Ropeways in Nepal

Introduction

- A **ropeway** is a form of naval lifting device used to transport light stores and equipment across rivers or ravines. It comprises a jackstay, slung between two sheers or gyns, one at either end, from which is suspended a block and tackle, that is free to travel along the rope and hauled back and forth by inhauls (ropes attached to the pulley from which the block and tackle are suspended).It is a very useful method of Transportation for very short distance.
- Because they are more stable, in particular in the direction along the ropeway, and because they require less guying, gyns are better than sheers for supporting a ropeway.

The history of ropeways

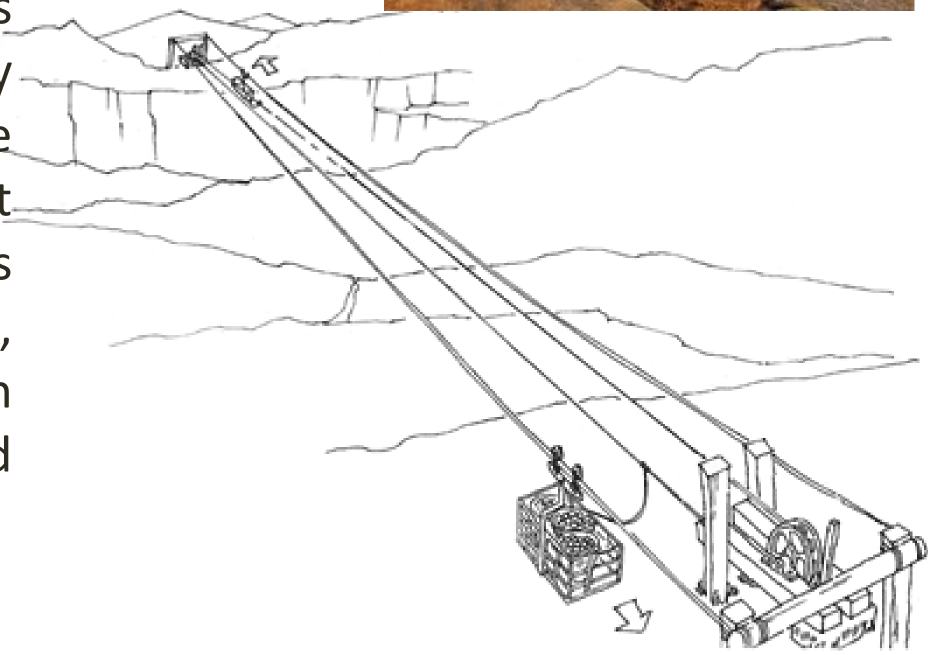
- The ropeway – a rope based transport system – is one of the oldest means of transportation system.
- The principle of rope based transport system was known even in ancient times. The early Chinese historical drawing shows, this technology has been in use for goods and human transportation since early 250 BC.
- Modern ropeways started in Europe, particularly in Germany, Austria and Switzerland and later, in Italy and France.
- Fausto Veranzio of Venice developed a bi rope passenger ropeway in early 1616. Later, in 1664, Wybe Adam, a Dutchman, constructed the first successful operational ropeway system.
- Ropeways developed rapidly with the introduction of wire ropes and later with the electricity driven ones. Extensive use of tramways during World War I between Italy and Austria in mountainous terrain paved ways for developing and adapting this technology into reliable transportation system for carrying goods and people.
- During the course of the industrial revolution, the invention of steel ropes by the German mining official, Albert in 1834, opened up the rapid development of various types of rope based transportation systems.
- Starting around 1900, higher-performance aerial ropeways also began to be built for passenger transportation. The first urban cableway was built in Lyon, France in 1862, where the three-car trains carried up to 324 people.
- During the 19th century, the funiculars were also used for leisure excursion transport, such as in 1874 at the Leopoldsberg hill, near Vienna, Austria. Included in the leisure time classification are also those short aerial cableways that provided visitors to expos and amusement parks with special entertainment.
- From 1907/1908, the know-how acquired with the intensive use of similar systems for goods began to be applied to the construction of modern aerial cableways for passengers. In 1908, the first ropeway for passenger transportation in Central Europe, the “Kohlernbahn” was built in Bozen, Italy, by LEITNER ropeways.
- Winter tourism required ropeways that were more and more efficient, yet at the same time comfortable. In year 1930 the first large cabin gondola lift was built near Freiburg, Germany, followed by the first ski tow lift in 1933 in Davos, Switzerland and the first chairlift in Sun Valley, USA in 1935. The year 1947 marked the first Italian chairlift made in Corvara by LEITNER ropeways.
- **Today**Ropeways are mature, efficient and comfortable means of transport that are used mainly in the areas of winter sports and tourism. Thanks to their specific characteristics, such as flexibility and cost efficiency, ropeways are also gaining in importance as a means of transport in urban areas

Past History of Ropeway in Nepal

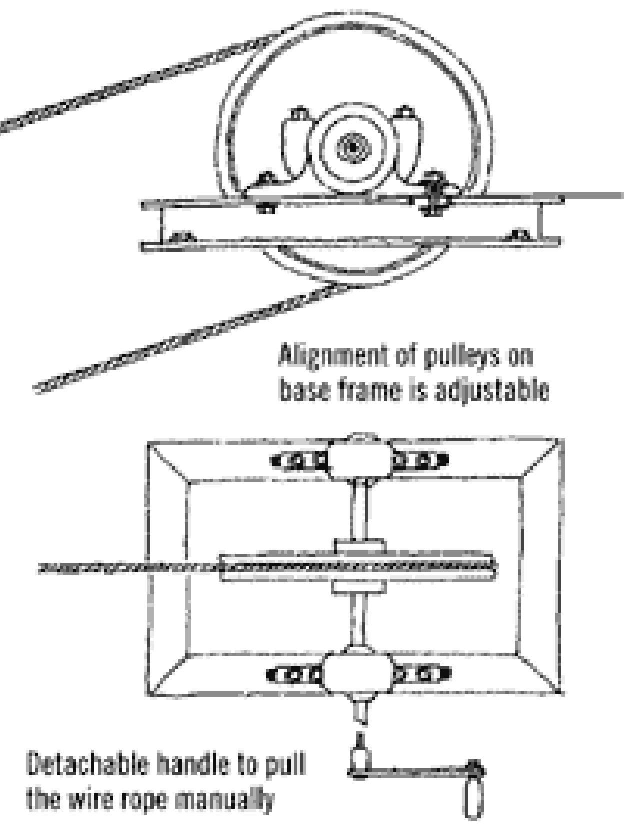
- In 1922 Shree Tin Maharaj Chandra Shamsher started building a 22km long cargo Ropeway from Dhorsing-chisapnai-chandragiri hills passing into the Kathmandu which was completed in 1927. Later in 1947, it was extended to teku (+6.5km)
- The first ropeway was operated since 1924 to carry stone s from the quarry from Halchowk to Lainchour (4Km) for the construction of Rana Palace.
- In 1964, this system was further improved and extended to 42 kilometer to Hetauda with the financial and technical assistance of the United State Agency for international Development (USAID) .
- Many Agencies carried out feasibility study in the past to explore the possibilities of the different types of Ropeway in Nepal. Unfortunately they all remained like academic excercises. Two goods carrying ropeways, Bhattedanda and Barpak, and Mankamana passenger Ropeway were actually built.
- The Feasibility report of these projects showed that demand for ropeway is high in remote areas of Nepal. But Policy makers did not give serious attention.
- The Ninth Five-year Plan mentioned ropeway in brief and encouraged involvement of private sector. But no provision in national budget was made for ropeway development.
- Despite the visible success showed by Bhattedanda Ropeway and Mankamana Cable car the transport bureaucracy do not view ropeway as the means of improving rural economy by connecting remote areas to the market.
- However Private sector and ropeway activists have now shown great interest in development of ropeway in Nepal.

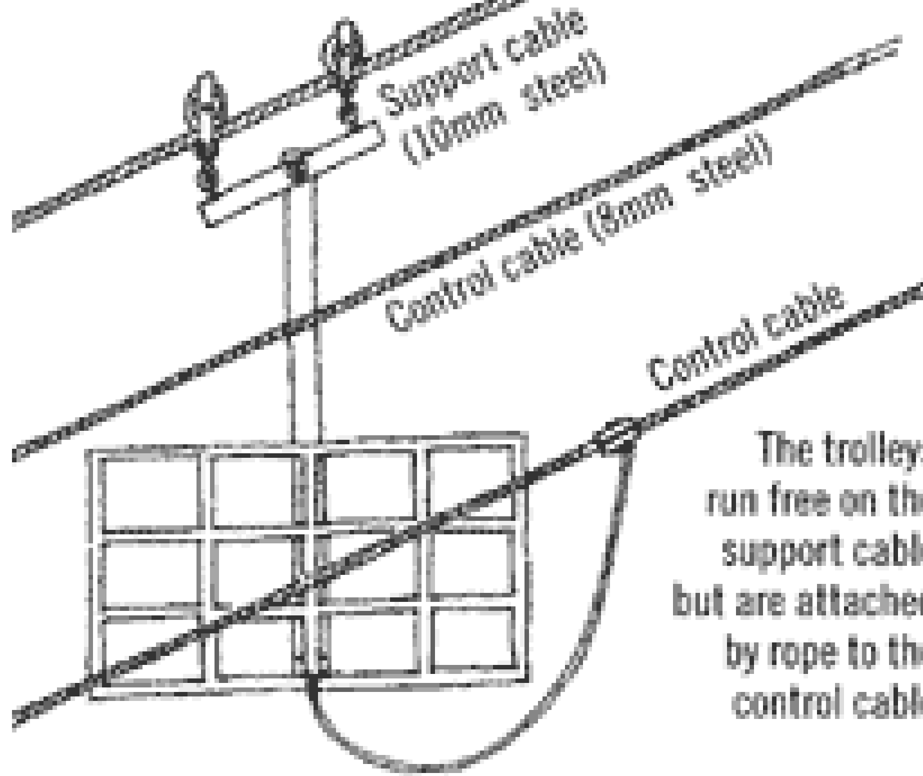
Gravity Goods Ropeway

- Depending solely on gravitational force – and using no external power – gravitational ropeways are simple and inexpensive to operate as well as environmentally friendly.
- Gravitational ropeways use no external power, only gravity. Two linked trolleys, on pulleys, run on separate 10mm diameter steel wires which are suspended from towers: as the full trolley comes down, pulled by the weight of its load, it pulls the empty one up, ready for the next load. The trolleys' progress is controlled by another, 8mm wire, looped over a flywheel. A wooden drum brake, with bearing and bracket, governs their speed.

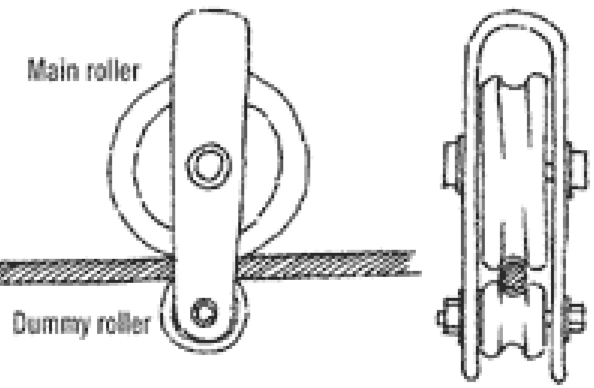


Rope and pulley arrangement at upper station

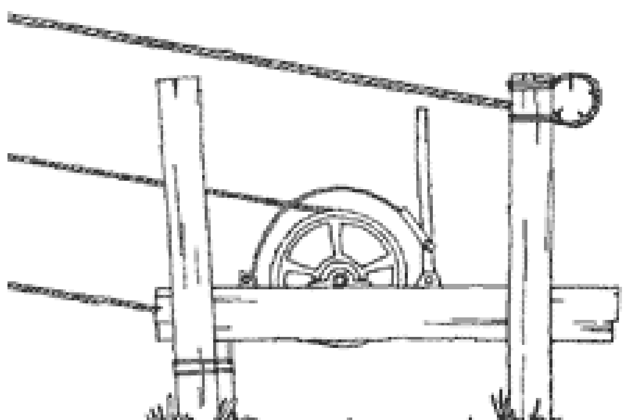




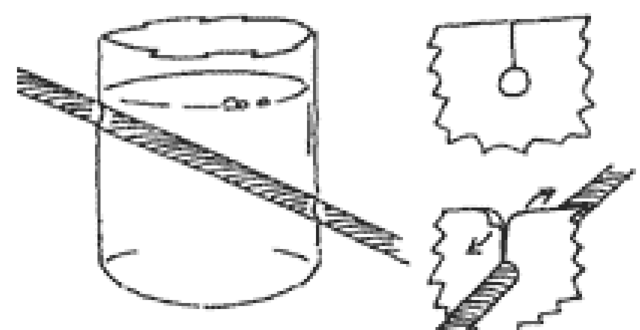
The trolleys run free on the support cable but are attached by rope to the control cable



The two-roller assembly which keeps the trolley on the support cable prevents dislocation from the cable



A braking system at the lower station is required to control the speed of descending trolleys laden with fruit and vegetables



Running the wire rope through oil or grease in a cut down plastic bottle is a simple method to keep the support cables lubricated

Ropeway Mechanics

Let

$m1$ be the mass of downward moving trolley with load and

$m2$ be mass of upward moving trolley with load.

Here, $m1$ is always greater than $m2$.

Here,

I. Initial potential energy of downward moving trolley (PE0) = m1gh0, where h0 is the elevation difference between the upper and lower saddles;

II. Potential energy of downward moving trolley at the point of consideration (PE1) = m1gh1

where h1 is the height of the first trolley from lower saddle at the time of consideration;

III. Potential energy of upward moving trolley at the time of consideration (PE2) = m2gh2, h2 is the height of m2 from lower saddle at the time of consideration;

IV. Combined work done by the masses against the friction (W1)= 0.25(m1+m2) cosβS

where S is the rope length covered by the trolleys at the time;

V. Combined Rotational Energy of sheaves (W2) = I ω2, where ω= v/r, I = . mr2

Where r and m are the radius and mass of the sheave respectively.

Now, as per the principle of conservation of energy,

0.5 (m1+m2+mh) v2 = PE0-PE1-PE2 -W1-W2

Here, m_h is the mass of the hauling rope.

From this relationship, the velocity of moving trolleys at specified time and point along the route can be calculated. The actual velocity for a given loading condition is usually less than the velocity obtained from this relationship. As the track rope and hauling rope are not parallel to each other in vertical plane, the hauling rope is pulled towards the track rope while the gravity ropeway is in operation. This leads to the excessive friction between the hauling rope and the sheave which leads to the loss of velocity. Nevertheless, the idea of tentative approaching velocity of the trolley helps to calculate the maximum possible impact load which is very important for the rope design.

Features of Gravity Ropeway

- **Cost effectiveness:** Construction and installation cost of gravity ropeway is lesser than other conventional means of transport like roads and railways. The approximate cost of the gravity ropeway is Rs. 1,400,000 where as per kilometre construction cost of a four metre wide earthen road in the hills is approximately Rs. 3,000,000.
- **Time saving**: As goods can be transported through gravity ropeway within few minutes, it is efficient and time saving.
- **Short route:** In the case of roads or railways, alignments are usually winding to acquire required gradient which makes the route longer and costlier. Unlike those, as the rope of gravity ropeway is suspended in the air, the alignment is straight which results in a short route.
- **Energy efficient:** Gravity ropeway operates solely from the gravitational force. It does not require any external power or fuel. This is very important for a country like Nepal where we can save costs by reducing the import of fossil fuels for air and surface transports.
- **Environment friendly:** Gravity ropeway is environment friendly technology. It neither causes noise nor air pollution. It does not disturb ambient environment and the existing ecology.
- **Simple technology:** Gravity ropeway employs very simple and robust technology which can be operated and maintained by local communities. It does not require external experts apart from the inputs and technical facilitation in surveying and designing, which can also be done by local engineers and technicians.
- **Nominal operation and maintenance cost:** As the gravity ropeway does not require any fuel or highly skilled manpower for its operation and maintenance, its running and maintenance costs are nominal

Limitations

- **Span**: Through the learning experience, the span of gravity ropeway is currently limited to 1500 metres for operational efficiency and safety. When the span exceeds over 1500 metres, the tension due to the self load of the wire rope increases as it is suspended between two points only. In addition, the energy loss due to the friction will be more in longer span ropeways. Therefore, for safety and efficiency, the span of gravity ropeway is recommended to the limit of 1500 metres only.
- **Slope:** One of the limitations of gravity ropeway is that it cannot be operated in a gentle slope. Experience shows that it requires at least 15 degrees of slope to operate smoothly. The upper limit can go as high as 40 degrees if proper loading ratio is maintained and an arrangement to prevent derailing of the trolleys from the track ropes is placed. However, according to current practice, preferable slope for gravity ropeway is from 20 to 30 degrees.
- **Up hauling capacity:** Gravity ropeway is mainly for transporting produces from hilly villages to the road/trail head markets. It has very limited capacity to haul up goods from the market to the villages up in the hills. As a rule of thumb, the downward moving load should be three times heavier than the upward moving load.
- **Loading ratio:** The speed of the trolley in gravity ropeway is mainly dependent on the slope and loading ratio along with several other factors including application of lubrication in the pulleys and wire ropes, and application of brakes. The loading ratio should be well maintained so that the trolleys approach the respective stations with minimum speed but will not stop in between. Actual loading ratio should be carefully evaluated after the test operation of the gravity ropeway and the recommended ratio should always be maintained. If the loading ratio is not properly maintained, the trolley moving downward may approach with excessive speed. Failing to apply brake can result in a ramming impact at the bottom station risking the safety of the haulage rope and other accessories and even endangering the life of the operator. Sometimes because of loading imbalance, the trolleys do not move with required speed and energy to haul loads up and down the stations requiring manual pulling of the hauling rope. Therefore, the operators need to be fully trained to make proper load balance between two trolleys while operating the gravity ropeway. Measuring/weighing equipment are essential to weigh the loads at both stations before it is put into operation.

Existing Planning Process

- Components for Planning process
  - Planning the project work
  - Planning the human resource and organization
  - Planning the financial resources
  - Planning the information system
- Project planning is a multi-stage process and is enumerated as:
  - Establishment of Objective
  - Establishing assumption based on facts
  - Establishing the logical sequencing of activities
  - Searching and evaluating alternative course of action
  - Identification of time and resources
  - Assignment of responsibilities and
  - Finalization of Project Plan

Cable car in Nepal

- **In Operation**
- Manakamana Cable Car
- Chandragri Cable Car
- Kalinchowk Cable Car
- Several Tuin and gravity goods ropeway at different parts of country
- **In study**
- Fewa lake to Sarangkot
- Maulakalika Cable Car
- Sagarmatha Ropeway (Lukla to Namche Bazar)
- Chandragiri Zipline
- Pathibhara Cable car
- Pokhara Cable car (Basundhara Park to World Peace Pagoda)
- And others for material in different hydropower and other project