"PREVENTION OF SOIL EROSION IN HILLY REGIONS USING JUTE FOOTRUBS MATS"

A

PROJECT REPORT

Submitted in partial fulfilment of the requirements for the award of the degree

of

BACHELOR OF TECHNOLOGY

IN

CIVIL ENGINEERING

Under the supervision

Of

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To

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HIMACHAL PRADESH, INDIA

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STUDENT'S DECLARATION

I hereby declare that the work presented in the Project report entitled **"Prevention of soil erosion in hilly region by using jute mats"** submitted for partial fulfilment of the requirements for the degree of Bachelor of Technology in Civil Engineering at **Jaypee University of Information Technology, Waknaghat** is an authentic record of my work carried out under the supervision of **Mr. Chandra Pal Gautam**. This work has not been submitted elsewhere for the reward of any other degree/diploma. I am fully responsible for the contents of my project report.

CERTIFICATE

This is to certify that the work which is being presented in the project report titled

"PREVENTION OF SOIL EROSION IN HILLY REGIONS USING JUTE MATS" in partial fulfillment of the requirements for the award of the degree of Bachelor of Technology in Civil Engineering and submitted to the Department of Civil Engineering, Jaypee University of Information Technology, Waknaghat is an authentic record of work carried out by **Jigyasu Khanna(151624), Shashi Shekhar(151647)** during a period from July 2017 to June2018 under the supervision of **Mr. Chandra Pal Gautam (Assistant Professor- Grade II)**, Department of Civil Engineering, Jaypee University of Information Technology, Waknaghat.

The above statement made is correct to the best of our knowledge.

Date: ………………

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Date……………….

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ABSTRACT

Topsoil erosion is the most common issues in today's world related to soil distresses. Soil erosion can cause contamination of drinking water, disturbs ecosystem of lakes and other water bodies and can cause landslides problems in hilly regions. It becomes necessary to prevent soil erosion by using some methods. This project discusses to prevent soil erosion by using jute mats or jute sacks in hilly regions. For this project work we have choose the nearby hill of Kandaghat which has experienced landslide in recent days. After that, we have to prepare the box model of dimensions 150cm*50cm*40cm to show all the site properties such as field density, moisture content etc. in physical modeling. Moreover, it is needed to measure slope inclination of the hill by help of theodolite surveying and prepare same slope in box model. Then, rainfall data analysis is necessary for simulation of rainfall in laboratory for this we have to take rainfall data of Solan district for last 5 years. Further then, scaling of model dimensions and rainfall data is done accordance with the need. Then simulation of rainfall must be done in laboratory by calibrating according to the scaling value of rainfall intensity and simulation of rainfall must be done by applying jute mats and steel fence as well as without applying them. After simulation of rainfall we have to measure soil erosion by the help of runoff collector method as well as we has to examine the slope changes and slope failure, if happen. Further then, if slope failure of box model not take place by applying jute mats then examine the slope changes or failure at different intensities greater than given district rainfall intensity.

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CHAPTER 1

INTRODUCTION

1.1 General: -

Land degradation reasons high erosion quotes resulting from agriculture, grazing, mining, woodland fire or deforestation and this causes monetary, social and environmental damage. However, the most important erosion charges and the most degraded soils are generally discovered in areas suffering from growth, infrastructure or urbanization. Civil engineering initiatives often result in steep slopes with naked soil, that's fantastically at risk of soil erosion, as a result of both effect powers from raindrops or by means of floor run-off. Well-set up, low-developing, dense plant life cover is able to manage soil loss via two or three orders of significance compared to naked soil conditions. The maximum decrement of erosive run-off turned into recorded on permanently grassed plots. However, the establishment of vegetation plant cover may be disrupted for the duration of early plant growth tiers, leaving the slopes uncovered to further erosion methods with poor consequences for slope balance. Soils play a vital role in most important worldwide biogeochemical cycles (carbon, nutrients, and water), even as web hosting the biggest diversity of organisms on land.

1.2 Factors Affecting Soil Erosion: -

1.2.1. The amount and intensity of precipitation: Precipitation is the most intense perspective causing disintegration through raindrops and extreme spillover of soil. Downpour drop disintegration is sprinkle, which winds up from effect of water drops, at the present time on soil. Despite the fact that the effect of downpour drops on water in shallow streams probably won't sprinkle soil, it reasons disturbance, providing an additional residue conveying capacity. On the off chance that downpour falls daintily, it'll enter the dirt wherein it activities and a couple of will gradually keep running off, in any case in the event that it happens in deluges, as for the most part the rainstorm downpours does, there isn't in every case enough time for the water to take in by means of the dirt and it keeps running off causing disintegration. Keep running off that reasons disintegration, in this way, depends on profundity, length, sum and recurrence of precipitation

1.2.2 Topography: Slope speed up erosion as it will increase speed of flowing water. Small variations in inclination make huge distinction in harm. As per legal guidelines of hydraulics, three time boom in inclination increase rate of water runoff by almost two times. This increased speed can increase strength of erosion by five instances as well as sporting potential from using thirty two times.

1.2.3 Physical and chemical properties of soil: A few soils dissolve more easily than other underneath the indistinguishable circumstances. The erodibility of the dirt is empowered by means of its surface, structure, and home grown depend, nature of day and the amount and state of salts present. There is a decent arrangement substantially less disintegration in sandy soil because of the reality water is caught up without trouble due to over the top penetrability. Progressively regular fertilizer in the dirt improves granular shape and water monitoring capacity. In sizeable, soil distinctness will development as the span of the molecule increments anyway soil transportability will increment with the lower in molecule estimate. Earth trash are more prominent extreme to segregate than sand, anyway are easily transported on a dimension land and masses additional quickly on slants.

1.2.4. Ground cover and its nature: The presence of flora cover retards erosion. Forests and grasses are more effective in supplying cover than cultivated vegetation. Vegetation intercepts the erosive hitting motion of falling raindrops retards the quantity and speed of surface run off, allows extra water flow into the soil and creates greater storage capacity inside the soil. It is the lack of flora that creates erosion permitting situation.

1.2.5 Deforestation and burning: The previously mentioned reasons are a piece of exchanging development rehearsed inside the sloping zones of northern India, especially north-eastern Indian states. When consuming obliterates trees, it likewise harms the vegetation and fauna, and effects water accessibility, for example, springs. The issue isn't any less genuine while ranchers consume crop deposits. It is through harvest buildup that supplement reusing happens in nature. The deposits amass on the dirt surface and discharge nutrients, which may be retained legitimately or in an indirect manner being incorporated into the natural be tallied. With consuming, those nutrients are almost totally lost. Another inconvenience brought about by consuming is the disposal of the conveyance of shimmering natural materials to the dirt.

1.3 <u>Need of study</u>: -

Soil erosion is a severe hassle threatening sustainability of agriculture and contaminating surface waters. Soil erosion can result in landslides trouble in hilly regions. When the topsoil is eroded from an area, that vicinity loses its maximum nutrient-wealthy layer, and consequently decrease soil quality. When soil is carried faraway from a farmer's land by water, it incorporates with it contaminants, together with fertilizers and insecticides which could reason water pollution that contaminates consuming water and disrupts ecosystems of lakes and wetlands. Soil erosion can also result in landslides and floods, negatively affecting the structural integrity of homes and roadways.

1.4 <u>Scope of study</u>: -

In order to study about soil erosion in landslide we have to perform different laboratory and field experiments such as field density, moisture content, direct shear test and sieve analysis. Moreover, we have to prepare the box model so that it can show the site characteristics. Also the site slope must be provided in physical modeling by the help of tachometric surveying. Then, collect the rainfall data and simulate the rainfall by scaling the rainfall data as per required. Now, collect the soil runoff in a cylinder container and put in oven and take the dry weight of it. This procedure must be done with or without jute foot rubs mats.

1.5 <u>Objectives of study</u>: -

The main objective of the project work is to minimize the soil erosion by using jute mats or jute sacks. For this, we need to prepare the box model having dimensions (1.5m x 0.5m x 0.4m) in which we need to calibrate the moisture content, slope and field density with the site slope and density. Then, there is need of analysis of rainfall data of the Kandaghat, Solan district from where the soil is taken and with the help of soil data simulate the soil in laboratory with the help of spray nozzle. The other objective of the project is the measurement of soil erosion by the help of runoff collector method. In this method, a runoff collector is used in which the collection of soil runoff must be taken and this soil is put in oven for 24 hours at the temperature of 105º and measure its dry weight and this method is been done by applying the jute sacks or jute foot rubs or without applying the jute sacks. Moreover, the another objectives is to check the soil erosion and slope changes or slope failure with the different intensities of rainfall by applying jute mats and steel fence if failure does not happen at the given district intensity of rainfall.

CHAPTER 2

LITERATURE REVIEW

2.1General:-

V. H. Duran Zuazo ·, J. R. Francis Martinez ·, C. R. Rodriguez Pleguezuelo ·, A. Martinez Raya ·, B. Carceles Rodriguez (2006)

Inside the Mediterranean spot the powers and measures of soil misfortune and spillover on inclining land are led by utilizing precipitation test and blooms cowl. Wild types of fragrant and vegetation have been chosen for disintegration plots to choose their viability in diminishing water disintegration on slope inclines of the Sierra Nevada Mountain (SE Spain). The disintegration plots (counting a stripped soil plot as oversee), set at 1,345 m in height, set up and had 13% slopes. the base overflow and soil disintegration cites, going from nine to 26 mm/year and from 0.01 to zero.31 Mg/ha.yr, individually, over the entire view term enrolled the absolute best rates a couple of the plant covers analyzed, spillover going from seventy seven to 120 mm yr and disintegration from 1.67 to a couple of 60 Mg/ha.yr. In the stripped soil plot, spillover extended from 150 to 200 mm/yr and disintegration from 5.46 to 8.32 Mg ha reliable with the outcomes, the most reduced developing plant covers disheartened the dirt disintegration and overflow more adequately than did the taller and open medium-sized bushes following enabled additional immediate linkage to be made among plant covers and the aversion of scraped area, with suggestions for feasible mountain horticulture and ecological assurance. The essential end that can be drawn from this examine is that the preservation or development of the vegetation with sweet-smelling, restorative, culinary and utilizes can help spare you overflow and soil disintegration on soak slants, accommodating economical rural and the natural assurance. From the impacts of the overall test the in connection to exposed soil decreased overflow by means of 80, 69, 65, 76, 59 and 39% even as disintegration by means of 95, 92, 90, 75 and 55%, separately.

This investigation gives that impact of mash strands increments on soil that are exposed to water retainment and development to look at its viability to diminish soil misfortune.

Raghuvanshi Ram, J.P. Shukla, E. Peters, S. Choudhary, K. Prasad (2009)

The paper exhibits the after-effects of a field test directed in the grounds of Propelled Material and Procedures Exploration Establishment (CSIR), Bhopal, Madhya Pradesh, India, to test the adequacy of geotextiles as a dirt disintegration control measure. Until now, there is no explicit geotextile like sisal geotextile economically accessible. Be that as it may, sisal is a locally accessible plant and the material can be created by little scale industry. Along these lines, this is a superior option material for soil disintegration control. There is a requirement for explicit data about huge parameters of such items as far as disintegration control. The outcomes uncover that treatment with sisal geotextiles in comparison with coir and jute geotextiles is an effective eco-hydrological measure to shield the precarious slant lands from disintegration. This paper examines the performance of the sisal geotextile as contrast with different geotextiles regarding soil disintegration control.

All the physical, synthetic, mechanical and field explore information demonstrate that the sisal geotextile has better degree for soil disintegration control. Subsequently, sisal geotextile might be utilized for incline adjustment and soil disintegration control. 251 Sisal providers should give dependable information giving specialized subtleties of the geotextiles offered and their normal conduct. Subsequently, near investigation demonstrates that, the sisal geotextile has extremely persuading outcome for soil and water preservation. The residue misfortune and spill over information demonstrate that the sisal geotextile assimilates more water and in this manner, the spill over and residue disintegration are less as contrast with Jute and coir geotextiles.

This study gives that effect of different materials such as coir, and sisal and their different properties on soil erosion.

T. L. Chow, H. W. Rees, S. H. Fahmy, and J. O. Monteith (2002)

The effect of joining this fabric at statements equivalent to 0.6, 1.1, 2.1, and 5.0% natural check number inside the furrow layer of a gravelly topsoil soil on chosen soil physical houses and soil disintegration become assessed. The objectives had been to decide the effect of mash fiber augmentations on chose soil homes, which may be relevant to water maintenance and movement and to assess its adequacy in diminishing spillover and soil misfortune, basic contributing ways to deal with soil corruption. Compound assessment of mash fiber discovered that each one substantial metallic fixation had been appropriately underneath suitable focuses. On the elective hand, the soaked pressure driven conductivity and specific dampness content quickened with developing expenses of cures. Results on water-solid totals discovered that the common issue in the mash fiber blended littler totals to shape vast totals, following in a bigger extent of macropores contrasted with micropores. The helpful impacts of the 4% natural be tallied treatment comprise of 2.0 occasions place off in overflow commencement, and 24and 74% decrease in spillover and soil misfortune, individually. In spite of the fact that the valuable outcomes in soil and water protection are evident, a minor drawback gives off an impression of being decline subject soil dampness content. Vast scale execution of the expansion of this fabric in potato fields must continue just with alert. In spite of the fact that the helpful consequences of the mash fiber are obvious, a minor weakness of fusing pulpfibre into the furrow layer is that it appears to bring down floor subject soil dampness content. Sufficient soil dampness is fundamental under a downpour encouraged potato generation framework. Expansive scale programming of mash fiber for soil protection in potato fields should continue with notice. This investigation gives that impact of mash fiber increases on soil that are appropriate to water maintenance and development to assess its viability to lessen soil misfortune.

R. Bhattacharyya, M.A. Fullen (2011)

Primer examinations propose organic geotextiles could be a viable and reasonable soil protection strategy, with tremendous worldwide potential. In any case, restricted quantitative information is accessible on the erosion-reducing impacts of natural geotextiles. Subsequently, the goal is to assess the adequacy of organic geotextiles in decreasing overflow and soil misfortune under controlled research centre conditions and under field conditions reflecting mainland, mild and tropical situations. In lab tests, interrill spill over, interrill disintegration and concentrated stream disintegration were mimicked utilizing different precipitation forces, stream shear stresses and incline angles. Field plot information on the impacts of organic geotextiles on sheet and rill disintegration was gathered in a few nations (UK, Hungary, Lithuania, South Africa, Brazil, China and Thailand) under common precipitation. Generally speaking, in light of the field plot information, the tried organic geotextiles decrease overflow profundity and soil misfortune rates all things considered by 46 percent and 79 percent, individually, contrasted with the qualities for exposed soil. For the field and research centre information of all tried geotextiles joined, no huge distinction in relative overflow profundity between field estimations and interrill lab tests is watched. Be that as it may, relative soil misfortune rate for the concentrated stream research centre trials are essentially higher contrasted with the interrill lab tests and the field plot estimations. Despite the fact that this investigation focuses to certain deficiencies of leading research centre examinations to speak to genuine field conditions, it tends to be reasoned that the range and the mean relative overflow profundity and soil misfortune rate as saw with the field estimations is like those as seen with the interrill lab tests.

This study gives that utilization of mats as buffer strips was very successful in conserving soil properties on a loamy sand soil.

Elisabeth Dian Atmajati, Elfin Yuliza, Hosni Habil, Imam Ahmad Sadisun, Muhammad Miftahul Munir (2016)

To decide the critical values of the measured physical parameters or take a look at the early caution system itself, a laboratory scale model of a rotational landslide turned into advanced. This rotational landslide model had a size of 260×40×35 cm^3 and become geared up with soil moisture sensors, accelerometers, and automated size gadget. The soil moisture sensors had been used to decide the water content in soil sample. The accelerometers have been hired to detect movements in x-, y-, and z-direction. Consequently, the drift and rotational landslides had been predicted to be modeled and characterized. The evolved landslide version could be used to evaluate the results of slope, soil kind, and water seepage on the incidence of landslides. The existing test showed that the model can display the prevalence of landslides. The presence of water seepage made the slope crack. As the time went through, the crack became bigger. After comparing the obtained traits, the be fell landslide become the drift type. This landslide took place while the soil sample changed into in a saturated situation with water. The soil actions in x-, y-, and z-direction have been additionally observed. Similarly experiments need to be executed to recognize the rotational landslide.

A laboratory scale version of a rotational landslide has been advanced. This model had a size of 250×45×40 cm^3 and it's far geared up with accelerometers, soil moisture sensors, and an automated size gadget. From the test, it became discovered that the model can display the incidence of landslide. The presence of water seepage made the slope crack. As time went by way of, the crack became bigger. Consistent with the traits acquired, the be fell landslide was categorized because the go with the flow kind. This study gives that model had a dimension of 250×45×40 cm^3, the model can show the occurrence of landslide.

Leo Stroosnijder (2005)

A handicap for the manipulate of the insidious erosion method is the issue of determining its significance. Four reasons are regularly cited inside the literature: the large temporal and spatial variation of abrasion, the paucity of accurate erosion measurements, the trouble of extrapolating facts from small plots to higher scales and the conversion of abrasion into production and economic gadgets (effect).This paper gives a crucial evaluation of current measurements strategies for erosion at unique spatial and temporal scales. Examples are supplied of techniques for direct measurements in addition to for indirect measurements, i.e., measurements of soil properties that serve as enter for models. The paper is concluded with a crucial assessment.

It is the creator's feeling that there is an emergency in disintegration estimations in light of the fact that there are deficient observational information of satisfactory quality, an absence of assets to improve that circumstance, an absence of improvement of new innovations and hardware and an absence of gifted work force. Because of their high information request and the narrative absence of good information disintegration forecast models frequently use input information which are assessed or got from (experimental) pedotransfer capacities. Subsequently, albeit numerous disintegration models are named deterministic they may be called experimental too.

This study gives that change in weight and change in slope are the best suited method for measurement of soil erosion.

Askarinejad, J. Laue, A. Zweidler, M. Iten, E. Bleiker, H. Buschor, S.M. Springman (2012)

A sequence of small scale bodily modeling exams is achieved in a geotechnical container centrifuge so as to analyze the triggering mechanisms of landslides due to rainfall. They may be conducted beneath controlled conditions of rainfall depth and period, ambient relative humidity, wind, and temperature. Those tests had been designed to look at the feasible failure mechanisms proposed for a complete scale landslide test. Accordingly, distinctive shapes and hydraulic properties of the bedrock, in terms of drainage and ex filtration, are supplied for the model. A three dimensional near range photogrammetric approach is used to song the actions and monitor the volumetric changes of the floor at some point of the cycles of wetting and drying. The slope elevation is filmed throughout and following the rainfall activities the use of an excessive pace digital camera.

Two landslide triggering experiments have been conducted on a natural slope in Switzerland. The primary test was not a success in terms of triggering a landslide, even though higher common rain depth for an extended length became applied to the slope. At the contrary, inside the 2d experiment a landslide changed into brought about on the same slope however with specific distribution of the rain awareness. Controlled situations of rainfall intensity and duration collectively with temperature and relative humidity are supplied in this chamber to examine the hydrological and mechanical responses of the slope to one-of-a-kind cycles of wetting and drying. Detained examine of pore water pressure, rate of change of slope, volumetric strains are recorded to provide conclusions regarding the soil erosion.

Mahuya ghosh, P.K. chaudhary, Tapobrata Sanyal (2009)

Characteristic filaments, similar to jute, coir, sisal, and so on have many intrinsic properties fit to meet the prerequisites of various kinds of geotextiles. Shorter sturdiness of regular geotextiles involves clear worry of end-clients when all is said in done, however their eco-similarity gives them an edge over man-made geotextiles. Accessibility of jute in plenitude, particularly in the eastern locale of the Indian sub-landmass, its spinnability and different highlights supported by more-than-exceptionally old ability of jute processes in making an assortment of textures should betoken a promising fate of Jute Geotextiles (JGT). This paper shows a few insights about use of JGT. Plus, utilization of other normal geotextiles and related investigations discovers notice in the paper. Furthermore, some new yet novel regular fiber-based geotextiles created to meet run of the mill end-use necessities have additionally been talked about.

With regards to 'Worldwide Year of Normal Strands (2009)' and modernization of framework in India, use of regular filaments in various national plans is pulling in support. In any case, there is have to create logical research based new characteristic geotextile items just as their advancement for commercialization. These are the main courses for the common item producing industry to achieve a similar stage as those effectively involved by engineered industry.

R. D. Lentz,* I. Shainberg, R. E. Sojka, and D. L. Carter(1992)

The objective of this examination was to decide if low groupings of anionic polymers in water system water would obviously decrease water system wrinkle disintegration on residue soil , a exceptionally erodible soil. Wrinkle slant was 1.6%, wrinkle length was 175 m, what's more, water system rates run from 15 to 23 L downpour 1. Inflow amid the first 1 to 2 h of the first 8-h water system was treated. Resulting water systems were untreated. Polyacrylamide (PAM) or on the other hand starch copolymer arrangements were infused into water system water entering wrinkles at fixations of 0, 5,10, what's more, 20 g m-3. Dregs misfortune from polymer-treated wrinkles was fundamentally less than that of control wrinkles in the first(treated) what's more, second (untreated) water systems, be that as it may not in the fourth (untreated). The PAM given better disintegration control than the starch copolymer. Viability of PAM medications shifted depending on its fixation, span of wrinkle presentation, what's more, water stream rate. In the beginning (treated) water system what's more, at low stream rates, 10 g m-9 PAM diminished mean dregs load by 97 looked at with untreated wrinkles. Leftover disintegration decrease in a resulting water system, moving forward without any more expansion of PAM, was around half. The PAM expanded net invasion what's more, advanced more noteworthy parallel invasion. Compelling disintegration control was reachable for a mama trial cost beneath $3 ha-1 irrigation'1.

Previously, utilization of polymer applications to improve soil reaction has not demonstrated conservative at the homestead scale. The extent of this fundamental examination is restricted to soils watered, yet it has shown a potential monetary utilization of polymers, i.e., the use of polymer in water system water for decreasing wrinkle disintegration. We stress the need for extra explore on these also, other soils, also, under other conditions, to decide regardless of whether this strategy is for the most part relevant. Our outcomes demonstrate that anionic PAM was more viable than anionic starch copolymer for controlling wrinkle disintegration under our exploratory conditions.

Jana Kalibová, Lukáš Jaˇcka, and Jan Petr (2016)

Vegetation spread is observed to be a perfect arrangement to most issues of disintegration on soak slants. Biodegradable geotextiles have been demonstrated to give sufficient assurance against soil misfortune in the period before vegetation achieves development, so supporting soil arrangement forms. In this examination, 500 gm jute (J500), 400 g m2(C400), and700 g m2 coir (C700) GTXs were first introduced on a 9 slant under "no-infiltration" research facility conditions, at that point on a 27 slant under characteristic field conditions. The effect of GTXs on run-off and soil misfortune was researched to look at the execution of GTXs under various conditions. Research facility run-off proportion (rate part of control plot) equalled 78, 83, and 91 %, while top release proportion equalled 83, 91, and 97% for J500, C700, and C400 individually. In the field, a run-off proportion of 31, 62, and 79 %, and top release proportion of 37, 74, and 87% were recorded for C700, J500, and C400 separately. All tried GTXs significantly diminished soil disintegration. The best soil misfortune decrease in the field was watched for J500 (by 99.4 %), trailed by C700 (by 97.9 %) and C400 (by 93.8 %). Independent of slant inclination or exploratory condition, C400 performed with lower run-off and crest release decrease than J500 and C700. The execution positioning of J500 and C700 in the lab contrasted from the field, which might be clarified by various slant inclinations, and furthermore by the job of soil, which was excluded in the lab test.

Jute and coir GTXs tried in this examination can significantly defer the commencement of surface run-off under the mimicked precipitation, at the point when contrasted with control plots (uncovered soil in the field, impermeable plastic film in the research center) without GTXs. Control plots would in general produce significantly higher run-off volume [L^3], release [L/s], and soil misfortune [g] than GTX treated plots. In the research facility, jute J500 demonstrated an expanding pattern of run-off control, not at all like coir GTXs, the execution of which bit by bit diminished. Further examination is expected to demonstrate regardless of whether this conduct likewise shows up in the field. Notwithstanding the conditions (slant, research center versus field), coir C400 appeared to be less viable

Lubos Mitas, Helena Mitasova(1998)

Soil disintegration is a basic ecological issue all through the world's earthbound environments. Disintegration dispenses numerous, genuine harms in oversaw biological systems, for example, harvests, fields, or woods just as in characteristic environments. Specifically, disintegration diminishes the water-holding limit in view of fast water overflow, and lessens soil natural issue. Subsequently, supplements and profitable soil biota are transported. In the meantime, species assorted variety of plants, creatures, and organisms are altogether decreased. A standout amongst the best measures for disintegration control and recovery the corrupted previous soil is the foundation of plant covers. Without a doubt, accomplishing eventual fate of safe condition relies upon rationing soil, water, vitality, and organic assets. Soil disintegration can be controlled through a procedure of appraisal at provincial scales for the advancement and reclamation of the plant spread, and the presentation of protection measures in the regions at most serious hazard. In this manner, preservation of these imperative assets needs to get high need to guarantee the successful insurance of oversaw and normal biological systems. This audit article features three majors themes: (1) the effect of disintegration of soil profitability with specific spotlight on atmosphere and soil disintegration; soil seal and outside improvement; and C misfortunes from soils; (2) land use and soil disintegration with specific spotlight on soil misfortune in rural terrains; bush and backwoods lands; and the effect of disintegration in the Mediterranean terraced grounds; and (3) the effect of plant covers on soil disintegration with specific spotlight on Mediterranean components influencing vegetation; plant roots and disintegration control; and plant spread and biodiversity

Robert J. Loughran(2016)

An article in the diary of the Australian and New Zealand Association for the Headway of Science, Search (Beckmann and Coventry, 1987), compared soil disintegration misfortunes in Australia to 'wasted withdrawals from a reducing account', yet no place referenced what rates of soil misfortune were knowledgeable about Australia. While roughly one portion of Australia's agrarian and peaceful lands are said to require security from disintegration (Anon, 1978), the setting of preservation needs in any case requires a learning of the spatial variety of soil disintegration status. Australia isn't the only one in this circumstance. 'There is as yet a need of exhaustive information in numerous nations ashore assets, the degree of debasement that has effectively occurred, and likely dangers later on' (Hauck, 1985). Walling (1982) has focused on the requirement for a straightforward method for estimating the fleeting and spatial circulation of long haul soil misfortune for seepage bowl studies, and data on rates of soil disintegration are required to adjust what's more, test the different soil-misfortune models now accessible. This article audits propels in the estimation of soil disintegration under regular meteorological conditions amid the most recent decade.

Procedures for estimating soil disintegration by water and wind can be isolated into plots and traps, looking over techniques for different kinds and tracers.

Joongdae Choi, Ye-Hwan Choi, Kyoung-Jae Lim and Yong-Cheol Shin(2005)

This paper examines soil disintegration instruments, factors influencing soil disintegration, the ebb and flow status of soil disintegration, and the effects of soil disintegration on water quality in Korea. Little and substantial spillover plots and field-scale observing strategies with or without precipitation reenactment were clarified dependent on the inquires about performed in Korea. In one of the investigations, no surface spillover was seen at the secured plots while 71.8% of surface overflow happened in the uncovered soil plots. This extreme contrast in overflow was broke down as the fundamental driver of soil disintegration control. A precipitation recreation spillover plot (5 m x 30 m) test on the sandy topsoil soil with 28% incline yielded a dregs of in excess of 70 t/ha from a precipitation reproduction of 40-minute, 50-mm precipitation. This implied dregs releases from the precarious slanting snow capped uplands may create substantially more than 70 t/ha/yr.

Soil erosion systems, factors influencing soil disintegration, the ebb and flow status of soil disintegration, and the effects of soil disintegration on water quality in Korea were quickly depicted. Little and huge spillover plots and field-scale observing techniques with or without a precipitation recreation were clarified dependent on the looks into performed in Korea. Soil disintegration control procedures that can be connected to soak inclined uplands in the elevated territory were assembled into the accompanying three classifications: authoritative framework approach, advertising and preparing, and specialized methodology. Fundamental hypotheses and standards for soil disintegration control, one of a kind qualities of the upland societies in the high territory, and proposals and recommendations to lessen soil disintegration from inclining uplands were made for every classification.

A. Balasubramanian (2017)

Soil erosion is a characteristic procedure in which particles of soil are moved by wind and water, and uprooted to another area. At the point when disintegration happens normally, soil is migrated at about a similar rate it is made, so no mischief is done to the earth. Disintegration is one of the greatest worries of earth's property surface. It impact affects rural creation and furthermore in all designing and development businesses. Disintegration can be brought about by numerous reasons, and each circumstance has a particular arrangement relying upon the seriousness of the issue. The target of this report is to feature the different strategies that can be utilized to control soil disintegration and the dirt protection rehearses that are required for issue soils.

Erosion is the loss of soil. As soil disintegrates, it loses supplements, obstructs streams with earth, and in the long run transforms the region into a desert. In spite of the fact that erosion happens normally, human exercises can aggravate it much. Erosion can turn once solid, dynamic land into dry, dead landscape and further reason avalanches and mudslides. Erosion can be controlled effectively on a building site when the correct methods, instruments, and strategies are utilized at the perfect time. The most normal and viable approach to avoid erosion control is by planting vegetation. Roots from plants, particularly trees, grasp soil and will adequately anticipate the abundance development of soil all through the ground. Another well known erosion control technique is the utilization of a sediment fence. A sediment fence is a long texture boundary that is introduced along a slope, and gathers any storm water that would convey free soil. Another powerful procedure utilized for soil erosion control is erosion control tangling. Erosion control tangling is laid over free soil and is verified into spot.

C.A. A. CiesiolkaA, B.YuB, C.W. RoseB, H. GhadiriB, D. LangC, C RosewellD (2004)

Soil erosion experimentation around the globe regularly utilizes field overflow plots from which spillover and soil misfortune is gathered. Volume of the gathered water-silt blend is generally so extraordinary that sub-examining strategies are required to gauge all out soil misfortune in any erosion occasion. It has been demonstrated that the usually utilized strategy including a gathering tank, fomentation of the water-silt blend and after that sub-testing can prompt genuine under-estimation of absolute soil misfortune. This paper traces and outlines a pragmatic, straightforward technique for decreasing the blunder by timing any slack that happens between fruition of mixing and test accumulation, and estimating the settling speed qualities of the dregs included.

Rorke B.BryanShiu, HungLuk (1981)

Tests from three Canadian Gray-Brown Luvisols were exposed to reproduced precipitation in a little research facility erosion plot. Albeit extraordinary consideration was taken to control every single main consideration known to impact erosion, impressive variability in wash misfortune, sprinkle misfortune and overflow was seen amid 60-min precipitation tests, with coefficients of variety running up to 28.8%. Endeavors were made to disconnect the wellspring of inconstancy by inspecting precipitation power, mass thickness, different total size and steadiness parameters and surface micro relief. The outcomes propose that a significant part of the watched fluctuation is identified with complex associations of collection, micro relief, overflow and downpour sprinkle. A portion of these co operations were analyzed in detail. The trials propose the presence of a natural inconstancy in soil erosion thinks about which is troublesome or difficult to dispose of. Results were utilized to plot bends demonstrating the expansion in exactness of soil erosion expectation with expanded test replication under controlled trial conditions and changes involved with expanding test span.

Choi, Bong-Su,Lim, Jung-Eun,Choi, Yong-Beum,Lim, Kyoung-Jae,Choi, Joong-Dae,Joo, Jin-Ho,Yang, Jae-E., Yong-Sik (2009)

Surface overflow and erosion are in charge of broad misfortunes of top soil and agrarian efficiency. In this examination, a research center analysis was led to explore the impacts of various polyacrylamides (PAM) on the assurance of soil from erosion and turbidity in loamy sand soil. To achieve this, 10 and 40 kg

h a − 1 of PAM were connected to the dirt surface. The impacts of precipitation on 10 and 20% inclines were then assessed in the research facility utilizing a precipitation test system. After air drying, the surface was exposed to rain at 30 mm /h r . The silt and clay of the overflow from tests treated with 10 kg PAM/ h a diminished by 43% and 13% when the 10% and 20% inclines were assessed, individually, when contrasted and the faucet water without PAM treatment as control. The mean substance of silt and clay were diminished as the measure of PAMs connected expanded at the two slants. In particular, examples treated with 40 kg PAM/ ha indicated decreases in the silt and clay of the overflow to 88% and 85% when the 10% and 20% slants were assessed, separately, when contrasted with control. Besides, the mean turbidity of spillover in the 40 kg PAM /ha treatment was decreased to 94.7% and 84.8% when the examples were exposed to 10% and 20% slants, separately, when contrasted with the control. Taken together, these discoveries show that PAM treatment will improve water contamination and agrarian efficiency on inclined land through a decrease in soil erosion.

CHAPTER 3

MATERIALS AND METHODS

3.1 General:-

The main aim of this chapter is to represent the laboratory methods employed in this study.

The experimental ―methodology for this chapter was divided into three parts:-

- Part one dealt with the testing of soil properties in laboratory as well as on field
- Part two was to prepare box model and analysis of rainfall data of the Solan district
- Part three was to do scaling of model area and rainfall data and then simulate the rainfall in the laboratory

3.2 Materials Selection:-

3.2.1 Soil:

The selection of soil is of the Kandaghat hill as there is landslide on that hill due to soil erosion .The Northern Hills are underlain via sandstone, siltstone and shale of Tertiary ages. The soils developed on these discern materials are brown in shade, generally loamy in texture and very strongly acidic in reaction. Steep landscape and soils have been specially evolved on steep slopes and some occur on extra mild slopes. Soils subject to erosion having topsoil with low content of clay. Soils are permeable in nature and due to presence of low clay content at the topsoil they have low water-holding capacity .Soil that is used for the project is having c-Φ characteristics. Soil is taken for the project by clearing the top layer of site of about thickness of 30cm since the top layer of soil must contain some unwanted materials which is not necessary in project work and moreover this can cause error in experimental reading during performing experiments as well as sometimes top layer soil properties does not resemble with the remaining soil of area.

Fig 3.2.1: Hill soil

3.2.2 Jute mats:

Since the jute mats can be used as a waste materials or scrap material in prevention of soil erosion. The properties of jute mats to make it selection for prevention of soil erosion are:-

- Jute mat is biodegradable, environment friendly and recyclable.
- Jute mats can be used to filter the rain water without runoff of the soil and prevent soil erosion as well as slope failure of hill.
- Jute mats have good coverage to all terrains and even slopes of hills.

Jute mats that are used for the soil erosion prevention must have void size less than soil grain size so that it can prevent soil runoff from the hill. Otherwise, the soil particles are also move with the water which will cause more soil erosion. Jute mats is better material for prevention of soil erosion since we have discussed in previous chapter that pulp fibers, coir fibers and potato fibers have some demerits in it as pulp fibers can only be used in sandy loamy soil, potato fibers cannot be used at large scales and coir fibers is not so effective in prevention of soil erosion in hilly regions.

Fig 3.2.2: Jute mats

3.2.3 Steel box frame:

The preparation of box model is very essential for the physical modeling in soil projects since for modeling we have to maintain all the characteristics and box modeling is the only method for showing all such characteristics in box model. For preparing of modeling of hill a box model is prepared having dimension of (1.5m x0.5m x0.4m) so that it can show all the site characteristics like water content, field unit weight and slope characteristics. The proper slope must be provided at the base of steel frame so that soil runoff can be collected in a runoff collector. For dimension of steel box frame we have take the reference of some research paper which is already discussed in previous chapter and further then we have take average of all such dimensions and then the dimensions of box model is finally concluded and moreover for the slope at the base of the frame the idea is also taken from the research paper.

Fig 3.3.3: Steel box frame

3.2.4 Steel fence:

In order to hold jute mat, in position on soil the steel fence is been provided over the jute mat. Steel fence must be corrosive resistant, durable and less maintenance as well as installment cost. Moreover, steel fence must be water resistant so that it remains prevented from rainfall. Steel fence hold in position by the use of anchor pins.

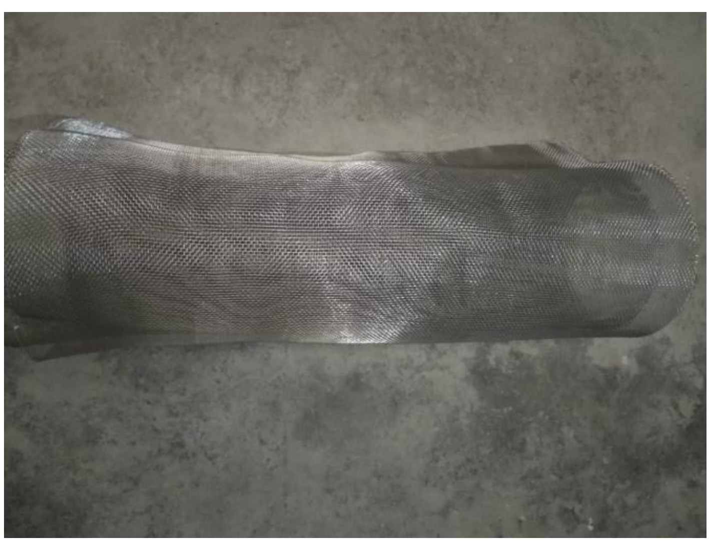

Fig 3.2.4: Steel fence

3.2.5 Anchor pins:

The U- shaped anchor pins is used to attach the steel fence with jute mat. The anchor pins used of such thickness so that it can hold the steel fence gently i.e., the thickness of anchor pins must be just less than void size of steel fence. Steel pins are angled at ends for easier and faster installment in fence.

Fig 3.2.5: Anchor pins

3.2.6 Spray nozzle:

A spray nozzle is a device that enables dispersion of liquid into a sprig. Nozzles are used for 3 functions: to distribute a liquid over a particular area, to increase liquid area, and create effect force on a solid surface. An extensive sort of spray nozzle applications use a number of spray traits to explain the spray. All size of spray nozzles are manufactured for the basis of laboratory conditions. For simulation of rainfall in laboratory, a spray nozzle must be provided. Spray nozzle is connected to water regulator so that it can be regulated according to the intensity of rainfall of the area. The opening size in spray nozzle must be sufficient so that it resemble the rainfall drop characteristics.

Fig 3.2.6: Spray nozzle

3.2.7 Runoff collector:

For collection of soil runoff during rainfall on model a runoff collector is been used. In this project, runoff collector is cylindrical in shape. Soil runoff is collected in runoff collector after that soil is separated by sedimentation and put in the oven and weighs its dry weight.

Fig 3.2.7: Runoff collector

3.3 <u>Testing on soils</u>:-

3.3.1 Water content:

Water content can be tested according to ASTM D 2216-92. Moisture content of soil can be defined as the ratio of weight of moisture in soil to that of the weight of dry soil. Oven drying method is the most accurate method so therefore it is used in laboratory. For determining the water content of the soil take an empty container and weigh it and let the weigh be W_1gm. Then, take a soil sample in a container and weigh it and let the weigh be W_2 gm. Then, put the container in the oven at temperature between 105-110ºC for 24 hrs. Take out the container and weigh it on weighing balance and let the weigh as W_3 gm.

Water content for the soil is given by:-

Water content of soil= $\{(W_2-W_3)/ (W_3-W_1)\}*100$

Fig 3.3.1: <u>Water content determination</u>

3.3.2 Particle sieve analysis:-

Particle sieve analysis can be tested according to IS: 2720 (Part 4) – 1985.

Wet sieving is a method used to assess particle distribution size or gradation of coarse grained particles. The sample is dried in the oven at a temperature of $110^0 \pm 5^0$C to obtain dry mass and the sieves that are to be used in the analysis should be cleaned. The oven dry sample is weighed on weighing balance. Each sieve is shaked for a time of at least 2 minutes. On completion of shaking of sieve, weigh the materials retained on each sieve. Further then, the percent retained (%), Cumulative retained &finer percent is calculated.

Percent retained on each sieve = Weight of sample retained on each sieve / weight of sample used

The cumulative percentage retained is calculated by using adding percent retained on every sieve as a cumulative system. The finer percent is calculated via subtracting the cumulative percent retained by 100 percent. The sieve evaluation result is shown graphically on a semi log graph, taking size of sieves on log scale on x axis and finer percent in arithmetic scale on y axis

Fig 3.3.2: Particle sieve analysis

3.3.3 Soil specific gravity:

IS: 2720 (Part 3) – 1985 is used for specific gravity test on soil using pycnometer method.

Specific gravity can be defined as the ratio of density of a substance to that of density of reference material in same volume. Specific gravity lies between the range of 2.65 to 2.85 and if soil has organic materials then specific gravity may lie below 2.0. The Pycnometer method is used for determination of specific gravity of soil particles of both fine grained and coarse grained soils. The determination of specific gravity of soil will help in the calculation of void ratio, degree of saturation and other soil properties. Pycnometer is a glass jar of 1 liter capacity that is fitted at its top by a conical cap made of metal. It has a screw type cover on top of it. For determination of specific gravity of soil take an empty pycnometer and weigh it. Let the weigh be W_1 gm. Then, put the oven dry soil in pycnometer and then weigh it and take it as W_2 gm. Further, weigh the pycnometer with oven dry soil and water and take it as W_3 gm. Then, weigh the pycnometer with full of water and let it as W_4 gm.

The soil specific gravity (G) is calculated by using the following equation:-

$$\textbf{Specific Gravity, } G = (W_2 - W_1) / \{(W_4 - W_1) - (W_3 - W_2)\}$$

Where,

W_1= weight of pycnometer only

W_2=Weight of oven dry soil and pycnometer

W_3=Weight of oven dry soil and water and pycnometer

W_4=Weight of water fully filled and pycnometer

Fig 3.3.3: Pycnometer method for specific gravity

3.3.4 Field density of soil:

This test is done to determine the in-situ dry unit weight of soil by sand replacement method as per IS: 2720 (Part 28) – 1974.

Calibration of sand density

Determine inner dimensions (diameter, d and height, h) of the calibrating cylinder and obtain its internal capacity, $V = \pi d^2 h$. Fill sand in sand pouring cylinder and weigh it as W_1 gm. Put sand pouring cylinder on a plate and open the cylinder above the cone by using the clip and allow sand to fill down. The sand will freely run until it fills the conical part. While there may not be similarly downward movement of sand within SPC, close the valve and determine weight of the sand used to fill the cone. Assume it as W_2 gm. Place pouring cylinder directly on top of the cylinder used for calibration. Open the valve to freely move the sand till the sand flow stops. The calibrating cylinder and conical part of pouring cylinder get filled by doing this process . Now close the valve and weigh soil remaining in SPC and let it be W3 gm.

$$\mathbf{W_{cal} = W_1 - W_2 - W_3}$$

$$\boldsymbol{\gamma_{sand} = W_{cal} / V}$$

Soil density measurement

Firstly ground must be leveled and cleaned of which the density is to be determined. Then, tray is placed with a central hole over soil of which density is to determine. Drilled hole in ground from hole in plate, up to 12cm depth which is approximately the height of the calibrating cylinder). The hole inside tray would manual the diameter of the pit to be made within the ground. Excavated soil is been gathered into tray and weight this soil and take it as W gm. Find the moisture content material of the excavated soil. Open valve of the SPC and permit the sand to run into the pit freely, till there is no downward motion of sand level within the SPC after which near the slit. Determine the weight of the SPC with the sand remaining in SPC and let it be W4 gm.

$$\mathbf{W_p = (W_1 - W_4 - W_2)\ gm}$$

$$\mathbf{V_p = W_p / \gamma_{sand}\ cm^3 \quad and \quad \gamma_{wet} = W / V_p\ g/cm^3}$$

Fig 3.3.4: Sand replacement method

3.3.5 Direct shear test:

Direct shear testing is tested in ASTM standard D-3080, “Method for Direct Shear Test on Soils under Consolidated Drained Conditions". Direct shear test is a laboratory test used to determine the soil properties such as cohesion, internal friction of soil etc. This test is used only for cohesion less soil not for cohesive soil since there is no parameter to measure pore water pressure in soil and there is no difficulty of pore water pressure in cohesion less soil. This test has a simple procedure.

Take the soil specimen that's either undisturbed or disturbed. The inner dimensions of sampler need to be 60 mm x 60 mm in plan that is additionally the internal dimensions of shear box. The Thickness of shear box is about 50 mm at the same time as the thickness of sample has to be 25mm.Now connect the 2 halves of the shear field with locking pins and put the base plate at the bottom. Above the lowest plate, vicinity the porous stone and above it put the grid plate. Plain grid plates are used for undrained conditions but perforated grid plates are used for drained conditions. Now we have base plate, porous stone and grid plate within the shear box. Weigh the box and note it down. After that place the soil specimen gently above the grid plate. Undisturbed sample is transferred to box. . Above the soil specimen, vicinity the top grid plate, porous stone and loading pad one above the opposite. Now the entire box is positioned in a field and installed on the loading frame. Proving ring is arranged in this kind of manner that it must touch the higher 1/2 of the shear field. Now locking pins are removed from the shear box and spacing screws are positioned in their respective positions of the box. The upper half of the box is slightly raised with the assist of spacing screws. Now the field’s starts off evolved reacting to loads applied and for every 30 seconds write down the readings of proving ring and dial gauges. If the proving ring reaches most and abruptly drops it, method the specimen is failed. Be aware down the most prices that is not anything however failure stress. Eventually eliminate the box and determine the moisture content of the specimen. Repeat the identical method for one of a kind normal stresses of 50, 100 and 150kN/m^2. Then, plot the graph between shear stress and normal stress called Mohr’s coulomb failure envelope . The value on Y-axis tell about the cohesion value ‘c’ and slope of the line will tell about the angle of internal friction ‘Φ’.

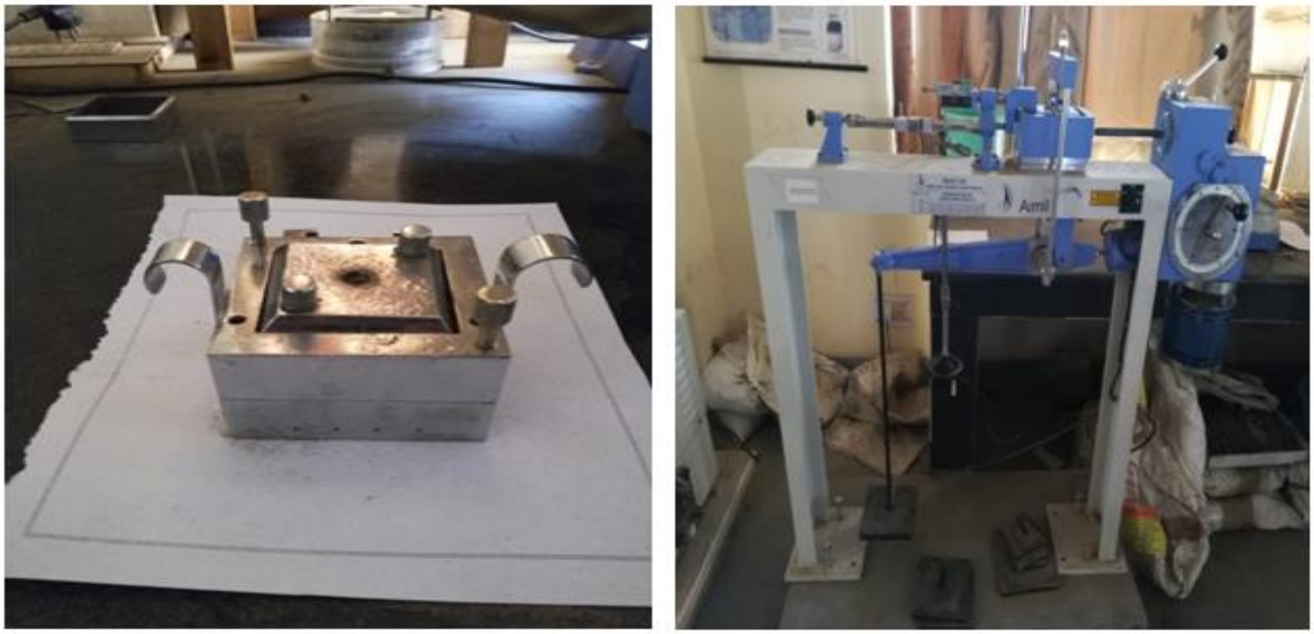

Fig 3.3.5: Direct shear test

3.4 Slope angle determination:-

For calibration of the slope in the model with respect to the prototype of the given hill, there is need of determination of slope of the hill. For determination of slope of hill, the theodolite surveying is been used. For theodolite surveying there is need of level staff, measuring tape, theodolite and tripod stand. First of all, centering of the instrument must be done by the help of plumb bob by suspending freely from the center of instrument. Then, leveling of instrument should be done to make the axis truly vertical. Further then, focusing of the theodolite should be done and it is necessary to remove all the errors like parallax error etc. For measurement of slope angle, bring the bubble of theodolite in center by help of clip screw and vernier reading of instrument must read zero for the first reading on level staff then for further other two reading move the vernier scale by 10 and 5 degree and note down the staff intercept. Then, use the formula to find horizontal distance and then slope angle.

$$\textbf{Horizontal distance, } D = ks\cos^2\Phi + c\cos\Phi$$

Where,

K=additive constant

S= staff intercept

Φ= vernier angle of theodolite

Fig 3.4: Theodolite surveying

3.5 Rainfall data analysis:-

For simulation of rainfall in laboratory the analysis of rainfall data is necessary. For this rainfall data of Solan district is taken for the last 5 years from the Meteorological department. Then, the maximum value of precipitation of particular month of a particular year is taken. Further, the data is been calculated in term of intensity. Moreover, there is need of proper scaling of rainfall intensity for simulation of rainfall in model area as the model area is small as compared to that the field area due to which scaling is required. The table of precipitation given below is in term of 'mm':-

Table 3.5: Rainfall data for last 5 years [Meteorological department, H.P.]

YEAR	JAN		FEB		MAR		APR		MAY		JUN		JUL		AUG		SEPT		OCT	
	R/F	%DEP	R/F	%DEP	R/F	%DEP	R/F	%DEP	R/F	%DEP	R/F	%DEP	R/F	%DEP	R/F	%DEP	R/F	%DEP	R/F	%DEP
2013	91.0	27	184.7	179	60.8	-3	4.4	-84	21.0	-57	348.9	168	185.4	-50	188.3	-43	89.6	-47	28.7	-35
2014	67.0	-7	99.9	51	121.1	93	62.9	125	71.5	47	125.8	-3	354.9	-4	157.0	-53	137.0	-19	24.6	-44
2015	64.2	-10	76.8	16	254.9	307	84.3	202	22.5	-54	81.9	-37	432.6	17	251.0	-24	49.2	-71	23.3	-47
2016	6.4	-91	33.2	-50	109.6	75	13.2	-53	109.9	125	253.4	94	274.6	-25	316.5	-5	54.4	-68	16.9	-62
2017	252.9	253	10.0	-85	37.8	-40	52.2	87	80.1	64	184.1	41	207.5	-44	306.7	-8	133.6	-21	0.0	-100

From the given table we can conclude that the maximum precipitation has occurred in month of June 2015 which is 432.6mm. Now, the precipitation is given in terms of mm so for conversion of precipitation in term of mm/hr the procedure will be as given below:-

Since, the June month consists of 30 days so,

Precipitation, 432.6mm= 432.6/ (30*24*60) mm/hr

Intensity = 0.6mm/hr

3.6 Scaling of model:-

The scaling laws are necessary for calibration of site conditions in physical modeling. In scaling laws, scaling of model area as well as scaling of rainfall depth and rainfall intensity must be done. The length of model is scaled down by the factor of 1/N less than that of prototype. The total duration of rainfall in model is scaled down by $1/N^2$ as compared to the prototype. Moreover, the length of total rainfall of model is scaled down by factor of 1/N less than that of prototype as well as rainfall intensity of model will be N times higher as compared to prototype as rainfall intensity can be defined as ratio of total rainfall by total duration so it is required to increase the intensity of rainfall in modeling. The calculations for scaling will take place in next chapter. Further then, this intensity is used for calculation of discharge of rainfall that to be done on model area. Discharge can be calculated by the help of discharge formula which is given by:-

Discharge, Q=ciA

Where,

c= runoff coefficient,

i= rainfall intensity in cm/hr

A= model area in cm^2

Table 3.6: Scaling laws for modeling [4]

S.no.	Term (dimension)	Prototype	Model
1.	Length[L]	1	1/N
2.	Total rainfall[L]	1	1/N
3.	Rainfall duration[T]	1	$1/N^2$
4.	Rainfall intensity[L/T]	1	N

3.7 Physical Modeling data or dimensions:-

Physical modeling is a method of modeling and simulating properties that consist of actual physical components. Physical modeling of data taken from the experiments is been shown in the box model. Physical modeling is necessary to show all the site characteristics. In modeling, plan area of box model is been provided and hill slope is also provided which is been find by the help of theodolite surveying. Moreover, while filling soil water content and field density must be same as that of site and in modeling hill slope must be checked by help of protractor or drafter scale

- **Dimensions of box model:-**

  i. Plan area = length * width
     = 44.8cm*50cm
     =**2240cm^2**
  ii. Height = **29.3cm**

- **Other data of box model:-**

  Hill slope provided is about 45º which is find by the help of theodolite surveying. Moreover, the water content and field density of soil is also alike as that of site properties so that it can show hill characteristics. Model density to be provided to the soil must be about 2.22g/cm^3 as well as water content that must be kept in box model must be about 7.17%.

Fig 3.7 Physical modeling of box model

3.8 <u>Calibration of field density in box model</u>:-

For the same soil properties of model as that of site conditions, it is necessary to calibrate the model density with field density of soil. For this we can use various methods but in this project it is calibrated by the help of shear box and tamping rod. In this method of calibration, first of all soil is filled in layer in each of 5cm layer then with the help of tamping rod tamp the soil so that it become compact and then after use the shear box and extract the tamped soil from the model. Further then weigh it on the spring balance and since we know the volume of shear box and weigh of the soil is also known. Then find the unit weight or density of the soil. If in case it is not same as that of site density then again tamp the soil more as compared to previous one but if the model density is less than that of field density and if the model density is more than field density then tamp the soil less than of previous case. When the model density get resemble with field density then write down the blows of tamping and do the tamping with the same of blows to the whole soil which is filled in layer of 5cm.

Fig 3.8 Calibration of field density in box model

3.9 Runoff collector method:-

Measurement of soil erosion by rainfall simulation in laboratory can be obtained by different method as per the research papers but runoff collector method is the best method to obtain soil erosion. In this method runoff collector is been used for collection of soil runoff obtain from the box model during rainfall. Further then kept the soil runoff for sedimentation process so that soil can settle down in runoff collector and water is been removed from the collector. Then this soil is put in oven at 105ºC for 24 hours and weight the soil on weighing balance and since we have the weight of soil filled in the model and also we have the weight of soil runoff from runoff collector. Then, we can compare the both weight of soil which tells about the percentage of soil erosion and also we have to soil erosion by applying jute mats and without applying jute mats. Moreover we have to check the slope failures of soil in both the cases with or without applying jute mats.

3.10 Experimental set up for soil erosion measurement:-

For doing project a proper experimental set up is needed in box model with or without the jute mats.

- **Without jute mats**

In modeling of box model without jute mats and steel fence, it is necessary to maintain proper slope of hill as well as proper slope of the box model so that water can easily runoff to runoff collector. The slope of hill must be properly checked with drafter or protractor. Before this, maintaining proper field density and water content in soil filling. Also, the dimensions of box model must be properly labeled so that we can compare the results in modeling before and after the simulation of rainfall. Moreover, water must be properly regulated through water regulation while simulation of rainfall in laboratory as well as proper calibration of rainfall data is necessary to simulate the rainfall with the same intensity as that of Solan district rainfall While doing experimental set up there must not be disturbance while filling the soil so that soil properties must not get changed. Also, it is necessary that there must not be loss of soil runoff while doing experiment and runoff collector must not be disturbed during sedimentation process and while collection of soil sample from it.

Fig 3.10.1 Experimental set up without jute mats

- **With jute mats and steel fence**

In physical modeling by applying jute and steel fence, factors must be same related to soil properties such as field density, water content and slope angle as that of discussed in previous case of without jute mats. Moreover, spray nozzle must be properly connected to water regulator and should be at the sufficient height for simulation of rainfall. Also, during calibration it must be take care that the water used in calibration must not disturb the soil in model. In applying jute mats and steel fence proper precautions must be needed. Firstly, before applying jute mats there must be proper cleaning of voids of jute mats then the jute mats do not create pore pressure on the soil otherwise it get failed and also jute mats must be applied in such a way so that it can cover whole soil of the model. Moreover in applying steel fence, it must be properly placed over the jute mats with the help of anchor pins so that jute mat will remain stable in its position.

Moreover, while doing experiment proper examine of slope changes as well as losses of soil runoff must be controlled i.e., there must be less or almost no losses during runoff collection.

Fig 3.10.2 Experimental set up with jute mats and steel fence

CHAPTER 4

RESULTS AND CALCULATIONS

4.1 Sieve analysis results:-

Table 4.1: Result of particle sieve analysis

Si.No.	Is Sieve No. or Size(mm)	Wt. Retained in each Sieve (gm)	Percentage on each Sieve (%)	Cumulative % age retained on each sieve	% Finer
1	10	37.8 gm	6.11%	6.11%	93.89%
2	4.75	60.9 gm	9.86%	15.97%	84.03%
3	2	144.9 gm	23.45%	39.42%	60.58%
4	1.18	121.1 gm	19.60%	59.02%	40.98%
5	0.6	110.8 gm	17.93%	76.95%	23.05%
6	0.3	64.2 gm	10.39%	87.34%	12.66%
7	0.18	28.9 gm	4.67%	92.01%	7.99%
8	0.15	10 gm	1.62%	93.63%	6.37%
9	0.075	27 gm	4.37%	98%	2%
10	Pan	11.7 gm	1.89%	99.90%	0.10%

From the given table, it can be concluded that percentage finer of soil passes through 4.75mm sieve is about 80 percentage while percentage finer of soil passes through 75 micron sieve is very less. For further classification in coarse grained soil fineness of soil must be checked which is less than 5% and moreover more than 50% of soil passes through 4.75mm sieve which shows that the soil is sandy. Now, it is need to find coefficient of uniformity and coefficient of curvature for that it need to find D_{60}, D_{10} and D_{30} which indicates the sieve sizes for percentage finer for 60, 30 and 10% respectively.

Now from the table,

Sieve size having percentage finer 60%, D_{60}= 2mm

Sieve size having percentage finer 30%, $D_{30} \approx$ 0.85mm

Sieve size having percentage finer 10%, $D_{10} \approx$ 0.21mm

Coefficient of uniformity, C_u= D_{60}/D_{10}

$= 2/0.21 \approx$ **10**

Coefficient of curvature, C_c= $D_{30}^2/(D_{60} * D_{10})$

$= 0.85^2/(2*0.21) \approx$ **1.72**

Since, the value of C_u is greater than 6 and value of C_c lies between 1 and 3 and as well fineness less than 5% which shows that the given soil is **well graded sand i.e., SW**

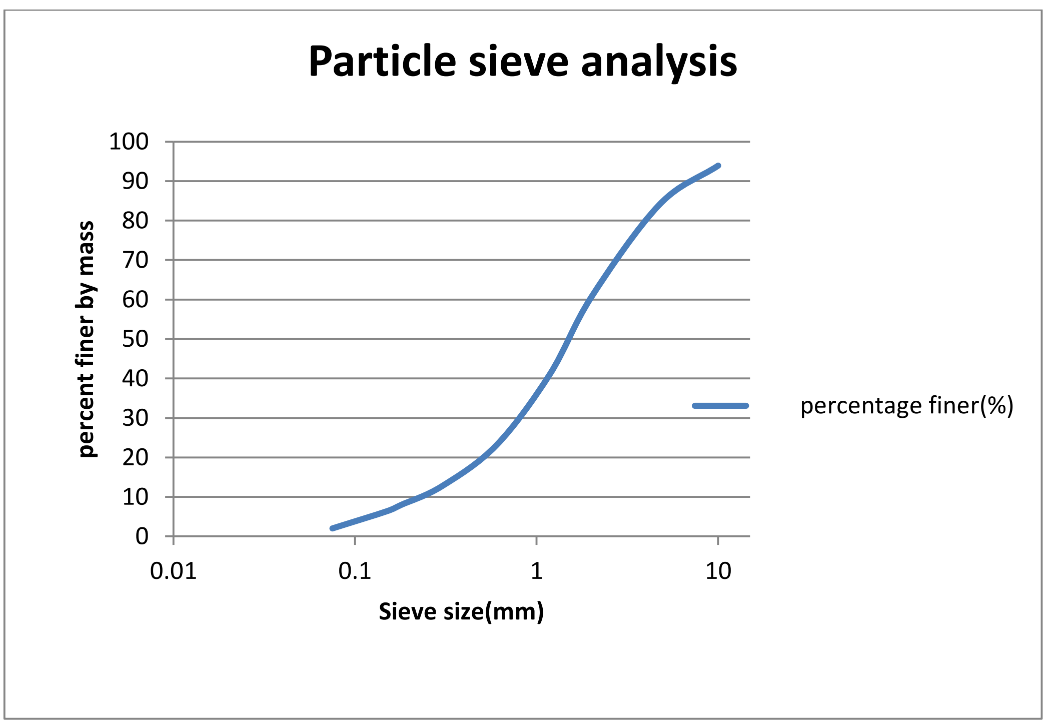

Fig 4.1: Graph plotted between percent finer and sieve size

From the graph plotted between percentage finer by mass and grain or sieve size from the data given in the table, it can be seen that the maximum portion of soil lies in sieve size 1mm to 4.75mm which also shows that the given soil is coarse grained in nature.

4.2 Testing on water content:-

Table 4.2: Result for water content determination

S.No.	Determinations	Sample 1	Sample 2	Sample 3	Sample 4
01	Mass of container and wet soil , in gm (W_w)	164.4	176.0	167.8	157.5
02	Mass of container and dry soil , in gm (W_d)	153.4	164.7	156.0	146.2
03	Water content, $W = (W_w - W_d)/W_d$	7.17 %	6.86 %	7.56 %	7.72 %

Average water content = (7.17% + 6.86% + 7.56% + 7.72%)/4

= **7.33%**

From the given table, it can be concluded that the water content of given soil is 7.33% since the soil characteristics of the site is mainly cohesion less due to which it has less water content as cohesion less soil particles does not attach with water.

4.3 Specific gravity of soil:-

The table given below will show the result of specific gravity of the soil find by the help of pycnometer method:-

Table 4.3: Result of specific gravity of soil

Si.No.	Determinations	Sample
01	Wt. of clean & dry pycnometer , in gm W1	781.3 gm
02	Wt. of pycnometer + dry soil , in gm W2	1090.0 gm
03	Wt. of pycnometer + dry soil + water , in gm W3	1970 gm
04	Wt. of pycnometer + water , in gm W4	1600.5 gm
05	Specific gravity ,G = $(W_2 – W_1)/\{(W_4 – W_1)\text{-}(W_3 –W_2)\}$	**2.64**

Specific gravity, G=$(W_2 – W_1)/ \{(W_4 – W_1)\text{-}(W_3 –W_2)\}$

= (1090-781.3)/ {(1600.5- 781.3) - (1970-1090)} = **2.64**

From the given table, it can be concluded that specific gravity of given soil is 2.64 which is applicable for the range of coarse grained soil i.e., 2.64 to 2.66. So, the specific gravity test result of the given soil is correct.

4.4 Slope determination of hill:-

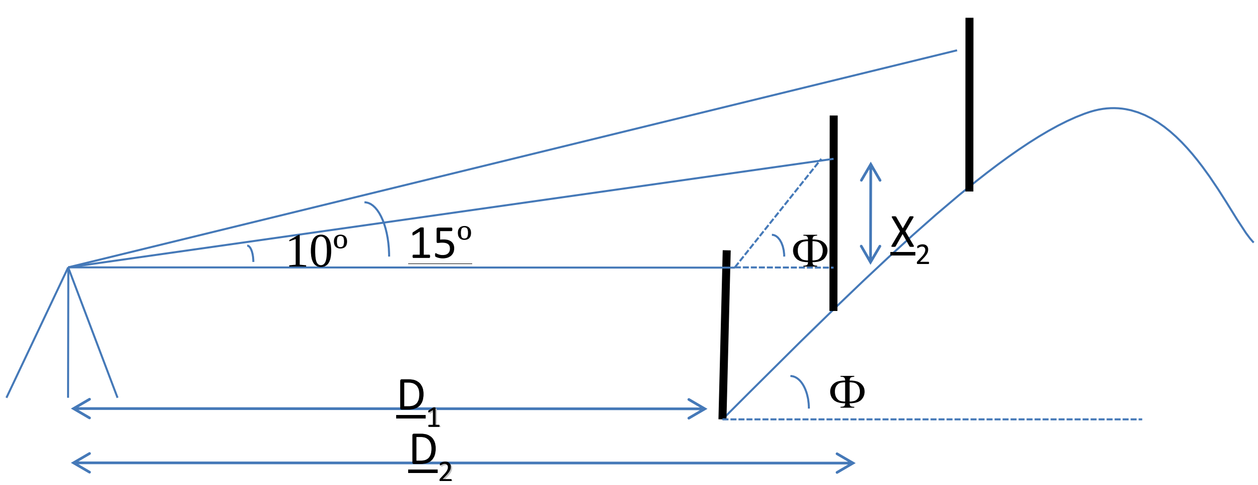

Fig 4.4: Theodolite surveying for slope determination

Table 4.4: Result of theodolite surveying

S.No.	Angle (in degrees)	Staff intercept (in cm)		
		S_1	S_2	S_3
1.	0	319.5	323	326.5
2.	10	334	338.5	343
3.	15	319	324	329.5

The given table shows the value of staff intercept at different values of angle i.e., at 0, 10 and 15 degrees. The value of additive constant (K) can be taken as 100 and the value of multiplying constant(c) can be taken as 0. So by using horizontal distance formula in case of theodolite surveying determine the slope angle of hill.

k=100, c=0

Case 1: $\Phi_1 = 0^o$

$D_1 = ks\cos^2\Phi_1 + c\cos\Phi_1$

$= 100*0.07*1 = 7m$

Case 2: $\Phi_2 = 10^o$

$D_2 = ks\cos^2\Phi_2 + c\cos\Phi_2$

$= 100*0.09*(\cos 5^o)^2 = 8.73m$

Case 3: $\Phi_2 = 15^o$

$D_3 = ks\cos^2\Phi_3 + c\cos\Phi_3$

$= 100*0.105*(\cos 15^o)^2 = 9.79m$

Now, $x_2 = D_2 * \tan 10 = 8.73*0.176 = 1.539$m

$\tan\Phi = x_2/(D_2-D_1)$

$= 1.539/(8.73-7)$

$\mathbf{\Phi = 44.138^o \approx 45^o}$

Therefore, the slope angle of hill determine is approximately 45 degree so in physical modeling of hill angle used must be approximately 45 degree.

4.5 Field density of soil:-

Table 4.5.1: Result for calibration for unit weight of sand

SI no.	Calibration of Unit Weight of Sand	Sampling
01	**Volume of calibrating cylinder, V (cm^3)**	1000
02	**Weight of SPC+ sand, W_1 (g)**	4696
03	**Weight of sand required to fill the conical portion on a flat surface, W_2 (g)**	440
04	**Weight of SPC + sand (after filling calibrating cylinder), W_3 (g)**	2574
05	**Weight of sand required to fill the calibrating cylinder, $W_C = (W_1 – W_2 – W_3)$ gm**	1682
06	**Unit weight of sand, γ(g/cm^3)**	1.683

Weight of sand used to fill, $W_C = W_1 – W_2 – W_3$

$= 4696-440-2574 = 1682$gm

Volume of calibrating cylinder, V= 1000cm^3

So, Unit weight of sand, $\boldsymbol{\gamma = W_c / V}$

=1682/1000 = $\underline{1.682 g/cm^3}$

The given table shows that the unit weight of sand for calibration is 1.682g/cm^3. This unit weight of sand is used further for calculations of field density of soil.

Table 4.5.2: Result of field density of soil

SI no.	Determination of field density of soil	Sampling
01	**Weight of the excavated from the pit (W) (g)**	2533
02	**Weight of sand + SPC , before pouring, W_1 (g)**	5240
03	**Weight of SPC after filling the hole & conical portion, W_4 (g)**	2880
04	**Weight of sand in the pit $W_P = (W_1 - W_4 - W_2)$ (g)**	1920
05	**Volume of sand required to fill the pit $V_P = W_P/\gamma$ (cm^3)**	1140.82
06	**Bulk unit weight of soil, $\gamma = W/V_P$ (g/cm^3)**	2.22

Weight of sand in hole, $W_p = W_1 - W_4 - W_2$

$= 5240-2880-440 = 1920gm$

Volume of sand used to fill hole, $V_P = W_P/\gamma$

$=1920/1.683= 1140.82cm^3$

Bulk unit weight of soil, $\boldsymbol{\gamma = W_p/V_p}$

$= 2533/1140.82 = \mathbf{2.22 g/cm^3}$

From the given table, it can be concluded that the bulk unit weight of the soil is 2.22g/cm^3 which is approximately in range for the sandy or cohesion less soil. Moreover, by the help of bulk unit weight the dry unit weight of the soil can also be determined.

4.6 **Direct shear test:-**

Table 4.6: Result of direct shear test on soil

S.No	Displacement (mm)	Normal load (0.5 Kg/m^2)		Normal load (1 Kg/m^2)		Normal load (1.5 Kg/m^2)	
		Load(KN)	Shear stress(KN/m^2)	Load(KN)	Shear stress(KN/m^2)	Load(KN)	Shear stress(KN/m^2)
01	0	0	0	0	0	0	0
02	0.02	0.004	1.12	0.014	3.89	0.024	6.67
03	0.05	0.008	2.24	0.02	5.56	0.037	10.28
04	0.25	0.015	4.167	0.031	8.61	0.055	15.27
05	0.68	0.03	8.34	0.05	13.89	0.075	20.83
06	1	0.041	11.38	0.068	18.88	0.1	27.78
07	1.19	0.048	13.34	0.082	22.77	0.121	33.61
08	1.3	0.053	14.72	0.09	25.02	0.134	37.22
09	1.48	0.061	16.94	0.104	28.88	0.149	41.38
10	1.64	0.067	18.61	0.114	31.66	0.163	45.27
11	2.02	0.074	20.55	0.133	36.94	0.19	52.77
12	2.28	0.081	22.50	0.144	40.02	0.211	58.61
13	2.55	0.088	24.44	0.158	43.88	0.231	64.16
14	2.97	0.096	26.66	0.18	50.04	0.256	71.11
15	3.32	0.102	28.33	0.197	54.72	0.275	76.38
16	3.8	0.105	29.17	0.214	59.44	0.298	82.77
17	4.21	0.11	30.83	0.224	62.22	0.312	86.66
18	4.65	0.113	31.38	0.231	64.16	0.321	89.16
19	5.76	0.116	32.22	0.238	66.11	0.324	90.07
20	5.94	0.118	32.02	0.237	65.83	0.323	89.72

The table give us the value of load and shear stress at different values of displacement and using this graph is been plotted between shear stress and displacement.

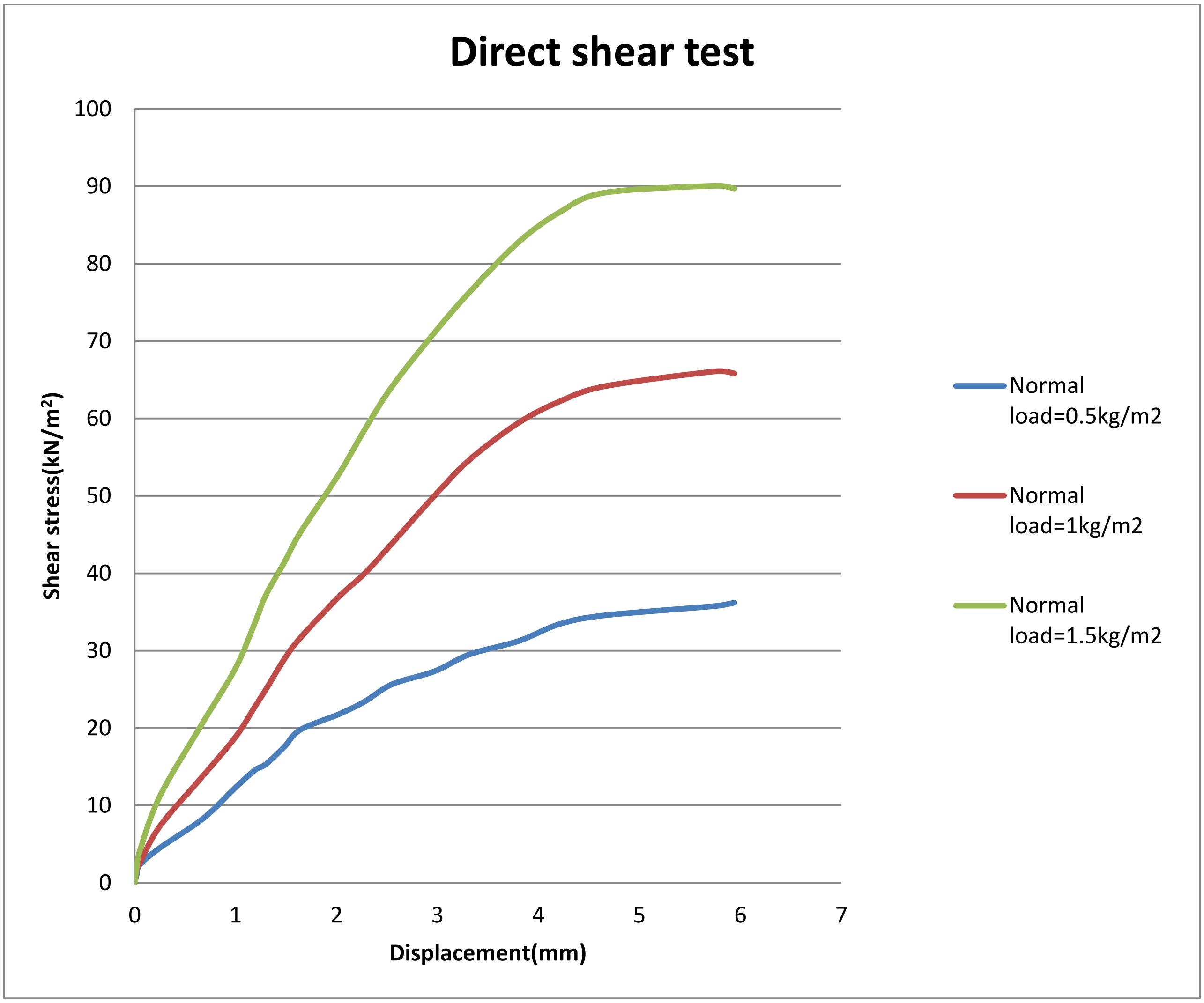

Fig 4.6.1: Graph plotted between shear stress and displacement

From the above given table of the load and shear stress value for the given value of displacement, the graph is been plotted between shear stress (kN/m^2) and displacement (mm). The graph is plotted for normal load of 0.5,1 and 1.5kg/m^2. Then from this graph value of normal load and shear stress is been taken and graph is plotted between shear stress and normal stress which is popularly known as Mohr's coulomb failure envelope which gives us the value of cohesion and angle of internal friction and tells us about the properties of soil.

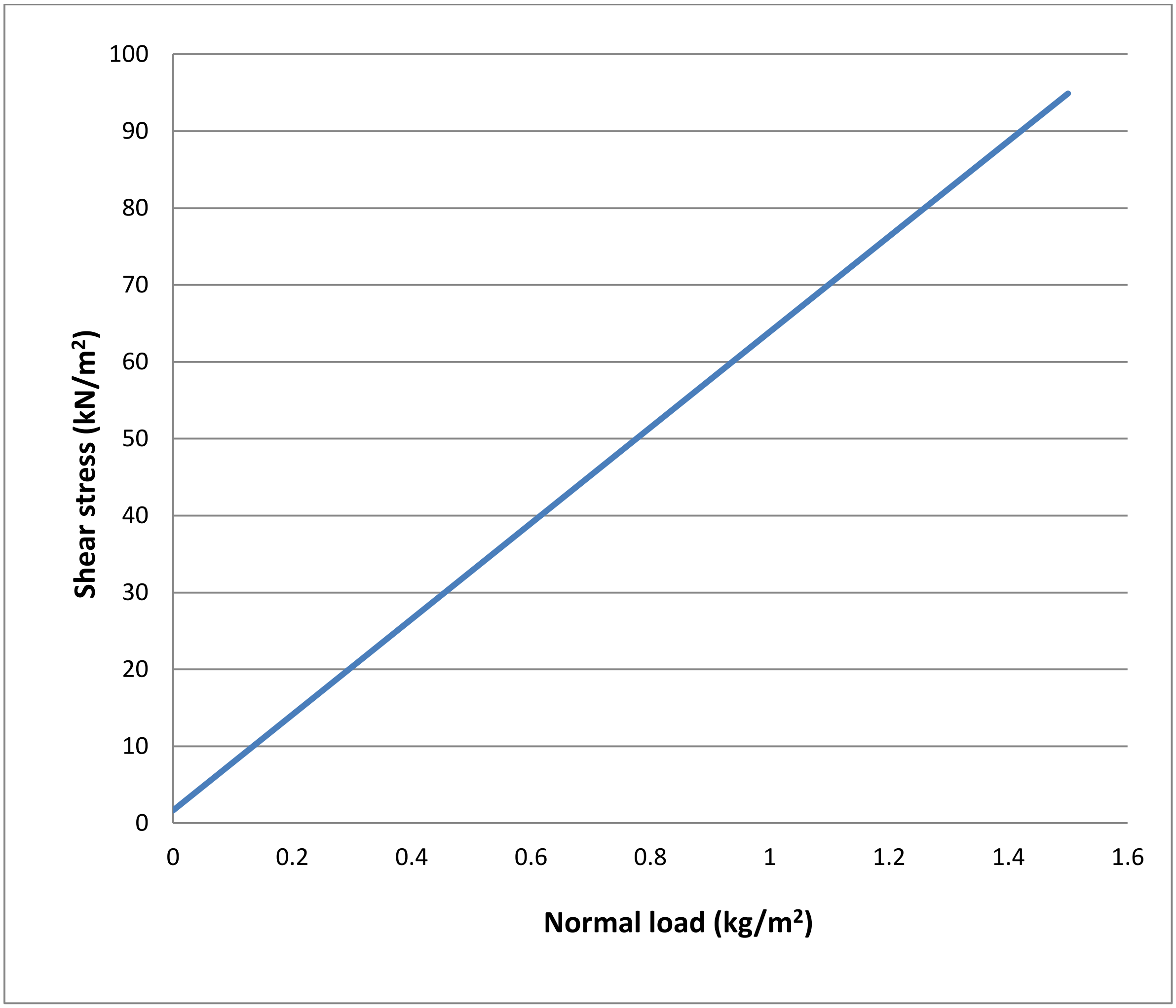

Fig 4.6.2: Graph plotted between shear stress and normal load

The graph plotted between shear stress and normal stress is linear will give us the value of cohesion and angle of internal friction which tells about the properties of soil.

From the graph we can conclude that,

Value of cohesion, **c**= **1.65kN/m^2**

Angle of internal Friction, **Φ= 32.45º**

This confirmed that given soil is having very less cohesive properties and soil is mainly cohesion less since it has very less cohesive value and high value of angle of internal friction which is properties of coarse grained soil.

4.7 Scaling of model:-

- **Length scaling**:-

In scaling of model firstly scaling of length take place for model dimensions so it can scale site dimensions to model dimensions. Here, solan district area is used for scaling as rainfall data analysis is taken of solan district.

Given Solan district area=1931km^2

Let 1cm=930m (scale)

Then, 1931km^2= $1931*10^{10}/93000^2*1$

Model area = **2240cm^2**

- **Rainfall intensity scaling:-**

Now the scaling for rainfall intensity is to be done and the scaling must be done accordance with the maximum value of precipitation taken from the last five years rainfall data of Solan district. The maximum value of precipitation came out to be 432.6mm and further intensity calculated is 0.6mm/hr as discussed in previous chapter. Now, scaling is done as:-

Rainfall intensity, **i** =0.6mm/hr

Let 1mm/hr = 200cm/hr(scale)

So, 0.6mm/hr= 200*0.6

= **120 cm/hr**

So, on model plan area we have to simulate rainfall of intensity 120cm/hr and take this intensity in discharge formula for finding discharge to be needed for one hour rainfall. This discharge formula can be used for both small and large areas i.e.,area less than 500m^2 as well as area greater than 500km^2 so in this project also this formula is also applicable for project calculations.

The discharge formula is given by:-

Discharge, **Q = ciA**

Where,

c = runoff coefficient (for hilly region =0.2)

i= intensity of rainfall in cm/hr

A= Model area in cm^2

Now, discharge Q= ciA

=0.2x0.6x2240=**47.49liters/hr**

So the discharge must be applied to the plan area of the model for simulation of rainfall. For applying this discharge first of all calibration of spray nozzle is necessary which is done by the help of water regulator by regulating the flow of water for 10 minutes and checked with this discharge value.

Fig 4.7: Discharge of rainfall on model

4.8 <u>Calibration of field density</u>:-

The calibration of field density in physical modeling is needed for showing the characteristics of soil of site. For calibration the shear sampling box is used of which volume is known and weight has been taken in shear box from each layers of soil which is filled by tamping the soil. After tamping the soil it has been concluded that tamping the each layer of soil 27 times would provide the same density as that of field density.

Weight of empty shear box sampler= 152gm

Volume of shear sampling box= 6cm*6cm*2cm

= 72cm^3

The table given below will show the value of weight and density of soil at successively at distance of 5cm.

Table 4.8 Result of calibration of field density

Layer no.	Weight of soil in shear box sampling in gm	Volume of shear sampling box in cm^3	Density of soil in g/cm^3
1.	158.9	72	2.206
2.	160.5	72	2.229
3.	159.7	72	2.218
4.	159.5	72	2.214
5.	160.2	72	2.226

From the given table it can be concluded that the model density of soil after fill up of each layer is resemble with the field density of soil which is 2.22 g/cm^3 so model has the same soil properties as that of site.

Fig 4.8: Calibration of field density

4.9 Soil erosion measurement:-

Measurement of soil erosion takes place by the help of runoff collector method. In this method soil runoff is collected in runoff collector and then by the help of sedimentation process removed the water and obtained the soil. Then put the soil in oven for 24 hrs and weigh it on balance. Soil erosion measurement will be done without applying jute mats and by applying jute mats andsteel fence. Moreover we have to examine the slope failures and rate of change of slope in both the cases

Dry Weight of the soil filled in the box model =138kg

- **Without applying jute mats:**

Dry weight of soil runoff or soil erosion comes out to be equals to **356gm**

Moreover, the slope failure of model takes place during simulation of rainfall without applying jute mats. In slope failure the soil from slope of hill will get dispatched and cause soil erosion

Fig 4.9.1: Slope failure and soil erosion without using jute mats

- **By applying jute mats and steel fence:**

Dry weight of soil runoff comes out to be equals to **102gm**

Percentage reduce in soil erosion as compared to above case = (356-102)/356*100

=**71.34%**

In case of applying jute mats and steel fence almost no slope failure has been taken placed as well as the soil erosion is also get reduced to more than two third as that in the case of without applying jute mats.

The figure given below will show the soil erosion, which is very less as compared to above one, by applying the jute mats :-

Fig 4.9.2: Soil erosion with using jute mats

3.10 Results for soil erosion at different rainfall intensities:-

Moreover, while performing the different intensities rainfall (greater than the former one) by applying jute mats we have examine different values of soil runoff and slope failure at high intensity even with jute mats.

- **At rainfall intensity, i=0.6mm/hr (given intensity)**

Dry weight or quantity of soil runoff comes out to be 102gm

Percentage reduction in soil erosion to that of without applying jute mats= (356-102)/356

=**71.34%**

Moreover, no slope failure will take place at this intensity

- **At rainfall intensity, i= 0.9mm/hr**

Dry weight or quantity of soil runoff comes out to be 136gm

Percentage reduction in soil erosion to that of without applying jute mats= (356-136)/356*100

=**61.79%**

In this case, slight slope changes take place but even in this case no slope failures take place.

- **At rainfall intensity, i= 1.2mm/hr**

Dry weight or quantity of soil runoff comes out to be 161gm

Percentage reduction in soil erosion to that of without applying jute mats= (356-161)/356*100

=**54.77%**

In this case, slope failure take place even by applying jute mats but that is less than soil without applying jute mats.

Fig 4.10: Slope failure and soil erosion at high intensity (i=1.2mm/hr) with using jute mats

The above results show that reduction in soil erosion percentage reduces with the increase in intensity of rainfall i.e., at intensity of 0.6mm/hr, 0.9mm/hr and 1.2mm/hr the soil erosion percentage reduction will be 71.34%, 61.79% and 54.77% respectively .So, the value of precipitation at which slope failure take place will be calculated since we know the value of intensity of rainfall.

So, the precipitation will be calculated as:-

Since the precipitation is maximum for June month as discussed in previous chapter.

So, precipitation value= 1.2mm/hr* 30*24

= **864mm**

So for this rainfall depth slope failure take place even with use of jute mats and steel fence. This show the limits of jute mats used in prevention of soil erosion that the use of jute mats get limited to 864mm of rainfall.

CHAPTER 5

DISCUSSIONS AND CONCLUSIONS

Since jute mats can be used as a waste material as well as it has similar properties as that of other erosion control materials so it also reduces wastage of jute. For checking whether the jute can be used or not in prevention of soil erosion, it must be needed that there must not be slope failure in model as well as less soil erosion. From the project work on prevention of soil erosion in hilly regions, it can be concluded that the use of jute mats or jute sacks on hilly regions can prevent soil erosion up to a great extent.

5.1 Conclusions:-

Based on the results of the experiment following conclusions can be derived:-

- Using of jute mats with steel fence reduced the soil erosion for more than two third at the given rainfall intensity in all type of soils.
- Using of jute mats do not show any slope failure and almost negligible slope changes while simulation of rainfall
- At intensity of 0.6mm/hr (given district rainfall), reduce in soil erosion percentage comes out to be 71.34%.
- While increasing rainfall intensity the reduction in soil erosion percentage also get reduced i.e., at intensity of 0.6mm/hr, 0.9mm/hr and 1.2mm/hr the soil erosion percentage reduction will be 71.34%, 61.79% and 54.77% respectively
- The slope failure of soil by using the jute mats is taken place at intensity of 1.2mm/hr or at the precipitation value of 864mm

5.2 Recommendations:-

From the above results the following recommendations can be made**:-**

- Jute mats or jute sacks can be used for prevention of soil erosion in hilly regions.
- It is also recommended to use steel fence and attach with the jute mats by help of anchor pins to properly maintain the jute mats in its position
- Moreover, jute mats can be used only below the precipitation value of 864mm above that failure may occur in soils that can cause landslides.

5.3 Future scope:-

There is always possibility of future research in area of prevention of soil erosion. So future study may have:-

- Further studies are needed to replace jute mats with any other materials such as coconut fiber mats so that it may prevent soil erosion at higher rainfall intensity.
- Further research are required to examine the soil erosion and slope changes in terrace faming type pattern which is very common in hilly regions.
- Further experiments can be done to measure the soil erosion by changing the slope angle of hill i.e., by increasing the angle greater than 45 degrees.

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