GEORG-AUGUST-UNIVERSITÄT GÖTTINGEN

M.SC. COURSE HYDROGEOLOGY AND ENVIRONMENTAL GEOSCIENCES

MODELING OF UNSATURATED ZONE PROCESSESS

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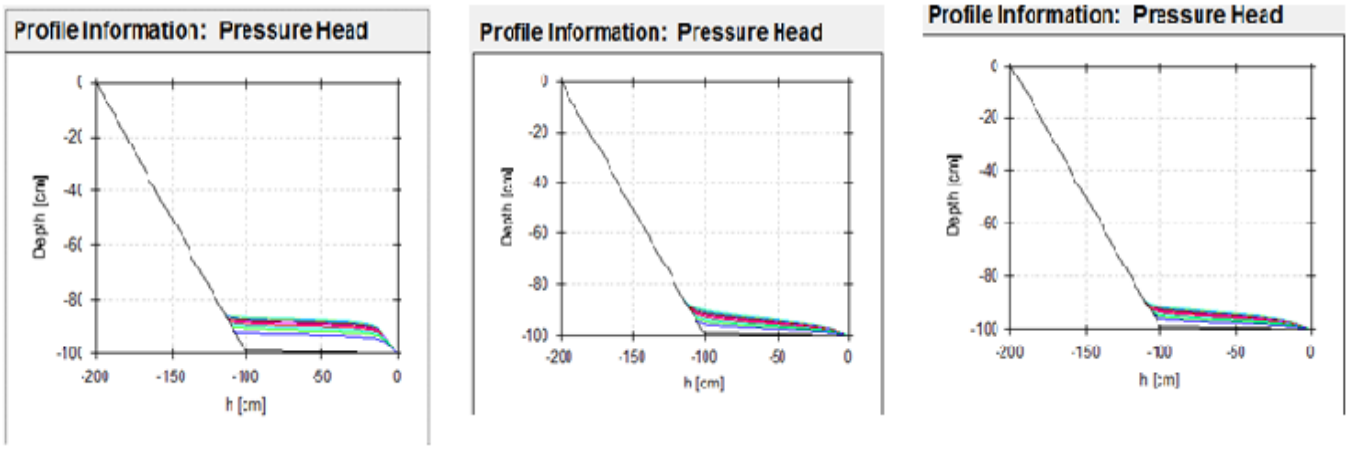
FEBRAURY 2016

EXCERCISE 2 - CAPILLARY RISE

A soil profile 100 cm depth. Initial condition of equilibrium with h=-100cm (z=-100cm) using formula H=h+z , where H (hydrualic head) = -200 cm which constant in whole system and thenh(z=-100cm) increases to a value of -1 cm (This may have been caused by the raise of the water table) .it is run for 3600 sec.

1.PRESSURE HEAD

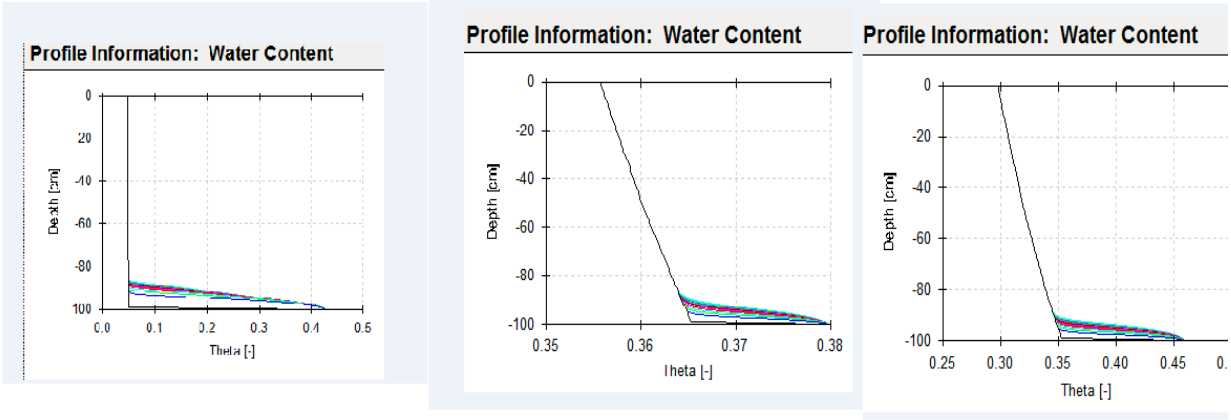


Sand Clay Silt

Figure 1 : Depth versus matrix head for sand ,clay and slit

Since sand has coarse structure where pore size is higher, capillary rise (h) is lower (h=0.15/r) whereas in clay and silt its pore size is lower capillary rise is higher. It tell us how much water is retain in soil.

2.WATER CONTENT

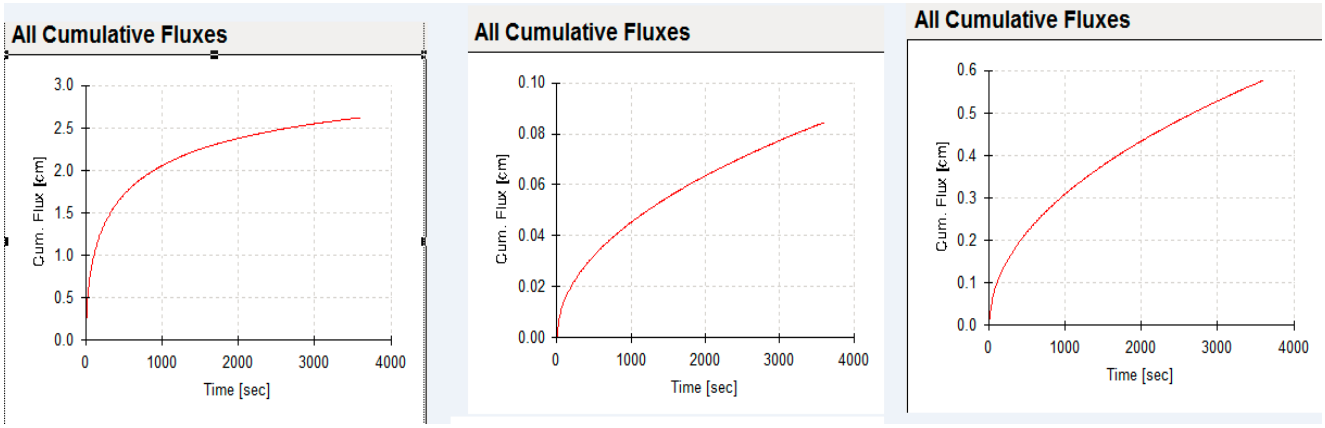


Sand Clay Silt

Figure 2: Depth versus water content in sand ,clay and slit

Difference in water content for sand , clay and silt is seen in above figure 2
We see that in sand water content does not reaches higher than 0.4 since more emptyspace water retain less at depth -90cm .therefore more water is retain in silt than in clay small pore size

3.CAPILLARY RISE



Sand Clay Silt

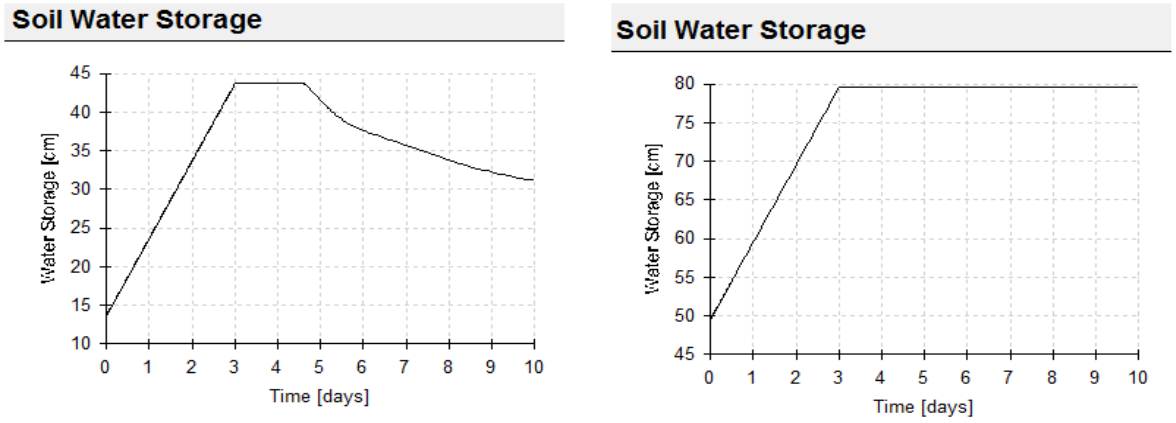
Figure 3: Depth versus time in sand ,clay and slit

In figure 3,we see capillary rise in silt is higher than in clay, time taken water to retain in the in silt is low because no empty space and low pore size. Where as in sand time to retain water in much lower in sand because more empty space and large pore size

EXCERCISE 3 -INFILTRATION

A soil profile of 300 cm at initial condition of equilibrium with h=-200cm at z=-300 cm (bottom of the sample). It starts raining with a precipitation rate of 10 cm/d. It rains for 3 days and then it stops raining.As boundary condition at the bottom put free drainage. As boundary condition at the top use Atmospheric BC with surface run –off.It was run for 10 days

1.SOIL WATER STORAGE .

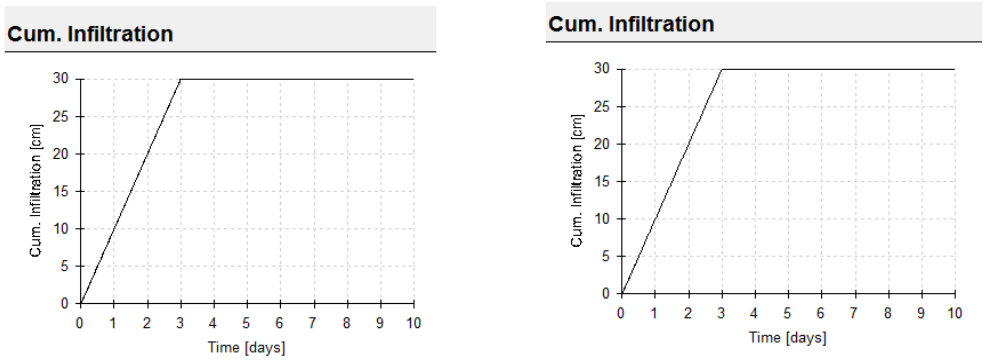


Sand Loam

Figure 1 : Soil water storage and time in sand and loam

The model was run for both sand and loam. Figure1 shows soil water storage versus time for both sand and loam. in sand, water storage start decreasing after one day after rain has been stop but in the loam it remain constant.

2.CUMALATIVE INFILTRATION

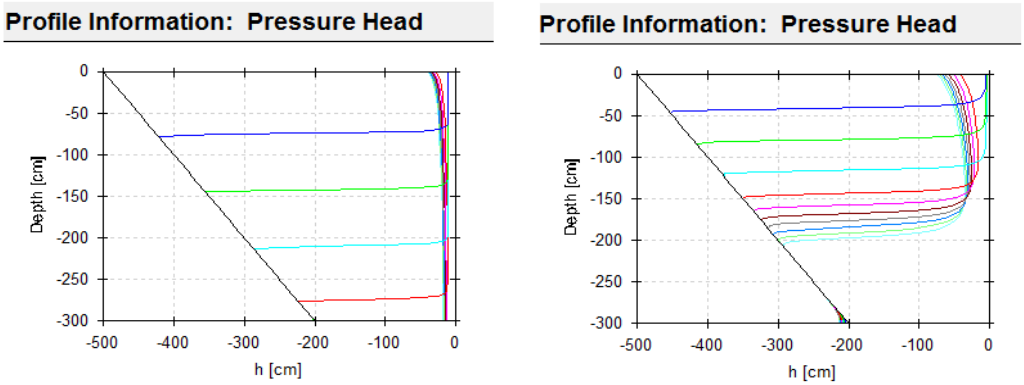


Sand Loam

Figure 2: Cumlative infiltration and time in sand and loam

In figure 2, cumalative infiltration rate remain constant for both sand and loam

3.PRESSURE HEAD

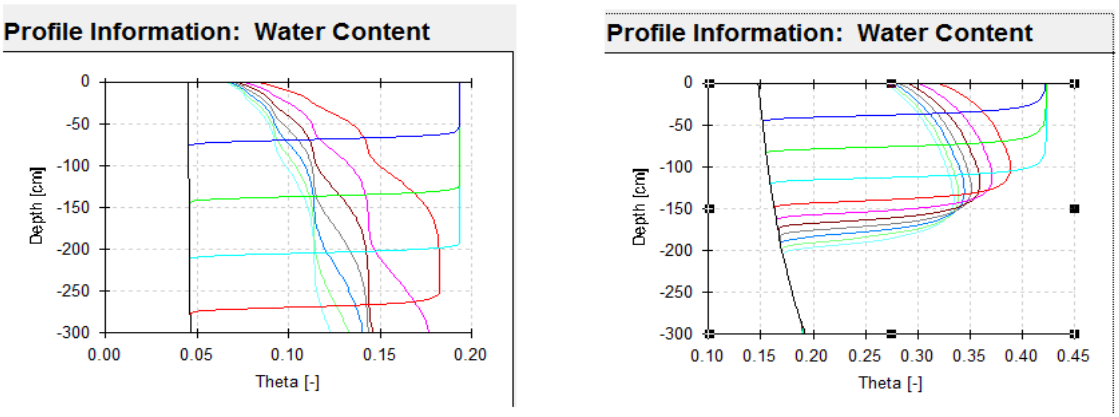


Sand Loam

Figure 3 : depth versus matrix head for sand and loam

Figure 3 show matrix head versus depth of both sand and loam. In sand, water filtrates faster, matrix head gets less negative in whole system where as in loam water infilterates slower there more part of soil remain dry at low matrix potential. The upper layer reaches matrix potential close to 0

4.WATER CONTENT



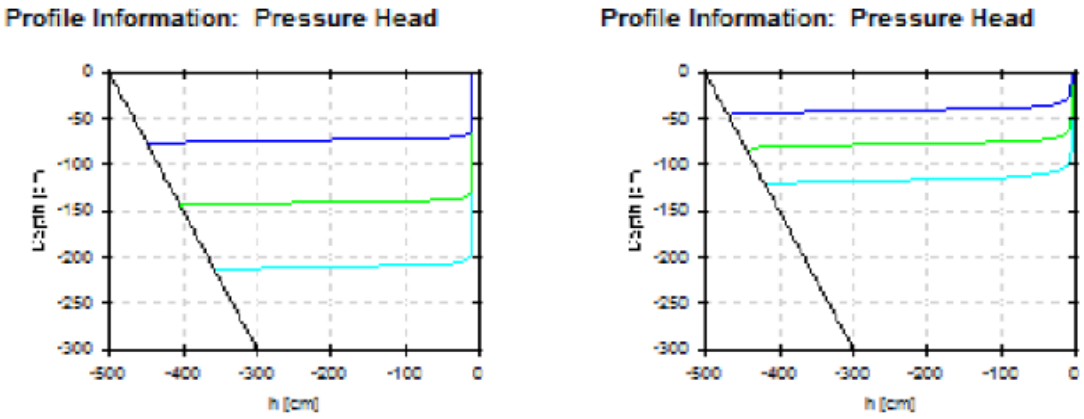
Sand Loam

Figure 4 :Depth and water content of both sand and loam.

In figure 4 we see that water content in sand does not reach water higher than 0.2 where as in loam ,water content exceed 0.2 of soil of depth -200cm depth . In loam water infiltrates slower

ther first day rain has not reach the bottom of soil. Whereas in sand , first day has already left from the soil due to faster infilterates .

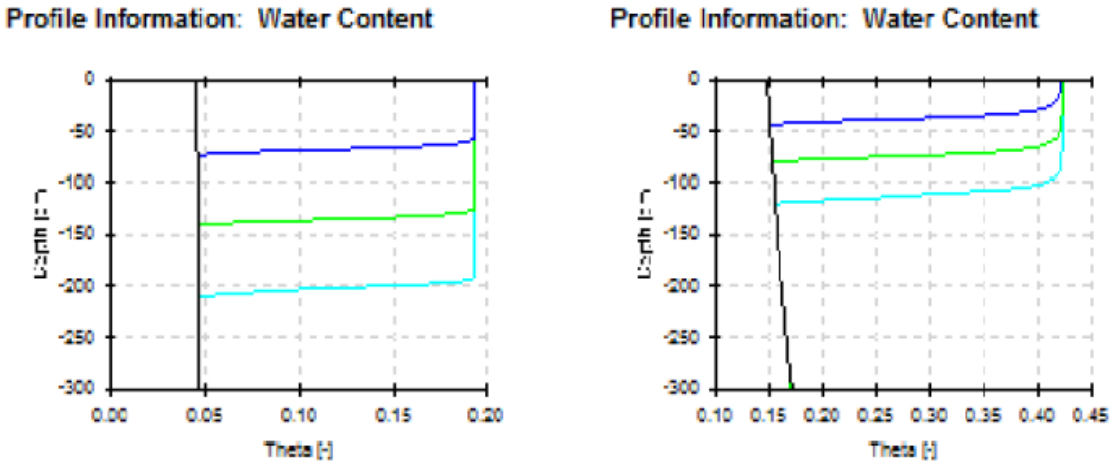
5.PRESSURE HEAD



Sand Loam

Figure 5 : depth versus matrix head for sand and loam of first three days

6.WATER CONTENT



Sand Loam

Figure 6 :Depth and water content of both sand and loam of first three days

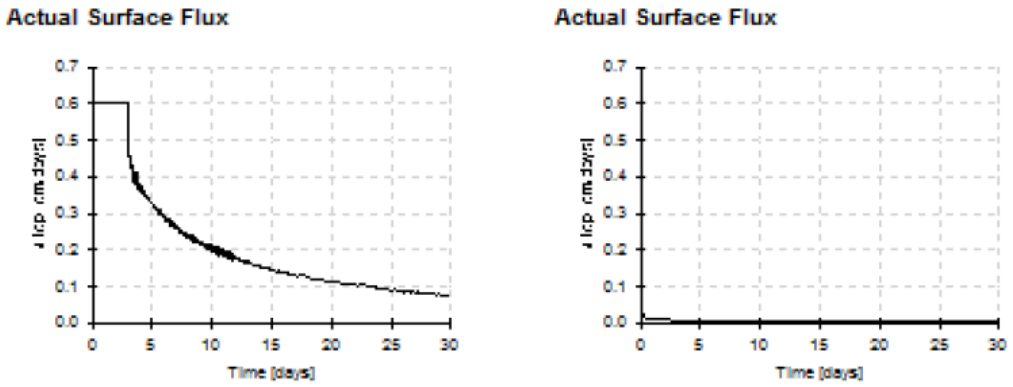
The first 3 days pressure head and water content of sand and loam is seen in figure 5 and figure 6 .The water in sand percolates faster whereas this process takes longer inloam. It is distributed differently.Accordingly, the suction/ matric potential gets less negative in sand up until greater depth than in loam in the same time

EXCERCISE 4 - EVAPORATION

Depth of soil profile is 50 cm,time is 30 days,Hydraulic Model -van Genuchten-Mualem
Hysteresis -No hysteresis
Upper boundary condition-Atmospheric BC with surface runoff
Lower boundary condition- No Flow (Boundary flux =0)

AT EVAPORATION RATE 0.6 CM PER DAY

1.ACTUAL SURFACE FLUX

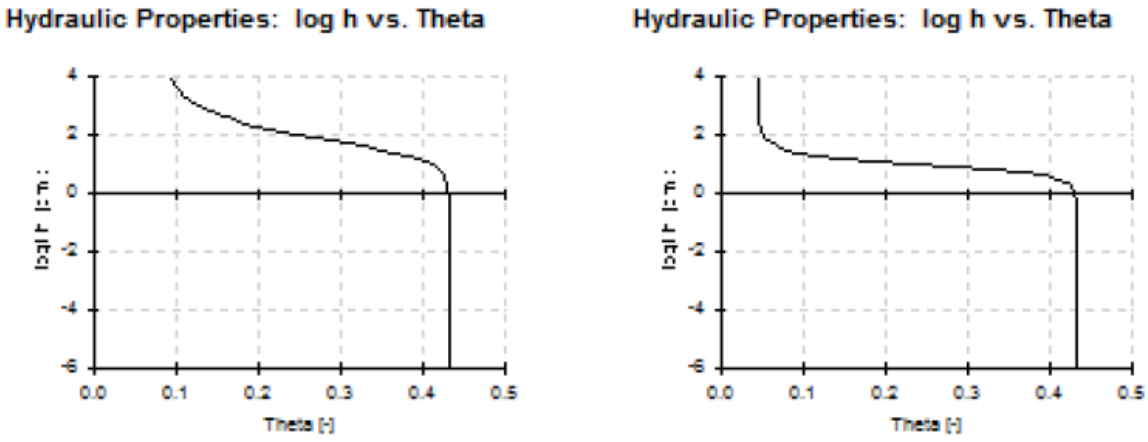


Loam Sand

Figure 1 :Actual Surface flux both sand and loam.

In figure 1,the actual surface flux is greater in loam due to water holding capacity is higher compare to sand its lesser.it based on formula ho= 0.15/r for loam pore size less higher capillary rise.

2.WATER RENTENTION CURVE

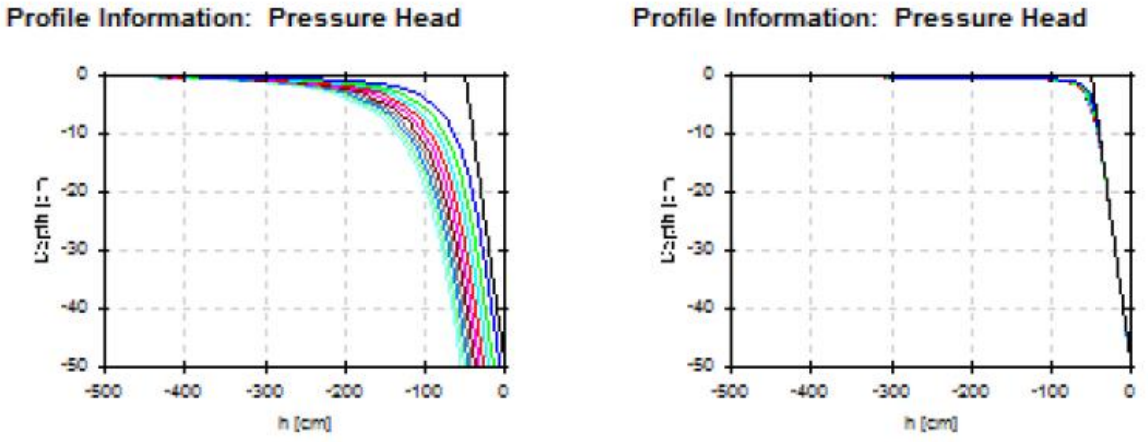


Loam Sand

Figure 2 gives the water retention curve of loam and sand

In figure 2 gives the water retention curve of sand and loam Here the air entry value for sand is less as shown in figure due to bigger pore size and water retain is low , where as air entry value for loam is more due to small pore size and water retain is high.

3.PRESSURE HEAD



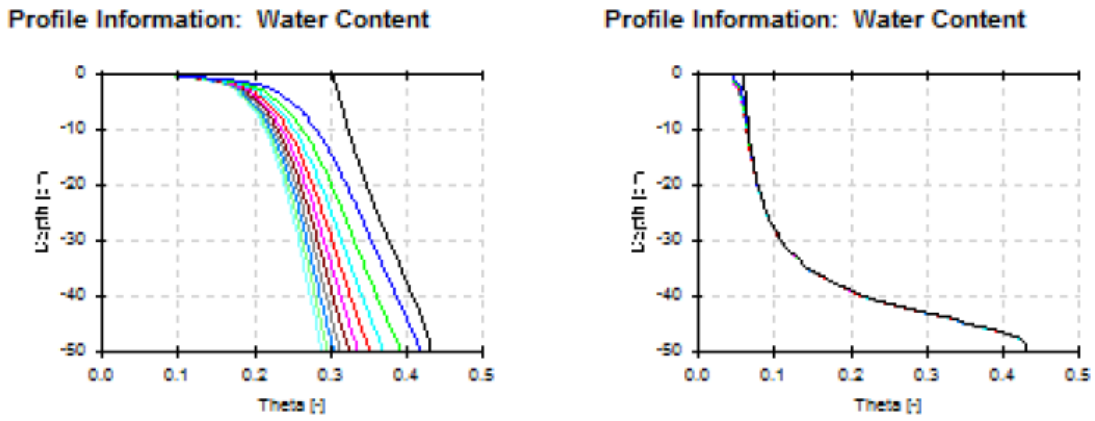
Loam Sand

Figure 3 : Depth versus matrix head for loam and sand

In figure 3,the loam as very negative h, where gradient increases more slowly and the amount of abstracted water is higher. Sand has higher negative values of h. where the gradient decreases more slowly in the beginning since per drop of matric potential a lot of water can be obtained; due to which conductivity loses.

As water evaporates top soil layer is dry and their conductivity decreases .there is crtical point where soil cannot takes sustain evaporation and evaporation drops

4.WATER CONTENT

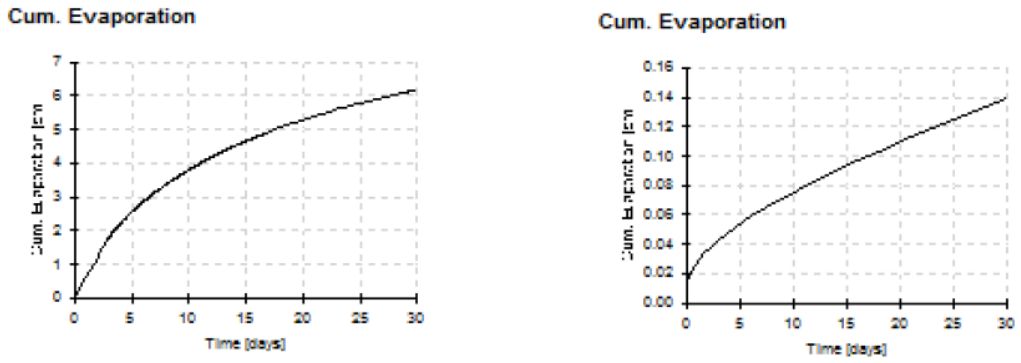


Loam Sand

Figure 4 : Depth versus water content for loam and sand

Sand only has a small amount of water in the topsoil, sand has low air entry value α is bigger due due to bigger pore size and for loam its vice versa larger due to which more water is lost. . The α value for sand is more than bigger than for loam.

5.CUMULATIVE ACTUAL EVAPORATION

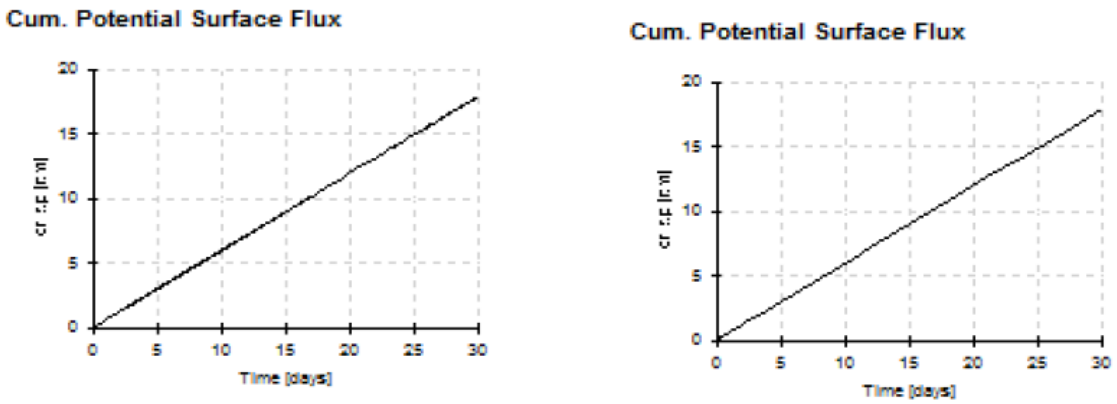


Loam Sand

Figure 5:Cumulative actual evaporation in loam and sand

The potential evaporation between soil types is equal (0.6 cm/day).
The differences between actual and potential evaporation are due to the fact that the conductivity of the soil is lower than the daily actual evaporation rate in loam .
For sand since its coarse texture tends to evaporates least whereas loam which is fine structure evaporation is most therefore more water is loss due evaporation will not recharge the soil.

6.CUMULATIVE POTENTIAL EVAPORATION



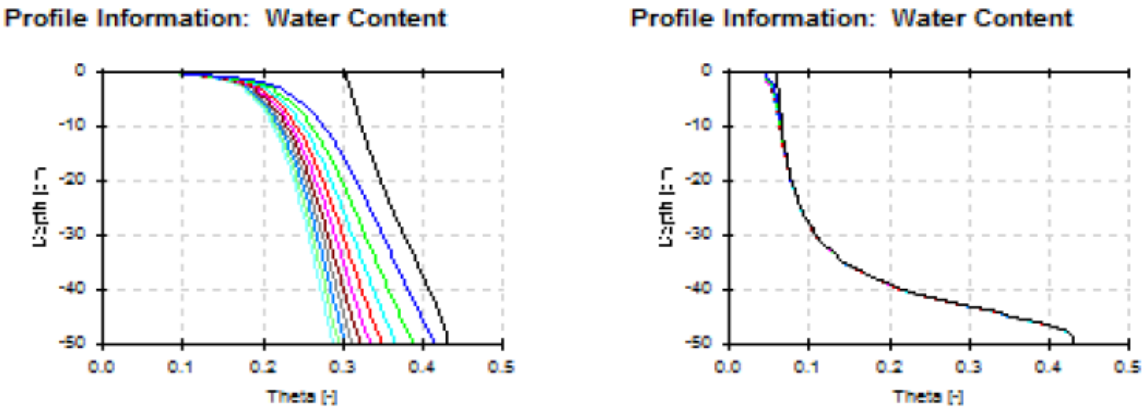
Loam Sand

Figure 6:Cumulative potential evaporation for both loam and sand

In figure 6,cumulative potential surface flux is same for both loam and sand

AT EVAPORATION RATE FOR 1.2 CM /DAY FOR SAME 30DAYS

1.WATER CONTENT

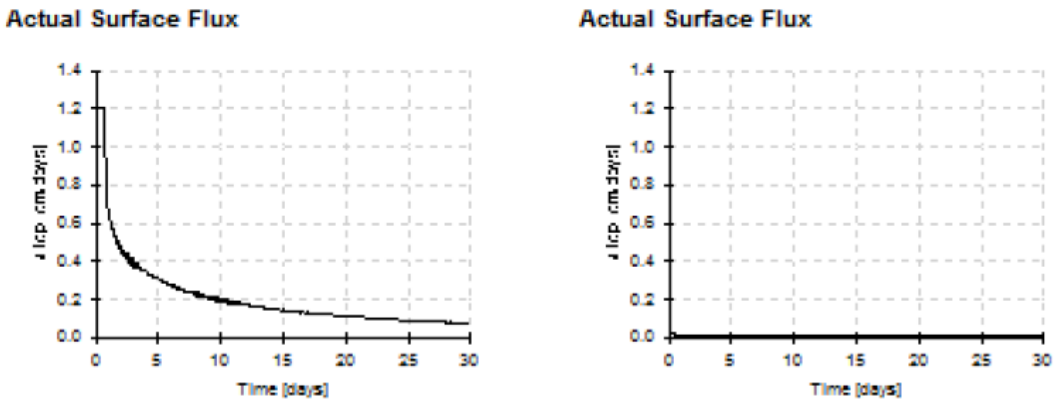


Loam Sand

Figure 4 : Depth versus water content for loam and sand

Similar to evaporation rate of 0.6cm/day sand only has a small amount of water in the topsoil, sand has low air entry value α is bigger due due to bigger pore size and for loam its vice versa larger due to which more water is lost. The value of α for sand is more than bigger than for loam.

2:ACTUAL SURFACE FLUX



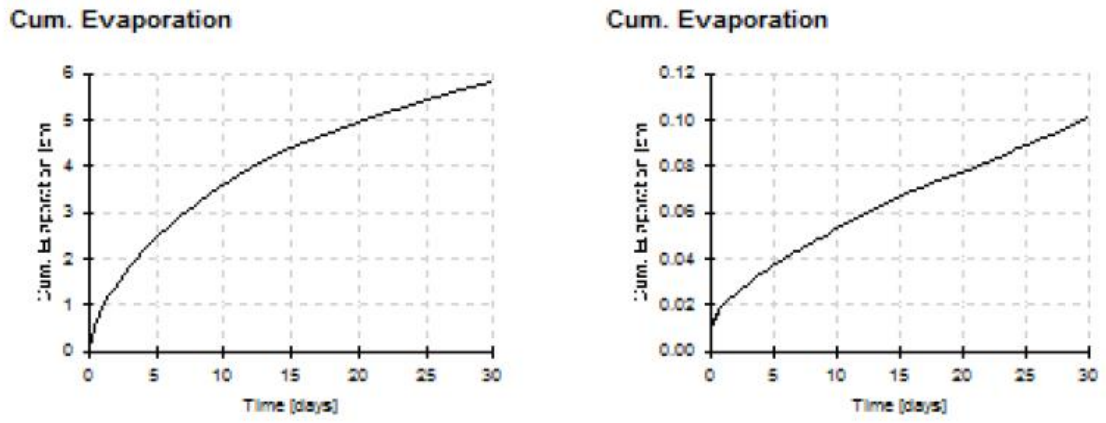
Loam Sand

Figure 2 :Actual Surface flux both sand and loam.

In figure 2,the actual surface flux is greater in loam due to water holding capacity is higher compare to sand its lesser.it based on formula ho= 0.15/r for loam pore size less due to which higher capillary rise.since sand is wet the evapration rate drop faster.

Therfore of evaporation can remain nearly constant as long as the moisture gradients Toward the surface compensate for the decreasing hydraulic conductivity

3.CUMULATIVE ACTUAL EVAPORATION



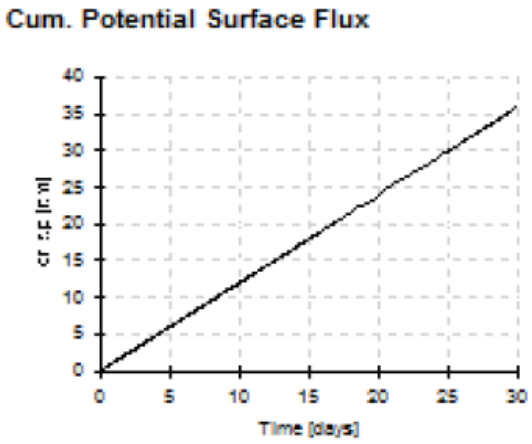
Loam Sand

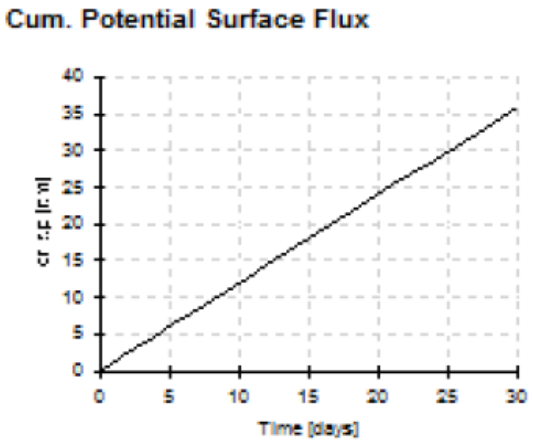
Figure 3:Cumulative actual evaporation in loam and sand

In figure 3, for sand since its coarse texture tends to evaporates least whereas loam which is fine structure evaporation is most therefore more water is loss dur evaporation will not recharge the soil.

During the initial stage, the soil surface gradually dries and soil moisture is drawn upward in response to steepening evaporation-induced gradients. The rate of evaporation can remain nearly constant as long as the moisture gradients toward the surface compensate for the decreasing hydraulic conductivity

4.CUMULATIVE POTENTIAL EVAPORATION





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Loam Sand

Figure 6:Cumulative potential evaporation for both loam and sand

In Figure 6,cumulative potential surface flux is same for both loam and sand at 1.2cm/day