# THE OAKDALE MALL SLOPES
# A PROBLEM IN MASS WASTING

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# ABSTRACT

In geomorphology the process known as mass wasting has particular impact on mans ability to control natural topography.In one such case,man's efforts are being thwarted by natural law.Here,a cause and effect relationship is developed between what was done by man,and the processes nature is using to find a balance.Concluding in how man's violation of natural law,given conditions,cause nature to take different approaches toward the same solution.

## INTRODUCTION

In the annals of geomorphology the process known as mass wasting ranks high on the list of contenders when discussions of land and land use is envolved. According to the glossary of geology the definition of mass wasting is(the dislodgement and down slope transport of soil and rock material under the direct application of gravitational body stresses. This happens when material is not being carried within,on or under some other medium. This displacement can be slow such as creep and solifluction, or fast like rockfalls,rockslides,and or debris flows). In short,mass wasting is a process that nature uses to balance erosional and depositional forces. These forces,by and large,act in a very methodical manner inching their way along slowly. However,there are rare occasions upon which nature takes a leap forward. Usually this is when the balance process is disturbed. Such is the case of land use or land development. Or,to be more poignant,when mans development interferes with and contradicts natural law.

Over the last century mans tools and developmental techniques have allowed us to carve and shape land surfaces as if we were slicing out a piece of pie. One such development is located here in the local Binghamton area. I am referring to the slopes which harness the Sears parking lot behind the Oakdale Mall complex in Johnson City N.Y..Since their inception the slopes behind the Oakdale Mall have been plagued with problems.These problems range from slope angle instability,given special hydrologic situations. To what may be a much deeper problem meaning the surfical sliding of the past may be in the process of developing into a much deeper slump system.But,before I delve into a discussion about these problems,it is certain that clarity is needed looking at some specific terms and their definitions.

First I have been looking at slopes. Slope-Gradient or an inclined surface of any part of the earths surface,as a hill slope. Also,a broad part of a continent. But,for our purpose hillslope will do.Slope element- curved part or portion of slope profile. Slope failure-Gradual or downslope movement of soil or rock under gravitational stress,often as a result of man-caused factors,eg-removal of material from the base of the slope(Glossary-620).To continue according to Yang H.Huang's text on stability analysis of earth slopes.He states on page 4 that slope movements is divided into five main groups;falls,topples,slides,spreads,and flows.For our purpose here I will define the one which applies the most and that is slides. A slide is - movement that consist of shear strength and displacement along one or several surfaces that are visible or may reasonably be inferred,or within a relatively narrow zone. This is the one definition most pertinent.Along with an understanding that slides also happen in a rotational manner,as overhead 1-f,and 2 indicate.

When I had first started looking into these slopes my thoughts vacillated between process and the cause and effect aspect of these slope problems.In order to clarify this I felt the need to consult one of my old teachers of whom which introduced me to the problems involving these slopes,that being a Broome Community College professor Karen Goodman.After interviewing her it became clear that a cause and effect relationship preceded the present day process problems.Plainly spoken,due to mans interference of the natural slope,stability of these slopes then became in question.Information then became necessary to aid in the resolution of this geomorphic problem.A sequential look as to what happened,what was done to fix the problem,and how the work is holding up at this time.

## PRESENTATION OF DATA

There are four levels of data presentation. One-information gathered as a result of personal interviews where their comments and ideas are interjected as appropriate.Two-pictorial information on the slopes following in a sequence of events moving frame to frame. This will be done in two segments.The first 18 slides will focus on how the problem was and what was done,and the second 11 slides will look at how the corrective repairs are holding up. Three-having gathered data from the slopes calculations are made and left in tabular form,as an adjunct,as a supportive measure.Four-graphical representations of corrective design measures taken and slope profiles,gathered from the archtectual and construction firms. Each section will be prefaced by a brief statement or paragraph.

## DATA ACQUISITION

The time line upon which I shall use,as well as the main body of the first 18 photographs and even the technical graphs were acquired through Mr. Arthur M. Phillips manager of the Oakdale Mall Complex.Supportive information came by way of interviews and discussions with Karen goodman,Marie Morisawa,and Peter Knuepfir.Textual support is noted within the works cited.Definitions came from the glossary of geology as noted.And,the drainage overview is from a U.S.G.S. town of union quadrangle map.

## INTERPRETATION OF DATA

As noted in the introduction the problem of mass wasting is one that exist more prevalent today due to the advent of industrial capability and urbanized development. In mans race to define his niche within our land scape,natural laws are bound to become victim to misuse. Such is the case of the slopes behind the Oakdale Mall Complex,the reasons for this are as follows.

According to Arthur M.Phillips,upon an introductory interview on 11/8/91. The slopes behind the mall were initially carved in their present day format back in 1978.

This was to accommodate Sears dept.store as well as 22 other store's. In order that Sears and the other stores would come into the mall,the parking lot was increased to it's present size.Which at this point in time added a square area of 550 feet for parking.At that time there was only one slope and the mall was much smaller,minus 1/3 of it's present northern section.Increasing the parking to this degree meant that the original or the natural topography had to be altered. A wedge was then cut into this topography leaving two slopes, both at an unusually high angles. There is a northern slope and an eastern slope which reside 90 degree's from each other, both slightly rotated 15 degree's northwest.In addition to the restructuring of the original slope Mr.Phillips said that several homes were removed and that eventually the home immediately beyond the northern slope off Reynolds road was purchased by the Oakdale Mall.

When asked about the original drainage pattern of the original slope Mr. Phillips said little information existed that he knew of that dates or pre dates the 1978 work. He said that he came to work at the mall after 1978,and that he was unaware as to the where abouts of any data concerning the original construction. He did however,meticulously record through the takeing of hundreds of photographs,the restructuring of the slopes,and through the acquisition of records maintain a watch on the slopes and their progress. Of these hundreds of photos Mr. Phillips allowed me to barrow those of which I could use. By request of my Professor

Mr.Peter Knuepfir I took 18 photos. I chose those pictures which most typified the problems and hopeful solutions of the slopes.

Mr.Phillips continued on stateing that two principal firms were contracted to do the work. One-Langan engineering out of Elmwood Park N.J.,and Kerr construction also of Elmwood Park.

I shall interject Mr. Phillips comments as I now move into the photographic aspect when appropriate.

Mr. Phillips noted that each slope was comprised of glacial till.However each slope was different in that the north one was more compact than that of the reynolds road or east slope. This he said this was due to the wetter conditions that exist on the eastern slope. He attributed this to a down slope channel focused on the east slope from the general direction of the Edwin A.Link airport.In the book soil mechanics and foundations by C.R.Scott on page 5 he states(change in the water content of the soil is the greatest single cause of variation in engineering properties,shear strength,compressibility and permeability are all,directly or in directly,related to water content).On pages 47 he goes on to say(changes in the total stress and in the pore pressures in the soil lead to changes in volume and shear strength). When interviewing Marie Morisawa A retired Geomorphologest from S.U.N.Y. Binghamton,who had done previous work on the slopes behind the Mall. She said that the slopes were heavily laden with clay minerals and that these clay minerals decrease the angle of repose from the norm in sand which is 35 degrees,to,with the clay down to 22 degrees.(The angle of repose is the angle to which a slope achieves stability on a continuing basis).She said that given the slope hydrology and steep angle mass wasting was going to continue.

Now that I have established the greater ramifications of hydrology to slope stability,and following in accordance to the old edict that a picture is worth a thousand words,I shall begin. As indicated on overhead-3,the green colored right angle wedge above the gravel pit is the relative position of the Oakdale Mall slopes.The blue lines are those of the major drainage systems upgrade from the Mall complex. Drainage areas-1,2,and 3 donot directly affect slope-A the east or Reynolds road slope.but,over time they do affect slope-B.However,given Mr. Phillips statement about the channel of drainage focused on slope-A,also noting the drainage areas-4 and 5,it is not hard to see why slope A could have hydrologic difficulties. Slope A quite literally acts as a focus for which all the drainage for areas 4 and 5 to come up against.

As seen on slide-one. This slump has a notable scarp now occurs just below the guard rails as well as a toe easily visible at the base. This falls more in line with overhead-one's plainer slide type (C).Slide-2 is a steeper look of the4 same slope-A during the winter.The first thing to note between slide 1 and 2 is the season.According to Morisawa mass wasting occurs most in the spring and when large amounts of rain fall.Generally speaking at any time water is on the move. Slide-3 shows this seasonal differential. Note-the single guard rail on slide-2 taken 3/6/86 just prior to spring thaw. Now look at slide-3 taken 8/28/86.Note-how the winter guard rail on slide-2 had been dragged down slope leaving a situation upon which a second guard rail had to be installed above it. The movement is probably some two feet.

To continue on with the hydrology problem of slope-A. Note-how on slides 4 and 5 the activity of water is such that the foundation of the sidewalk has virtually been eroded away.And.that concrete was added to the guardrails to keep them standing. Look how even that is being pulled down slope.

I now shift the focus from slope A to slope B. Notice on slide-6 and 7 the active scarp system developed at the head of this slide,and that a toe is visible.This is more readily seen on slide 6 than on slide 7.This is the only slide element to be found on slope-B,or the north slope.The reasons for this element is again,water on the move.Only the cause differs from the other slope in that it has a greater surface flow due to the hydrous upslope barriers and the highly impermeable nature clay exhibits as Morisawa suggest. Note-the house on the upper right of slide-6. This is the one the Mall had purchased and is now rented out. The property was purchased to aide in the solution of slope-B.

I have been discussing mass wasting problems associated with the slopes behind the Oakdale Mall. These problems led up to a series of corrective measures that needed to be taken by the Mall,and this was done in 1987.The Mall hired Langan engineering and Kerr construction to do the work. We have seen to some degree how the slopes were.Now,I will discuss changes,and what was done.

For the north slope.Having bought the property above the north slope,the Mall installed a series of two drainage ditches running parallel to the long axis of the top of the slope. One of which is illustrated on figures 2,3,and 4.The other was added some time after the total work was done. The next steep was to clear out existing debris from the slide area as seen on slide-9.Note-the pills of fill to be added. At this point a six inch perforated PVC pipe was layed parallel with the slope,and approximately half way up,wrapped in filter cloth.This was done to allow quicker drainage of the slope.The slope was repacked and redressed to an angle of 25 degrees,as noted on figure-3,and slide-10.

Like the north slope. Slope-A,the east slope was treated in similar fashion. First cleaning out the old slide refilling it later with new material.Figure's 1,5,and 7 show it's angle and PVC conduit.UNlike slope-B,slope-A had existing drainage systems above and parallel to the slopes as illustrated on figures 5,7,and 10. Mr. Phillips stated that the existing underdrain was changed from the pipe that is noted on figure-10 to a fill of lose rocks housed within the dementions of the dotted line. This he said would allow for greater drainage.Which he said it did.But,he added it only helped to further exacerbate the problem.Instead of carrying water away from the site,it only served to bring more water to it.A problem we will see later in slides 24 and 28.

Slide-11 shows the finished slopes.But whats this a it's base,it is a gabion. According to websters unabridged dictionary. Gabion is (a cylinder of metal mesh filled with earth or stone used in building foundations).The use of a gabion is an engineering principle.If you lift the base of a triangle at the point where the hypotenuse and adjacent join you serve to decrease the angle of the slope adding to it's stability.

As a forethought to the gabion seen in slide-12 is the installation of the stone underdrain of the north slope.This aides in the transit of water. This structure is illustrated in figures 1,3,4,5and 7,and is shown parallel to the base of both slopes.

The gabion construction is as follows;First like the rock drainage system.The gabions are recessed into the earth.In this case by some two feet.The wire mesh is first put into place and then filled with the appropriate stone or debris. There is a space between the slope and the mesh to allow workers access,which is later filled to gabion height.But before this is done a filter cloth is layed between the slope and the gabion. Note-on slide-13 the apparent bend in the gabion.This bend is intentional and can be shown on figure's 4 and 5 at point 7+00. The entire gabion array was erected at right angle's to the ground.the gabion construction is shown on slides 13 to 16.

Another step taken,but not directly seen in slide-11 was the laying of the filter cloth.This is a water permeable resistant layer. This is a surface that water can easily penetrate while becoming a layer plants can bind to readily.The cumulative intertwined layer of roots,it was hoped,would form a surface resistant to the slopes downward trend.The truck in the upper left hand corner was offloading cobble stones to be used as a base for the soil that was later put on top.Mr.Phillips said that to everyones surprise,the stones didnot freely tumble down slope. He said they had to rig a cross beam with chains on both sides to literally drag the stones down the slopes with. This beam can be seen if you look closely on slide-18 midway up the grade where both slope join in the center.It appears as a nearly horizontal dark line.

Now I come to a transitional zone from slide-18 which was in 1987,to,slides-19 through 29 which were taken on 12/1/91. This brings us now to the present. This is the time questions are asked like how are the slopes doing after four years.To try to ascertain this data had to be acquired on pertinent slope locations that typify angles taken. These angles and locations are recorded on figures 4 and 5.I took a yard stick and layed it on a part of the slope in the area of the circles noted.Pointing the yardstick down slope perpendicular to it's base. I then used a geologic compass to measure the angle's taken.With the aide of a S.U.N.Y.

professor Peter Knupier,I then applied the numbers taken to the slope stability formula(Ritter-129).The formula and calculations can be found on tables 1 through 6.

Comparing slides 11 and 20 one can see the effects of erosion. When the slopes were completed in 1987 the central joint as seen was fairly straight. Now a drainage system is under evolvement. As is typical of any drainage system it is steeper at the head than at it's base. Note-the concave bend up on slide-20,and the angles recorded on figure-5.The bend at it's base to where I point is 23 degrees.Upgrade near the top is 30 degrees.As indicated by the calculations on table-4,b and 3,a the slope is within the stability range.3,a might be considered borderline stable.

After repairing the slopes in 87,guess what is back in 91,slope failure.Take notice of slides 21 and 22. This shows the slide structure now underway again in the same place again as seen on slide 6 and 7. This time there is a twist. There are two drainage systems that come off the top of the slope and come together into a V structure.At this point a catch basin forms on what appears to be a shelf system on an parallel to the slope.In slide -21 I am standing in the catch basin.This drainage system comes over the top of the catch basin forming the steepest location on all the slopes at 40 degrees.This angle is radically unstable. Noting it's position on figure-4 cross referenced in the table,now look at the gabion on slide 20 and question why it is fully erect.

The upper slope above the catch basin is 26 degrees and is stable according to table 3,b. I consider this to be a scarp similar to position S1 on overhead 1,c. In my opinion the head of the slide is building up to some critical point beyond 40 degrees. This may let go in a single event or topple like in overhead 1,e. Now off to the east slope.

After reconnoitering the east slope I now assert that a much deeper process is at work than that of the slide developing on the north slope.In fact the old slope before the repair as seen on slide-1 typifies a slide as illustrated on overhead 1,c. Note on slide-1 how the toe extends over the parking lot and does not appear to breach underneath it. Now look at slides 23 and 24. Note-the toe on each slope element.Slide 23 has the position 7+00 on figure 5. Slide 24 has the position of B-8 on figure 5.Note-how in both slope elements the toes have effectively breached under the gabion.In fact the appearance of these toes are more typical of a rotational type of failure as is illustrated on overhead 1,f. Upgrade is a scarp system developing unaffected by corrective measures.

Morisawa stated that it would had been better if they had just cleaned up the old slide,and not refilled the slope. This according to her was because nature had already dealt with the problem. Now man comes along and recreates the problem the nature had just fixed. The worst of the east slopes elements is illustrated at position A,9 on figure 5.On table 5,a calculations show this slope to be unstable. The element immediately south of the above angle is found to be within stable parameters as table 5,b shows. However,given the special hydrology of the slope even this is unstable as is shown by photograph.

Slides 25 and 26 shows the movement of the gabions on both slopes.As is seen on the north slope slide 25 has had virtually no movement.The east slope on the other hand,slide 26,was found to be tipping 26 degrees. at some time in the future as the slope continues to move this gabion will fail.

The next two slides 27 and 28 shows me indicating the position and relative height of the east slopes upper scarp. Both slides show a back drop of the upper retaining wall that was installed subsequent to slope restructuring.This retaining wall was added to try to stabilize the upper slopes scarp failure as indecated by slides 3 and 4. This was done by drilling 10 to 20 feet holes. then sinking 10 to 20 feet beams into the slope as illustrated by figure 9,a & b.Mr Phillips said that through these beam 50 foot holes were drilled at an angle back through and under the road so as to install a series of tie backs.An illustration of how this was don is shown on figure 10. Each tie back was then tested up to a sustained 2650 psi as table 7 shows.A detailed graph on how these tie backs are anchored can be found on figure-11.The cost of this retaining wall was 330,000 dollars.

The problem of this retaining wall at this time is water and it's effect. Note - on slide 28 just after the second beam is the water leaching through the wall.Also given the fact that these beams were originally set in line as illustrated on figures 9 and 10. It would seem as if the third beam is pulled out at the base.This in my view is an much deeper process than that of earlier time before restructuring.Perhaps this is due to the greater amounts of water present a few feet away in the other side of the wall in the underdrain that was overhauled as previously discussed,and shown on figure 10.Morisawa said that this didnot surprise her a bit,and that in her opinion these beams serve only to form channels for water to follow all the way to their base.

The final slide,# 29 was taken under an assumption.I am pointing to an area about midway across the road between the double yellow lines and the curb.This is the notorious crack that has developed in the road way.This is parallel to ,and I believe associated with,the upper portion of the slope. Where the upper boundary of fill meets the glacial till.This is illustrated on figure 7.Both Phillips and Morisawa stated that traffic conditions are aiding to exacerbate slope failure by the repeated pounding and vibrations added to the upper portions of the east slope. If conditions were to arise to catastrophic failure. I am talking about the kind illustrated on overhead 1,f. Then,it would be most probable for this crack to be the point of separation between the head of the slump and the scarp.

Also to note-comparing old slides to new I would say at least the Oakdale Mall got it's money's worth out of the filter cloth. The vegetation is all fairly uniform and intact in the present slides over the old.

Mr. Phillips didnot have on hand the total cost of.all the work done to stabilize the slopes.But,he knew for certain the cost of the upper east slope retaining wall.He estimated all cost well over the million dollar mark and he added that more money was certain to be spent.

ADDITION-note the western limb of the north slope on figure 4. It is speculation given the angle of 32 degrees,but,as the tables show this area should be undergoing some form of failure. However,the area above grades off to expedite drainage,and the overall mass of the slopes is visibily quite less. this is the reason I suspect slope failure has not occurred.

## SUMMARY

I have discussed and introduced the ramifications of mans violation of natural laws in such areas as mass wasting. I have chosen and discussed one such violation,the north and east slopes developed north of the Oakdale Mall complex in Johnson City N.Y..I have taken a sequential look at the problems and solutions taken by way of photographic slides,graphical figures,overhead projections,mathematical slope stability formula tables,and introduced people who have been closely associated with these slopes in the past. While adding their comments and thoughts when appropriate.

Through out the presentation I have shown the kind of slope failure that typifies mass wasting. The first 7 slides shown the problem in 1986. the next 11 slides shows a progressive means about how the work was done and by who.The last 10 slides were taken on 12/1/91 to show present conditions.This led me to a situation of disfavorable results.

## CONCLUSION

The problems seen here and discussed in terms of mass wasting are becoming more common place as man continues to develop.Man in it's zeal to progress has a tendency to overlook the long term ramifications of geomorphic processes. The slopes at the Oakdale Mall complex is but one example of how man struggles to defeat the cumulative forces of nature. Although temporarily successful,I have shown to some degree how water in conjunction with gravity can prove irresistible in the long run.And, that these can act differently as contrasted between the north and east slope.

To focus my conclusion I state that differences exist in the hydrus aspect between the north and east slope.The north slope being more compact till and having effective upslope parallel drainage except at the point just above the catch basin,is exhibiting more of a plainer type slide than that of the east slope. The east slope,having shown that it is in effect a focus of hydrus activity through upgrade and man made drainage,has visible signs leading toward a much deeper problem illustrated by overhead 1,f. In my opinion,an imminent rotational type of failure is in the works. One thing is certain.Natural laws have the patience to win out over time,despite mans developmental prowess.

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# PROBLEM SOLVING

across the curriculum

Lardy—

Thanks so much for lending me this paper and giving me the slides. I do use them in class.

Sorry it took me so long to return it.

Good luck in all your future studies, etc.

Karen Goodman

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