were the economic safety in each region and destruction of mills in wars was the death.

Today these mills decrease and its technique and engineering have been decreasing.

The mills that work with water called water mill we can divide mills according to usage of water power into kinematics and potential.

We can divide mills according to system and making technique into 2 groups:

1. vertical axis watermill
2. lateral axis watermill:

   A: under spinning axis

   B: over spinning axis

This paper after introduction of mills and state of systems of mills describes the assemblage of mills in Maymand (kerman) which are in the margin of a seasonal river of region that because of being seasonal some parts were added to these vertical axis mills.

WATER MILLS AND ASSEMBLAGE OF MILLS OF MAYMAND IN KERMAN

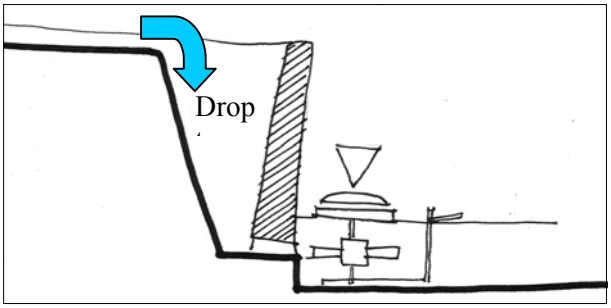
Water mills are the best tools for showing the humans usage of natural and strong power of water that works without pollution and with spoke natural energy. Although these small and simple factories had an important role in past, today they decreased and new systems with using other energies took their places.

The aim of this paper is introduction and consideration and dividing of mills according to engineering and technique of its making in using the powerful energy of water and deep look in such mechanical engineering tools that they and their makers are forgotten.

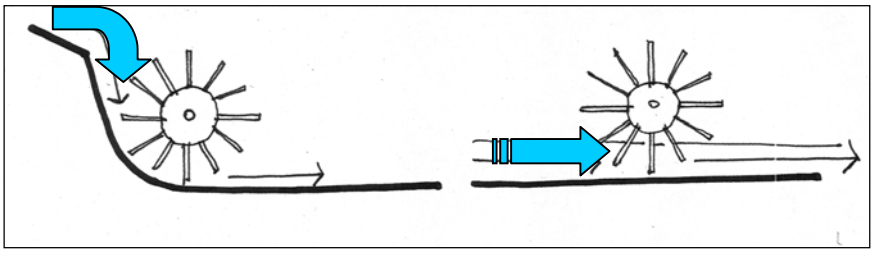
At first we consider the root meaning of "Asiab" (mill), mill is a combination of "As" and water with the meaning of water mill. "Asia" was "As Ab" that in phonetic

changing changed to "Asiab"(mill) and with elimination of consonant "B" of its end it changed to "Asia", Arabic word "Tahoon" and "Tahoone" use for this.

In general use can divide watermills to kinematics and potential according to their usage of water energy. Both of these types, use the potential energy of water in this way that by making difference between the height of entrance channel and existence channel, potential energy changes to kinematics energy and make the wheel of the mill (vertical axis) moving or at first use the kinematics energy of water and make the wheel of ill (lateral axis) moving. In both group of watermills comes from a channel that cover with lime and cement and has needed gradient for moving water calmly toward water wheel that in different stages saved energy change to kinematics energy and cause moving the water wheel and then the mill stone that flour is the production of it.



Potential mill



Kinematics mill

We can divide the mills in 2 groups according the technique of making and it water wheel:

1- vertical axis mills

2- lateral axis mills

1- VERTICAL AXIS MILLS:

This mill that is known as drop tower mill most seen in dry regions with much obtainable, Supporting water in these mills can be from the water of subterranean canal, river and spring. When the supporting water of mill is the subterranean canal, mill is in subterranean canal system, in this way that in place which water come to ground the mill was made or under ground in the way of water. Like mills in Meybod in Yazd and Ardestan and….

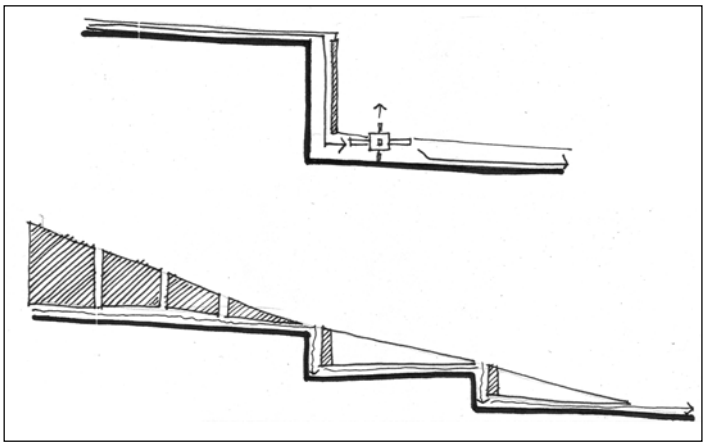
In some regions that the source of supporting water is seasonal river, before the flue of mill there is a big pool to gather the needed water for moving the water wheel: like mills in Fars and Kerman.

In some regions, the supporting source of mill is a brook or small river that water gathers in flue from it: like mills in Kashan and Abyane.

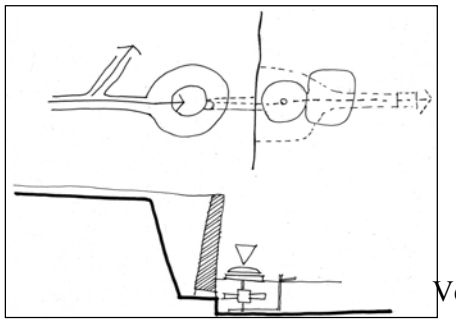
In some places use the gradient of region or natural water fall for guiding water to flue: like mills in Shoshtar.

The main parts of this vertical axis mills are: The canal of water, by pass stream, drop tower, water wheel, under and over stones, corn hopper, flour collect, tail race.

This mill has a waterwheel that its spokes are connected to a vertical axis, saving water of drop tower come to the wings of water wheel and cause the water wheel to spin and so the vertical axis which connected to water wheel – which pan from the under stone of mill and take place in stone by an iron blade like butterfly – that cause the movement of over stone on under stone and pouring cereals between two stones change to flour.

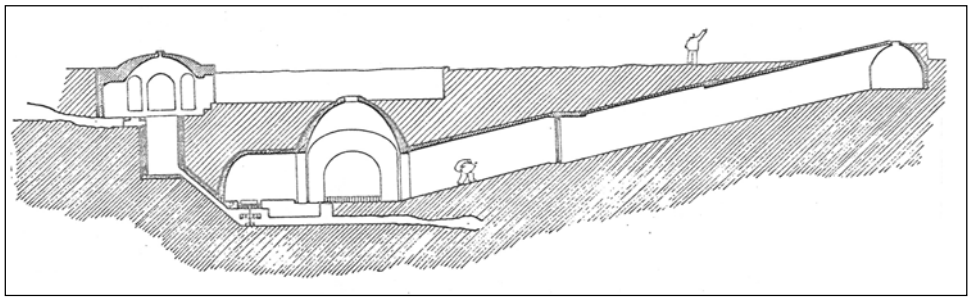


Vertical axis mills

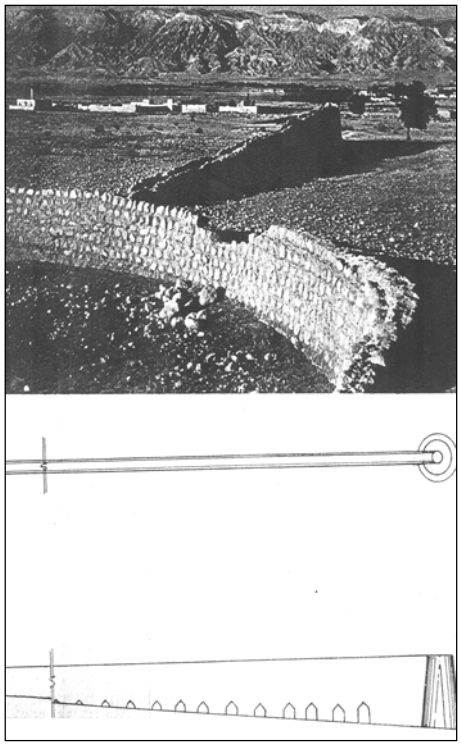


Vertical axis mills

Bande Amir (Fars)

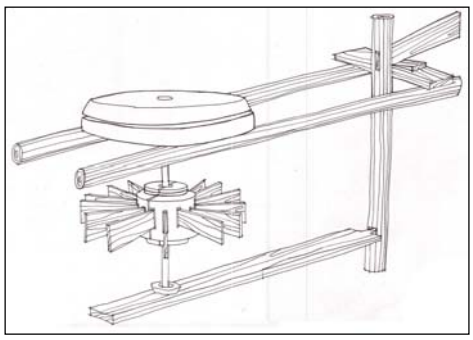


Subterranean drop tower mills
(Yazd nosratabad)



Pool of mill (Shiraz,Tarmoon)

Shooshtar mills



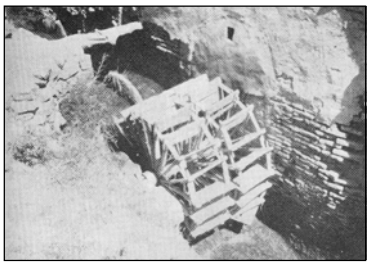
Ingredients of Vertical axis mills

2- LATERAL AXIS MILL

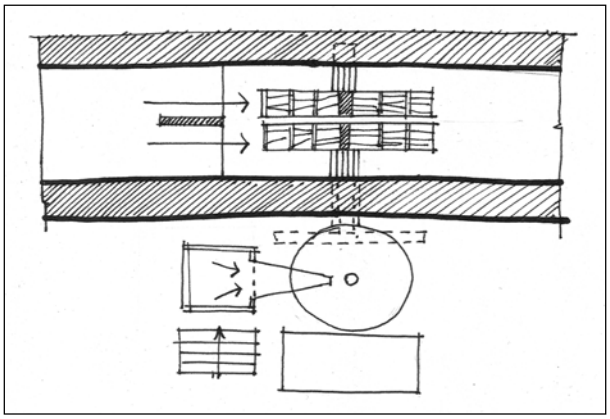
This mill most seen in watery region with low gradient. It has a water wheel that its spokes are connected to a lateral axis. Parts of this mill are more complex than vertical axis mills, because it has gears that transfer the movement of water wheel of lateral axis to stone. Other parts almost are like vertical axis mill with this difference that there isn't any drop tower in this mill. This mill can be divided in to 2 groups: A: over spinning lateral axis B: under spinning lateral axis

A: over spinning lateral axis

This mill known as Vitruian, in this mill, a branch separates from river or small river and water like a water fall pour from a declivitous canal with height about 1 meter on the spoke of water wheel and move it and cause the movement of gears and so connected axis to over stone of mill move and produce flour. The mills of Isfahan are of this type.

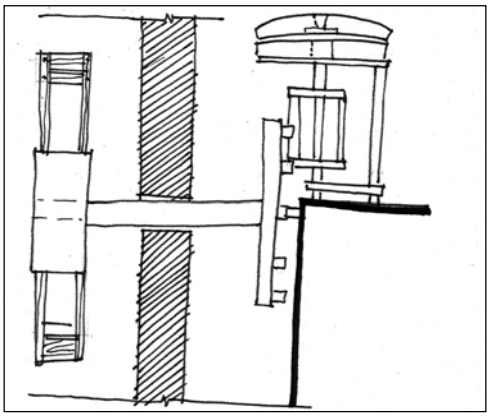


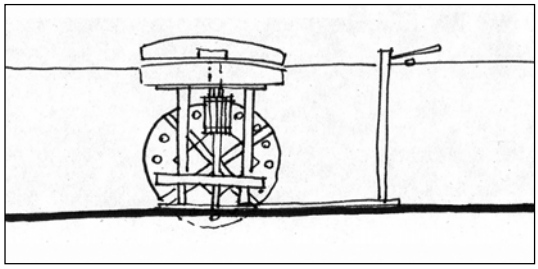
Over spinning lateral axis (Isfahan)



Over spinning lateral axis (plan)

Spoke of water wheel





Section of over spinning lateral axis

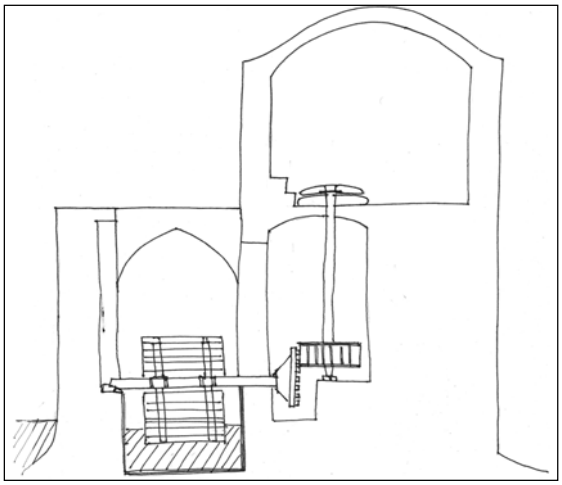
Over spinning lateral axis (Isfahan)

Gears of water wheel

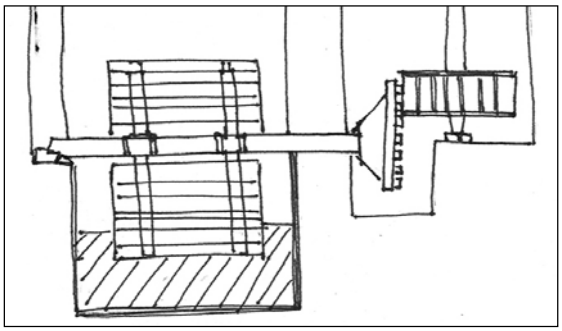
B: UNDER SPINNING LATERAL AXIS

This mill known as supernatant wheel, this mill with wings that are connected to lateral axis, are in rivers, the water impact to the wings of water wheel with pressure and spin it and this system transfer movement by gears to a vertical axis that is connected to over stone and spin it. The stones in this mill are consist of several parts and aren't unit and they are connected together with metal braces or belt.

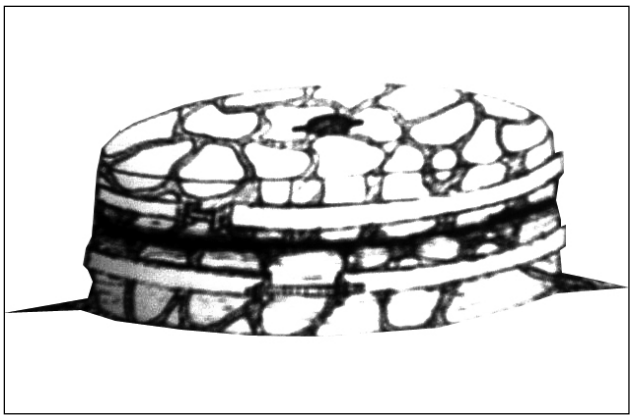
This kind of mill is seen in the south of Iran in cities like Dezful and Shahjerd in Ahvaz. In general in all the systems of water mill use the powerful energy of water for spinning of wings of the wheel and resulting movement of stone and production of flour.



Dezfool (under spinning lateral axis)



Dezfool(gale geh mill)



Mill stones (Dezfool)

Over and under stones mills

THE MILLS OF MAYMAND

Meymand the center of Maymand, central part, the town of Sharebabak is in Kerman province. The main activity of people of Maymand village is animal husbandry. Because of droughty, low range of utilized land, not using machines in these lands and animals like swine agriculture is low in this region.

In past the cultivation of needed wheat and grain did in flat lands (called Keshmoon) around the river and its deficit come from Istahban of Fars and around yazd. For producing little flour or when there isn't water mill they use handy mill.

Mills in Maymand village were drop tower mill in which the drop tower have 4 meter to 8 meter height and by topography recognized that apart of mountain is dinged and a part of it is covered by stone and lime and cement.

The water of drop tower from a hole that called "Na" goes toward the wings of wheel, The "Na" is made of wood and its diameter is 15cm and its length is 30cm, there is a hole at the center of it that its diameter is 6cm and made of darnel of weeping willow.

The place that "Na" is in is a stone that called "Shahna" that its thick part is inside and thin part is outside and Shahna is 50-60cm above it.

For making height difference, across the river make fence of stones and called "Benoodan".

On the way of it make a window and called it "Kote pole" that can open it and close it easily and see the Benoodan and drop tower of mill for pool to gather water when droughty and have needed pressure for spinning the spokes of water wheel. On day close the way of water of pool that called "Glang" to gather water.

For filling the drop tower, they close the window at the end of it, after filling the open the window and water impact the spokes of water wheel has a woody cylindrical part that its height is 40cm and its diameter is 30cm and its made of berry wood and has wings that are made of darnel of weeping willow the become voluminous by water. spokes have diameter about 2.5cm and has dimensions about 13 ×40 cm and is in the woody part. Wings wheel spin around an axis of iron that has a length about 1 to 1.2 meters and has a diameter about 5cm.

The end of axle is on a stone that called emery that is like a triangle that its base is 5cm and its mane is 10cm and in a flat with the thickener about 7cm, width about 3cm and length about 2meters.

The up part of axel is like a can with a height about 3cm and called "chahar rokh" that is inside "Tabareh". There is a marble under "Tabareh" that doesn't allow it to move. "Tabareh" is like butterfly and it made of iron that its width is 10cm and its length is 25cm and the top of axel is at the center of it, over stone put under it and spins it.

The diameter of over stones in these mills is about 1meter and thickener of them is about 105cm. The haven of these stones is on a wood of "Tai" or "Bane" tree that is resistant against wet and pressure.

The stone put on gradient toward the place of falling flour that is called "Akhore" that is dinged on the floor.

At the end of wood that the emery stone is, there is a wood called "Pa" and is vertical and install by connection of mortise and tenor. The diameter of wood is 15cm; its length is 2 meter and is made of weeping willow. At the top of it there are 2 splits that are vertical for putting a lever and wedge. The wood takes the wheel up and down by this and in crease or decrease the attaching of the wheel with water. This activity changes the speed of stone movement and can control the middling and soften of flour.

At the top of the 2 stones there is a reservoir of cereals that called "Doul" that is like a square by dimensions 100×100 and height about 80cm, at the top of it there is a hole and in front of it there is wood that called "Makoo" by dimensions about 20×20 that its center is a little deep and a rope connect to it, The range of falling wheat control by "Makoo" and rope.

Canal of water& drop tower

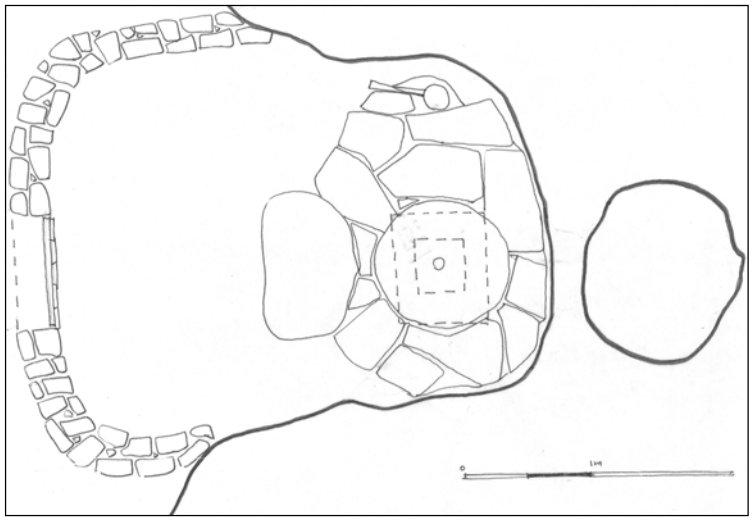
By pass stream

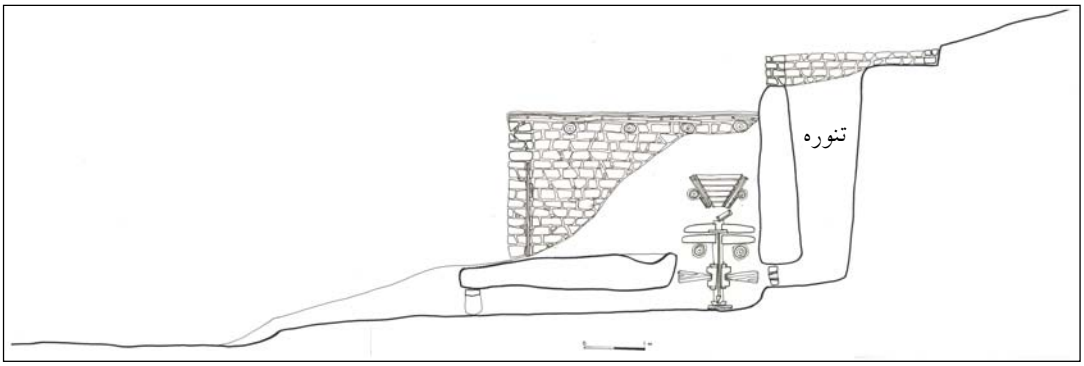
Ston,Dool,Akhore

Pool

Benoodan

Kote pele,Benoodan

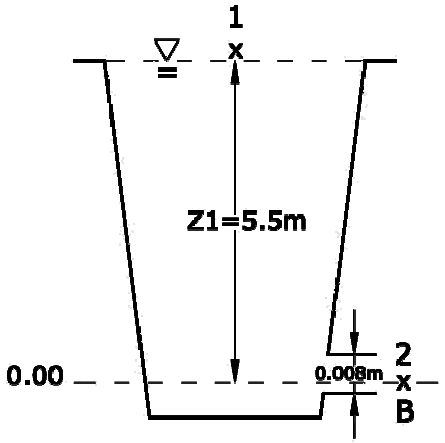




Plan & section of maymand mills

THE DYNAMIC AND HYDRAULIC CONSIDERATION OF MILLS OF MAYMAND

At first by having the data like height of drop tower Z1= 5.5m and the
Window at the end of the drop tower 0.008m, we can calculate the speed of water when it exits from window (V2).



$$V2 = 10.4 \text{ m/s} \Leftarrow 5.5\times 9.81\times 2 = \sqrt{V2} \Leftarrow 1\ Z\ 2g = \sqrt{V2}$$

With attention to roughen of drop tower body and salts in water and viscous currents, as said some energy lost between places 1 and 2 so real speed of water exit is Cv= 0.96

$$V = Cv\sqrt{2g\ Z\ 1} \Leftarrow V = ./96\sqrt{2\times 9.81\times 5.5} \Leftarrow V = 9.98 \text{ m/s}$$

The speed of exit of window (Q) calculate like this, the level of window $A=0.008m^2$

$$Q = Cv\ Cc\ A\sqrt{2g\ Z} \Leftarrow Q = 0.96\times 1\times 0.008\sqrt{2\times 9.81\times 5.5}$$
$$\Leftarrow Q = 0.079\ m^3/s$$

By

$$\rho = 1000 kg/m^3 \text{ و } \theta = 95 \text{ و } V=0 \text{ و } VA = 9.98 \text{ m/s و } A= 0.008\ m^2$$

The force on water wheel calculates.

$$F\ x= A\ \rho\ VA(\ VA– V)(\ 1\ -\cos\theta) \Leftarrow$$
$$Fx = 0.008\times 1000\times 9.98(9.98 - 0)(1- Cos95)$$
$$\Leftarrow Fx = 866.2\ kg$$

The beam of water wheel is 0.5m and by earned force we calculate the entropy.

$$M = F\times R \Leftarrow M= 866.2\times 0.5 \Leftarrow M = 433.1\ Kg/m$$

The entrance power of impact the water by wing calculates by this.

$$\text{entrance power} = M\omega$$
$$M\omega = \tfrac{1}{2}\rho\ A\ VA^3 \Leftarrow \tfrac{1}{2}\times 1000\times 0.008\times 9.98^3 = 3976$$
$$\Leftarrow M\omega = \tfrac{1}{2}\rho\ A\ VA^3$$
$$\omega = \rho\ A\ VA^3 / 2M \Leftarrow \omega = 3976/ 433.1 \Leftarrow \omega = 9.18 \text{ rad/s}$$
$$V = R\ \omega \rightarrow V = 0.5\times 9.18 \Leftarrow V = 4.59 \text{ m/s}$$

. Then we change the efficiency to a theory

$$\eta = 2V/\ VA\ [\ 1 – V/\ VA\ ]\ (\ 1\ -\cos\theta)$$

$$\Rightarrow \eta = 2\times 4.59/ 9.98 [1 – 4.59 / 9.98](1- \cos 95)$$
$$\Rightarrow \eta = 0.54\times 100 = 54\%$$

. The power of water when the wheel spins by the liner speed about4.59 m/s can calculate.

$$Fx = 0.008\times 1000\times 9.98\times(9.98- 4.59)(1- \cos 95)$$
$$Fx = 467.8 \text{ kg}$$

OBSERVING THE EFFICIENCY OF THEORY BY ACTIVITY:

According to calculations in Mr. Halverson's essay in a mill that has a height of drop tower about 5m and the diameter of window is 3 Inch, theory efficiency in the mill of Maymand comprised with the practical efficiency of this mill.

$$\omega = 121 \text{ R.P.M}$$
$$\omega = 121/60 = 2.02 \text{ R.P.Sec(دور بر ثانیه)}$$
$$\omega = 2.02\times 3.14 = 6.34 \text{ rad/s}$$
$$V = R\omega \Rightarrow V = 0.5\times 6.34 \Rightarrow V = 3.17 \text{ m/s}$$
$$\eta = 2V/ VA [1 – V/ VA] (1 -\cos \theta)$$
$$\eta = 2\times 3.17/9.98 [1 – 3.17/ 9.98](1 – \cos 95) \Rightarrow \eta = 0.47\times 100 = 47\%$$

Earned efficiency in theory is 54٪ and in practice is 47٪ , and this difference is because of the friction of mill’s parts and also the large friction that is between two stones of mill, of course some of this friction is important that cause the changing of wheat to flour.