CABLES

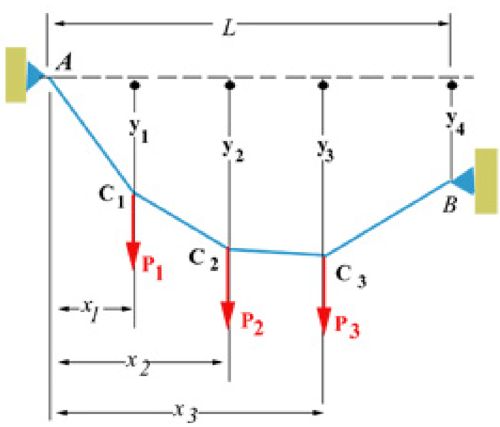
Suspension bridges are primarily consisted of beams supported or suspended by cables. Cables are flexible members capable of withstanding only tension and are designed to support either concentrated or distributed loads.

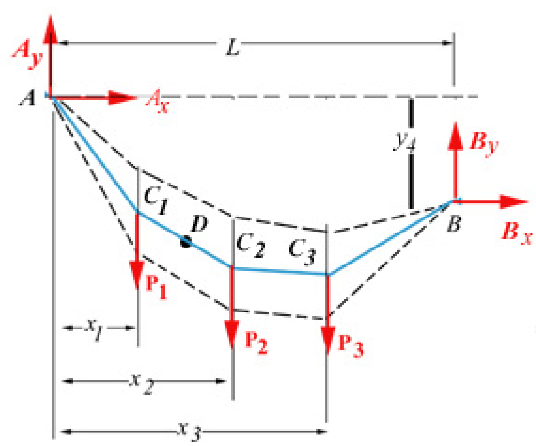
Cables may be classified in two categories, according to their loading:

1) cables supporting concentrated loads,
2) cables supporting distributed loads.

Cables Supporting Concentrated Loads

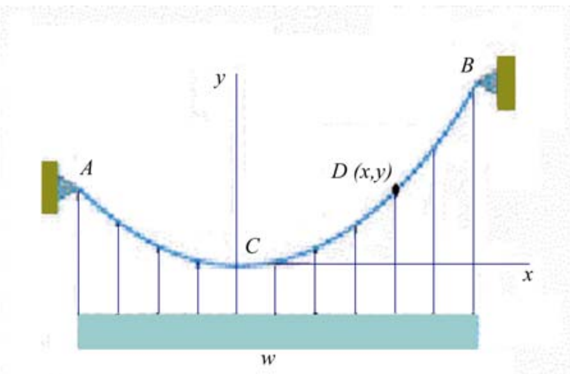
Concentrated loads are spread across the length of the cable and do not have to be equal. Consider a cable attached to two fixed points A and B. The cable then supports n vertical concentrated loads P_1, P_2, ... P_n. The cable is assumed to be flexible, resistance is small and can be neglected. We further assume that the weight of the cable is negligible compared with the loads supported by the cable. So any part of the rope in-between can be looked at as a two-force member and any point in the cable can be reduced to a force of tension directed along the cable.

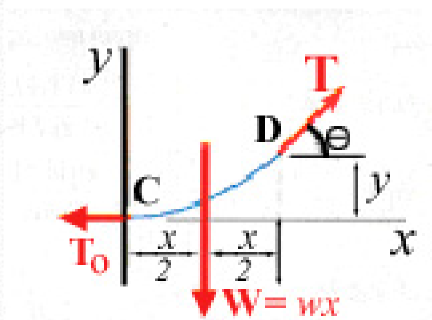




Cables Supporting Distributed Loads

Consider a cable attached to two fixed points A and B and supporting some load. Assume cable AB carries a load *uniformly distributed along the horizontal.* Cables of suspension bridges may be assumed loaded in this way, since the weight of the cables is small compared with the weight of the roadway. We denote *w* as the load per unit length expressed in N/m or in lb/ft. Choosing coordinate axis with origin at the lowest point C of the cable, we find that the magnitude W of the total load coordinates x and y is
$W = wx$





The relations defining the magnitude and direction of tension force at D become

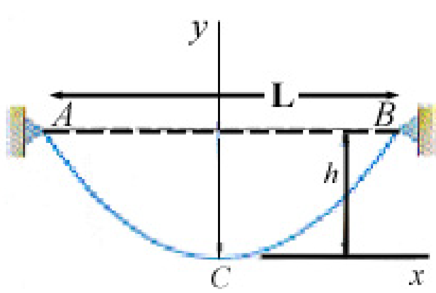
$T = \sqrt{T_0^{\,2} + w^2 x^2}$ $\tan\theta = \dfrac{wx}{T_0}$

W = weight of rigid platform
w = weight per unit of x
x = distance from origin
T_o = tension in lowest point of cable
T = tension at x units from point C

$y = (wx^2)/(2T_0)$

This is the Equation of a parabola with a vertical axis and it's vertex at the origin of coordinates. The curve formed by cables loaded uniformly along the horizontal is thus a parabola.

When the supports A and B of the cable have the same elevation, the distance L between the supports is called the span of the cable and the vertical distance h from the supports to the lowest point is called the sag of the cable. If the span and sag of the cable are known, and if the load *w* per unit horizontal length is given, the minimum tension T_o may be found by substituting x = L/2 and y = h in the above equation. Then use the other equations to find the tension and the slope at any point of the cable. $y = (wx^2)/(2T_0)$ defines the shape of the cable.



SUSPENSION BRIDGES – High School Level

Problem Statement

You plan to build a bridge across a tidal inlet on the Atlantic Coast. . The inlet is 50 ft deep. The tidal prism here ranges from $3.6 * 10^7$ to $5.3 * 10^7$. The side slope of the inlet is ½. There must be at least 30 ft of roadway on both sides of this span and the roadway must be at least 2 ft. from the ground or supporting base.

Sag in cable must be at least 10% of the span not exceeding 15%.

You are to design specifications for the bridge you will build calculating all necessary calculations such as: Theoretical Weight, sag in cable, Tension at minimum sag in cable, tension at ends of cable, cost analysis, free body diagrams of forces involved and any other calculations deemed necessary. This will be recorded along with any other ideas in your design notebook.

You will also build a 1:120 scale model of your bridge out of the materials you are given. This means that your model will be 1/120 of the length of the bridge you designed.
(Scale: 1 in. = 10 ft.)

You will present you project and the bridges will be tested for the amount of weight they hold. Judging will be according to the judging criteria page.

Please record all calculations, sketches, drawings and ideas in your design notebook.

RIGID FRAME & TRUSS BRIDGES – Middle School Level

Problem Statement

You plan to build a bridge across a tidal inlet on the Atlantic Coast. The inlet is 50 ft deep. The tidal prism here ranges from $3.6 * 10^7$ to $5.3 * 10^7$. The side slope of the inlet is ½. There must be at least 30 ft of roadway on both sides of this span.

You are to design specifications for the bridge you will build calculating all necessary calculations such as: Span bridge needs, Theoretical Weight, cost analysis, free body diagrams of forces involved (weights and supports) and any other calculations deemed necessary. This will be recorded along with any other ideas in your design notebook.

You will also build a 1:120 scale model of your bridge out of the materials you are given. This means that your model will be 1/120 of the length of the bridge you designed.
(Scale: 1 in. = 10 ft.)

You will present you project and the bridges will be tested for the amount of weight they hold. Judging will be according to the judging criteria page.

Please record all calculations, sketches, drawings and ideas in your design notebook.

Caculations:

Calculations of distance across inlet or the span is in Packet labeled " Tidal Inlets ", using tidal prism, depth and slope. Tidal prism can be chosen anywhere within range given.

Thoughts of length and width of bridge should be discussed. Depending on bridge design what type of factors should be considered.

Calculations of theoretical weight of bridge using information given in " Geotechnical Engineering " packet using concrete as assumed material. Diagrams of forces should be based on this weight.

With length determined sag should be determined as 10 – 15% of length. Using equations in the "Cables" packet should be helpful in recognizing forces involved. With known sag and weight the tension can then be calculated; also can be checked after tension is measured during contest.