

## Analyzing Stability of a Dam using MATLAB

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### **Abstract:**

Today we are living in the world of technology. Various massive constructions were being carried out every day to ensure certain purposes. Dams were one among such constructions. They were used for the purpose of irrigation, power generation or sometimes simply to store water. Number of forces act on these dams like water force, own weight etc. Considering all these forces and analyzing them manually is tedious process. In this paper, we were using MATLAB software to analyze various forces acting on the dams. The code written doesn't exist before and reduces manual calculations. The code written also offers flexibility in selecting the number of forces acting on the dams in both X and Y directions and gives final result concluding whether the structure is safe or not.

**Keywords:** Arch Dam, Barrages, Dam, Embankments, Stability, MATLAB, Moment

### **I. INTRODUCTION:**

A dam is a barrier that impounds water or underground streams. Dams generally serve the primary purpose of retaining water, while other structures such as floodgates or levees (also known as dikes) are used to manage or prevent water flow into specific land regions. Hydropower and pumped-storage hydroelectricity are often used in conjunction with dams to generate electricity. A dam can also be used to collect water or for storage of water which can be evenly distributed between locations.



### **II. TYPES OF DAMS:**

Based on the structure of the dam, dams are classified as follows:

#### **2.1 Arch Dams:**

In the arch dam, stability is obtained by a combination of arch and gravity action. If the upstream face is vertical the entire weight of the dam must be carried to the foundation by gravity, while the distribution of the normal hydrostatic pressure between vertical cantilever and arch action will depend upon the stiffness of the dam in a vertical and horizontal direction. When the upstream face is sloped the distribution is more complicated.

#### **2.2 Gravity Dams:**

In a gravity dam, the force that holds the dam in place against the push from the water is Earth's gravity pulling down on the mass of the dam. The water presses laterally (downstream) on the dam, tending to overturn the dam by rotating about its toe (a point at the bottom downstream side of the dam). The dam's weight counteracts that force, tending to rotate the dam the other way about its toe.

### 2.3 Arch-Gravity Dams:

A gravity dam can be combined with an arch dam into an arch-gravity dam for areas with massive amounts of water flow but less material available for a purely gravity dam. The inward compression of the dam by the water reduces the lateral (horizontal) force acting on the dam.

### 2.4 Barrages:

A barrage dam is a special kind of dam which consists of a line of large gates that can be opened or closed to control the amount of water passing the dam. The gates are set between flanking piers which are responsible for supporting the water load, and are often used to control and stabilize water flow for irrigation systems.

### 2.5 Embankment dams:

Embankment dams are made from compacted earth, and have two main types, rock-fill and earth-fill dams. Embankment dams rely on their weight to hold back the force of water, like gravity dams made from concrete.

## III. FORCES ACTING ON A DAM:

In the design of a dam, the first step is the determination of various forces which acts on the structure and study their nature. Depending upon the situation, the dam is subjected to the following forces:

### 3.1 WATER PRESSURE:

It might be external water pressure or uplift pressure. External water pressure is the pressure of water on the upstream face of the dam. If the hydraulic gradient caused vertical uplift pressure, then the upward pressure is called uplift.

### 3.2 EARTHQUAKE FORCE:

The effect of earthquake is equivalent to acceleration to the foundation of the dam in the direction in which the wave is travelling at the moment. Earthquake wave may move in any direction and for design purposes, it is resolved into the vertical and horizontal directions.

### 3.3 SILT PRESSURE:

If  $h$  is the height of silt deposited, then the forces exerted by this silt in addition to the external water pressure is also taken into consideration.

### 3.4 WAVE PRESSURE:

Waves are generated on the surface of the reservoir by the blowing winds, which exert a pressure on the downstream side. Wave pressure depends upon wave height.

### 3.5 ICE PRESSURE:

The ice which may be formed on the water surface of the reservoir in cold countries may sometimes melt and expand. The dam face is subjected to the thrust and exerted by the expanding ice.

### 3.6 WEIGHT OF DAM:

The weight of dam and its foundation is a major resisting force. In two dimensional analysis of dam, unit length is considered.

## IV. INTRODUCTION TO MATLAB:

MATLAB (Matrix Laboratory) Is A Numerical Computing Environment And Fourth-Generation Programming Language. Developed By Mathworks, MATLAB Allows Matrix Manipulations, Plotting Of Functions And Data, Implementation Of Algorithms, Creation Of User Interfaces, And Interfacing With Programs Written In Other Languages, Including C, C++, Java, And Fortran. MATLAB® Is A High-Level Language And Interactive Environment For Numerical Computation, Visualization, And Programming. Using MATLAB, We Can Analyze Data, Develop Algorithms, And Create Models And Applications. The Language, Tools, And Built-In Math Functions Enable Us To Explore Multiple Approaches And Reach A Solution Faster Than With Spreadsheets Or Traditional Programming Languages, Such As C/C++ Or Java. We Can Use MATLAB For A Range Of Applications, Including Signal Processing And Communications, Image And Video Processing, Control Systems, Test And Measurement, Computational Finance, And Computational Biology.

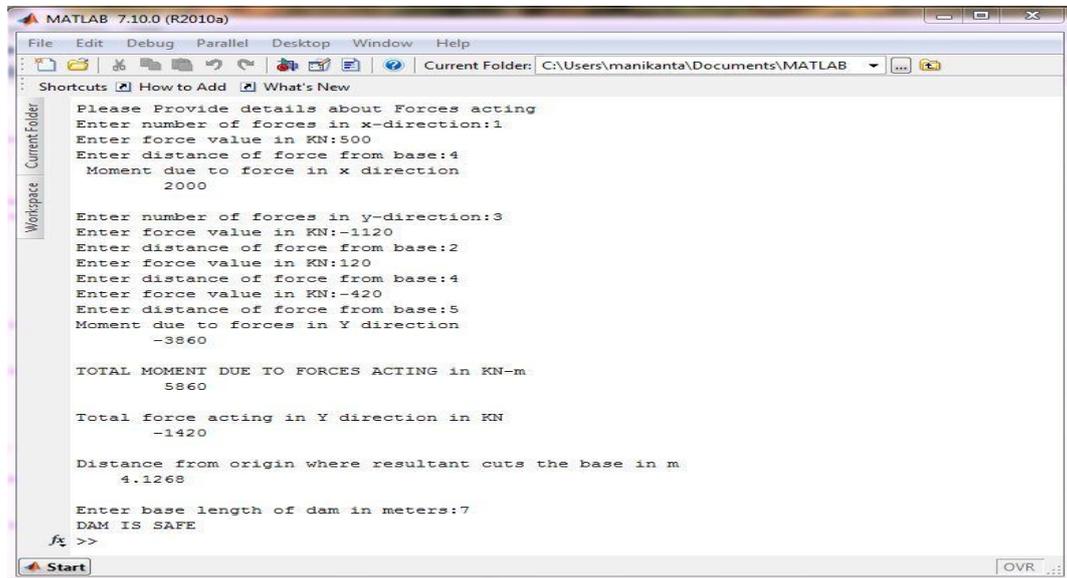
## V. PROBLEM:

Consider a problem where we need to analyze stability of a dam. A number of forces, as mentioned earlier, act on the dam at different points. Force acting in X direction is taken as positive if it is towards right

while force acting in Y direction is taken as positive if it towards south direction. Consider a Dam with following forces: Force in X direction= 500 KN at a distance of 4 m from base  
 Forces acting in Y direction: 1120 KN acting upwards at a distance of 2m from origin  
 120KN acting downwards at a distance of 4m from origin  
 420KN acting upwards at a distance of 5m from origin  
 Base length of dam = 7 meters

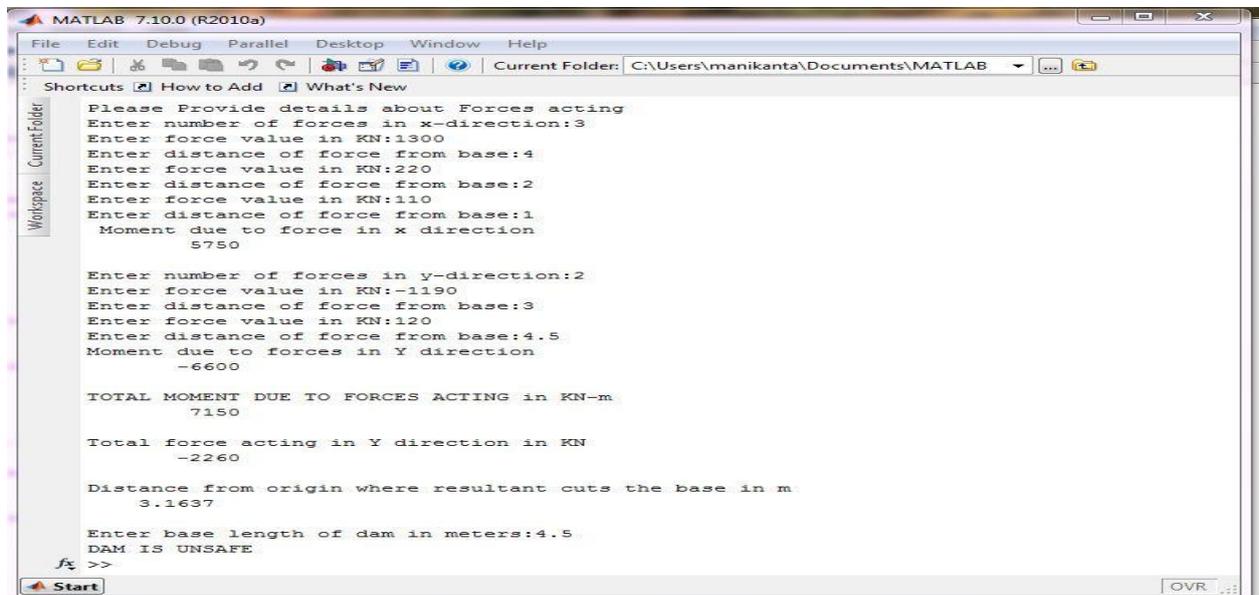
This problem can be solved using MATLAB and the results obtained are as follows:

### VI. MATLAB OUTPUT WINDOWS:



### VII. DAM UNSAFE CASES:

Similarly as done above any problem can be solved to check the stability of the dam constructed or that is to be constructed. Dam is considered to be unsafe if the resultant doesn't pass through middle third of the base. i.e. if  $r$  doesn't lie in the range  $(b/3, 2b/3)$  MATLAB code written can be checked by taking various values and one of such results is as in the fig below:



### **VIII. CONCLUSION:**

The MATLAB code written for analyzing the stability of the dam was proved to be correct as the results obtained from MATLAB matched exactly with that of various problems chosen from different textbooks. The MATLAB code written was very effective, time saving and can be applied to any dam. The MATLAB code written works for any number of forces which are given as input to study the stability of the dam.

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