PROACTIVE DISASTER MANAGEMENT
Detection of Landslides

01. THE BIG RESPONSIBILITY

It can be observed that 'World Sciences' in 21st Century, are being reached to sky summits but leaving lots of voids and gaps while some other fields look almost abandoned or overlooked with no development through centuries. Otherwise how such sweet natural things like Wind, Water, Land etc. could disguise all at once as Tornados, Tsunamis or disastrous landslides etc. to kill thousands of unprepared people?

Therefore scholars, scientists and heads of knowledge departments have a big responsibility to review their subject fields to identify voids in so far developed stocks of knowledge, in order to enhance maximum yield upon mankind, as a timely need of the era.

Any science can naturally become a blind belief, unless theories are frequently challenged.

Besides that, technologies are not easily accessible and far off from the general public who are directly exposed to danger with no knowledge of disastrous situations. Knowledge is costly with no argument about that but disaster management scenarios must be proactive enough either to afford the safety of general public or otherwise give them necessary knowledge at least to look after their safety by themselves.

02. SCOPE OF THE TECHNICAL PAPER

This letter is aimed to introduce a novel technique for ***early detection*** of landslide possibilities very quickly (by even a layman who read this paper) in order to raise ***preparedness*** and easy application of ***safety measures*** to save lives from disastrous landslides.

EARLY DETECTION
FORECASTING
SAFETY MEASURES
NO DANGER

LATE DETECTION
EARLY WARNING
PREPAREDNESS
LESS DANGER

UNDETECTED
NO ALARM
UNPREPARED
DISASTER

FIGURE-1

03. HOW LANDSLIDES ARE INITIATED?

If you are living in a sloppy land with steep earth bank cuts of roads or building constructions, you had better knowing what are the landslide possibilities in your locality and how they can be initiated.

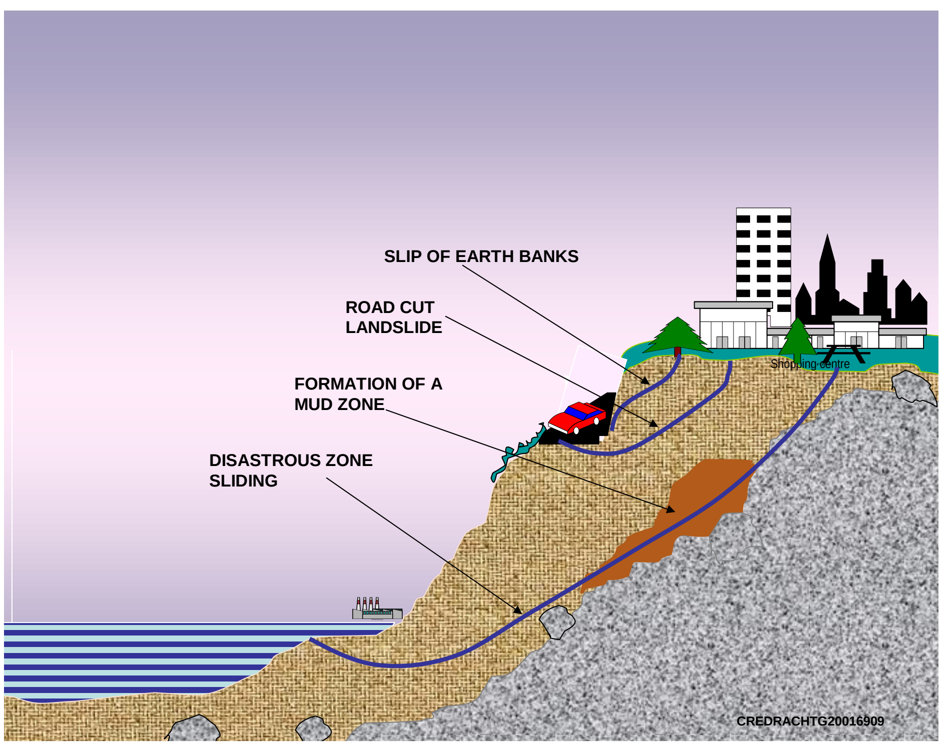

FIGURE-2

- **Data collection:**

There are different types of soils with many different properties and these qualities are crucial of identifying in detecting landslides;

i. **angle of internal friction (Ø) of the local soil type**
ii. **cohesion (C') of soil**
iii. **bulk density (ɤ) of soil**
iv. **bearing pressure (P_a) of soil**

Such qualities of soil can be easily find if you bring a sample (collected from the susceptible site or area) to a soil laboratory for testing. Other important physical measurements that you have to collect are; 1. **slope of the earth bank(β)** and 2. **depth of the cut(D)** for road, building or whatever it is of a construction.

- **Detection of landslides:**

The three types of landslides are;

i. **normal slip of earth banks (at steep slopes)**
ii. **landslide of toe failure (at steep cuts for roads or buildings)**
iii. **zone sliding (at sloppy areas)**

1. ***Slip of earth banks***:

This type is of very common occurrence at where angle of the slope is too steep as shown in the picture-1 of figure-3. Therefore too steep slopes of earth banks or earth cuts are not recommended for constructions unless the banks are protected with special safety measures (explained at the end).

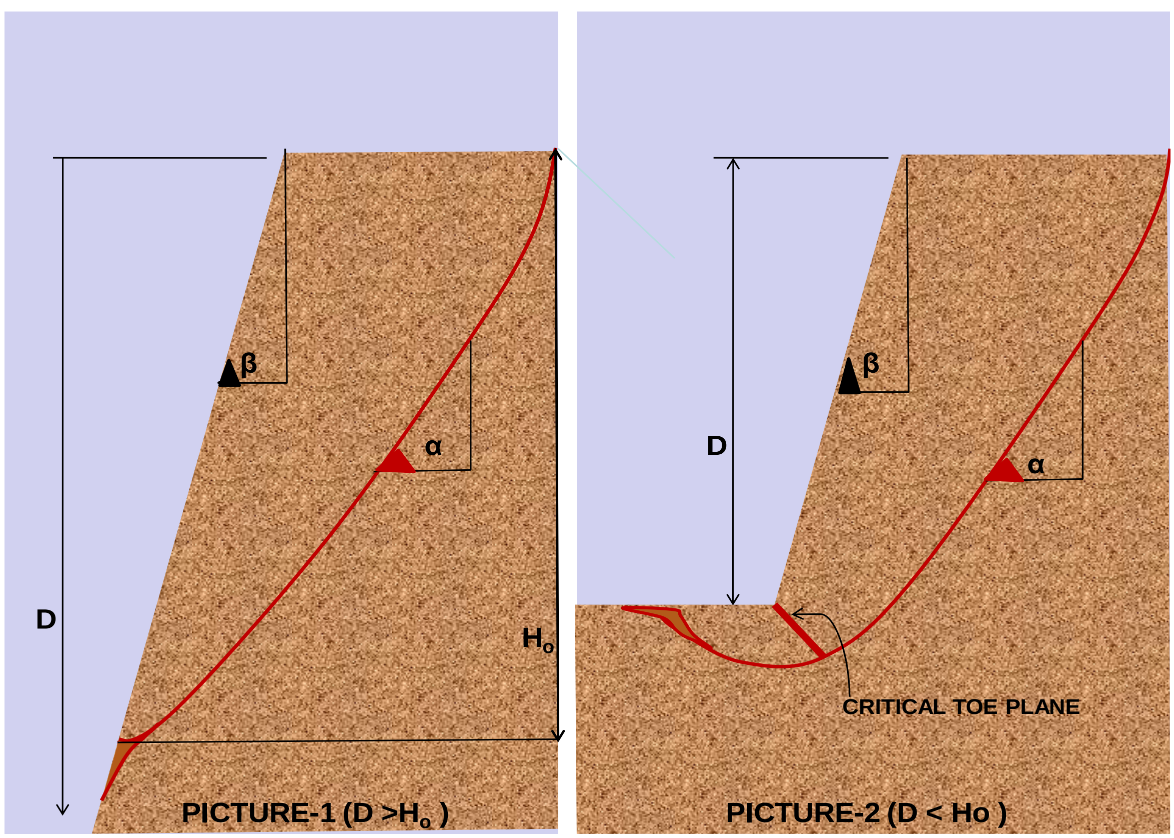

FIGURE-3

2. ***Landslides of toe failure***

In this case bearing pressure of toe soil, has a main role to play because load of the slip can be safely transferred further down unless the critical toe plane is failed. Bearing limit(Pa) is exceeded first, at the deep end of the critical plane 'CC' due to the load from the earth segment above, as shown in the figure-4, and the slip plane is turned gradually and curved at the toe with springing out muddy water as a result.

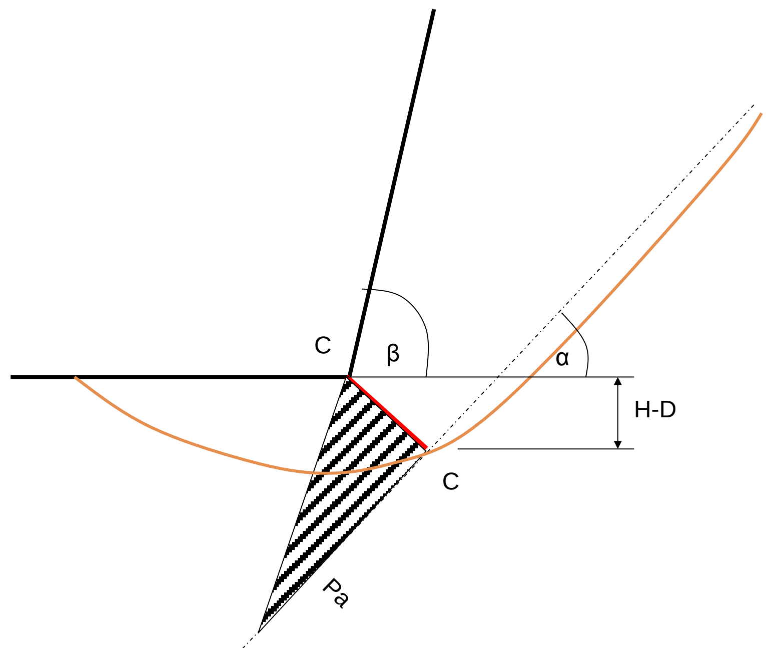

FIGURE-4

This phenomenon is well supported by case study observations of thick muddy water springing out from the toe area when, landslides are imminent.

Therefore as a measure of safety special protections have to be implemented at identified weak tore areas (described at the end of the letter).

3***. Disastrous Zone Sliding***

This is the most dangerous type of landslides must be detected early to give early warning, improve preparedness and implementation of safety measures.

It could not be difficult for anybody to understand how pressure is grown with the increasing depths in water and similarly pressure in wet soil too is increased at depths. The most important fact to be considered is that, any soil type has a bearing capacity of its own which cannot be exceeded. When that limit is exceeded by overloading, a dry soil may loose its texture but no significant harm could be observed. But under wet conditions it could be liquidized in to a mud, causing lots of problems. Perhaps mud zones are formed at bottom, as shown in figure-2, due to the self weight of high earth columns. A mud layer upon the base rock in a slope, could lubricate the bottom of soil columns, to initiate a disastrous zone sliding.

That is why we have to be more attentive of landslides under long lasting rainy conditions. Because they could not take place at all as far as soil at susceptible slip planes are dry. Therefore much attention has to be paid on improving drainage facilities for rainwater runoff in steep sloppy areas, in order to keep subsurface soil layers dry as far as possible.

04 HOW TO FORECAST LANDSLIDE POSSIBILITIES:

Computation part is always boring and therefore it is left behind in the ***attachment-2***, (pl ref attachment-2 by those who are interested) and only the magic box to get results of the deduction is exposed in the ***attachment-1*** for the general public.

Only thing that you have to do is, typing your values [**β, Ø, ɤ** & P_a] in the data box provided in a XL sheet.(pl see ***attachment-1***) and you will get most important outputs such as angle of the slip plane(**α**) and critical depth of the possible slip (**H_o**).

H_o is the most important figure that you have got and it indicates what depth in the slope is most critical for initiation of a landslide.

Also you can get the critical depth (**D**) which indicates the critical stage of a bank cut, road cut, or earth cut for any other construction, which is not the safe depth but the depth at the critical stage of danger.

So you can check whether your actual depth at the site (***Da***) is smaller or bigger than the critical value of D. The forecasting can be done therefore with introduction of a suitable safety factor **1.2** such as;

i. If **D**≥ 1.2 ***Da*** …………**NO DANGER.**

ii. If **D**≤ 1.2 ***Da*** …………**DANGER**

Once the danger at your site, is identified safety measures as described herein, have to be implemented to avoid the possible danger.

05 HOW TO FORECAST DISASTROUS ZONE SLIDING:

In identification of zone sliding we have to get the depth (**h**), to the base rock in the slope. That can be easily got by means of a seismic wave instrument or otherwise by drilling a bore hole. Theoretically, the critical soil column height for mud formation is given by $h_o = P_a / ɤ$

Forecasting is such that the slope is not in danger if $h < h_o$ and it is in danger if $h \geq h_o$.

As far as the bottom layers are dry, sliding cannot be initiated and therefore infrastructure development in the region for quick draining of rainwater runoff is of immense importance as a safety measure.

However solutions are very much difficult in this case of zone sliding and only thing to be done under long lasting rainy conditions, is evacuation of residents from identified dangerous localities.

06 SAFETY MEASURES AGAINST LANDSLIDES

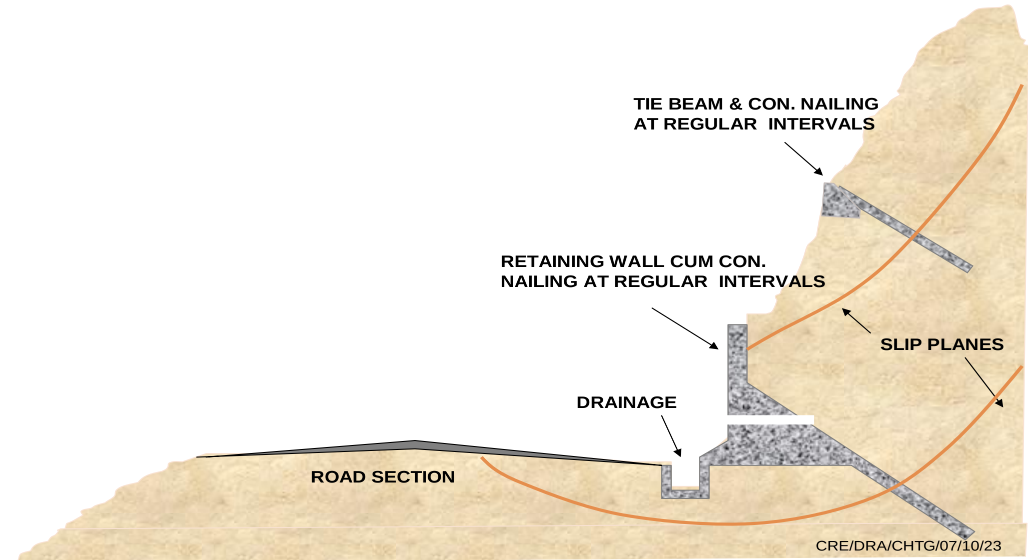

FIGURE-5

- **Preservation of earth banks at steep road cuts**

As shown in figure-5, susceptible steep banks can be protected by application of reinforced concrete nailing at a regular spacing(12 inch diameter concrete nails with four 20mm bars at 3m space in a line perpendicular to the slope) can be recommended for those who don't like much calculations.

At the toe, a retaining wall type protection has to be provided with concrete nailing at regular spacing and the nails in each case, have to be extended to cross identified slip planes. Drilling a borehole and filling with concrete is the easiest way of nailing. Surface erosion in slopes can be problematic and it has to be buffered by turf terracing of banks.

Such bank preservation techniques can be applied only for the detected weak sections as a measure of cost saving in constructions.

- **Preservation of slopes against landslides**

Safety measures have to be implemented under three main components such as;

i. Grid of concrete nailing

ii. Sand-well drainage system

iii. Turf terracing

As shown in figure-6, nailing has to be extended to cross detected slip plains and nails have to be connected by tie beams to buffer surface erosion too. Sand well drainage system is of immense importance to deep down the ground water table at the susceptible landslide area. The well can be of porous tubes or just a bore pit filled with coarse sand or metal so that the seep water from surrounding is drained through a pipe provided at the bottom.

Besides that turf terracing of the slope is necessary to buffer surface erosion in the slope.

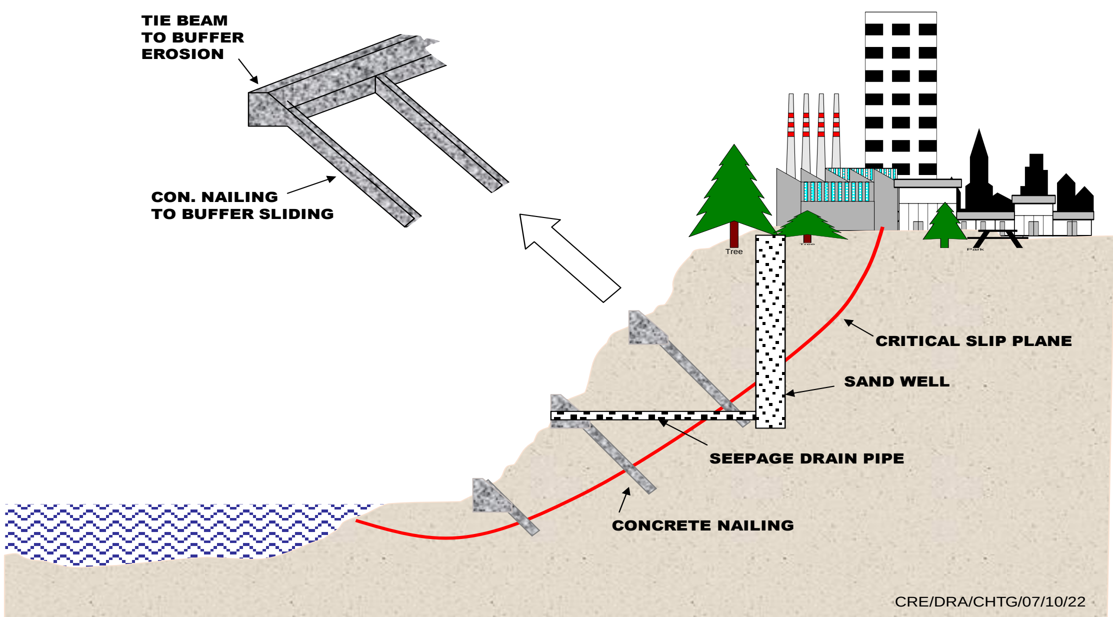

FIGURE-6

06 CONCLUSION

There are a number of methods in the background science to analyze slip plains such as; Taylor's chart method, Slip Circle method, Fellenius method & Bishop's method etc. Most of those analytical procedures are much complicated and tiring for a designer who wants to determine the possible slip plane of a susceptible earth bank.

Case studies on landslides prove that sliding don't take place sometimes even if the upper linear crack of the possible slide is visible. That is because the tore area is still holding the earth segment against sliding even though, the portion is already separated from the slope.

Soil in the tore area is not just slipped but squeezed in to mud losing the texture due to high pressure as observed in many cases. Therefore the allowable bearing capacity of tore soil seems to play a key role in this stability analysis.

Quick evacuation is the best thing to do whenever symptoms of a failure such as; springing out muddy water from the floor at the toe area of a steep slope, or swelling up a land strip etc. are observed in sloppy areas under long lasting rainy conditions. At such a situation, the residents at above the toe, can undergo only a sliding down perhaps with less damages but those who settled below the toe, are in utmost danger of being buried.

However the approaches of reactive dispute resolution are like postmortems of less significance and therefore ***Proactive Disaster Management*** has to be introduced at this critical stage when the Globe is at peril of warming, which aggravates all the type of disasters.

Knowledge should not be for knowledge's sake but to enhance maximum benefits upon mankind and therefore, technologies should be available for people who are directly exposed for danger, at least to save their lives by themselves.

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by

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References:

Attachment-1:- the black box to get easy results

Attachment-2:- the complete technical publication (request if interested)