THE FEASIBILITY STUDY OF USING EXTERNAL ELECTRIC FIELD TO REDUCE THE LIGHTNING HAZARDS

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Outline

- 1.Introduction
- 2.Project objectives
- 3.Governing equations
- 4.Physical relationships
- 5.Simulation model
- 6.Simulation results
- 7.Summary and Conclusions

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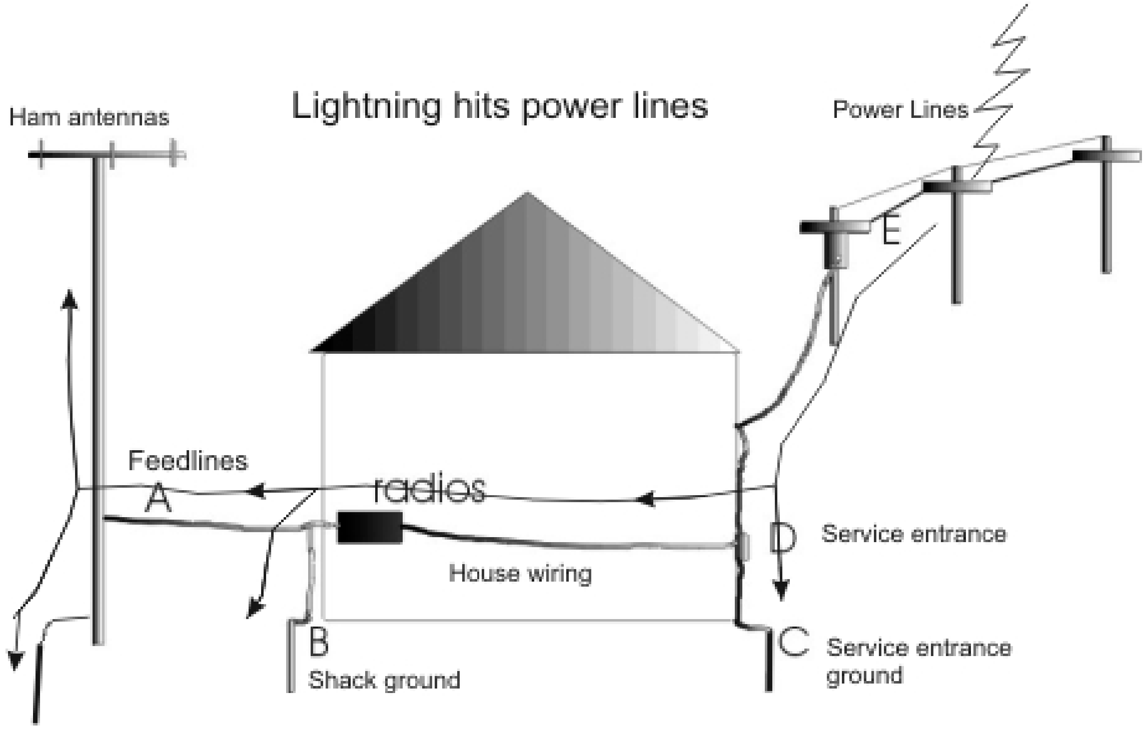
1. Introduction



Dangerous!! May cause casualties and economic loss!!

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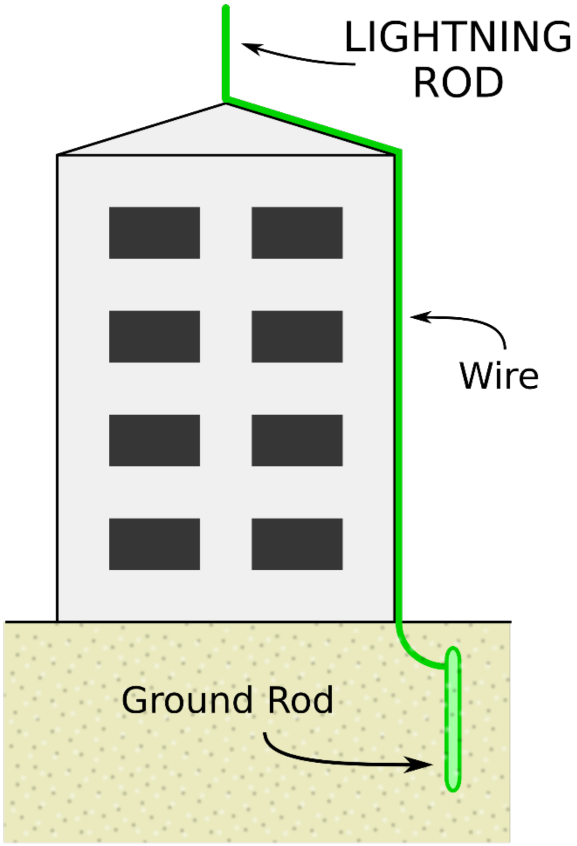
1. Introduction



Does it work effectively?

The surrounding soils should have high electric conductivity.

High moisture content!

1. Introduction

Four main gradients driving water flows.

1. Height gradient;
2. Electric gradient;
3. Chemical gradient;
4. Thermal gradient.

If we put an anode around the ground rod, will it help to maintain high moisture content?

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2. Project objectives

Is it feasible to drive water flow by putting an anode?

How efficiently does it help to hold water?

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3. Governing equations

The coupled electro-saturated-unsaturated water flow:

$$S_r \frac{d(H+z)}{dt} = div[K_h \nabla (H+z) + K_{eo} \nabla V]$$

Electric potential:

$$div(K_{eo} \nabla V) + \phi = 0$$

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4. Physical relationships

Electric conductivity of soils:

$$\sigma_e = K\sigma_w S_r^a n^b$$

Hydraulic conductivity of soils:

$$\sigma_e = S_e^{\ 0.5}\left[1-\left(1-S_e^{\ 1/m}\right)^m\right]^2$$

A function of degree of saturation

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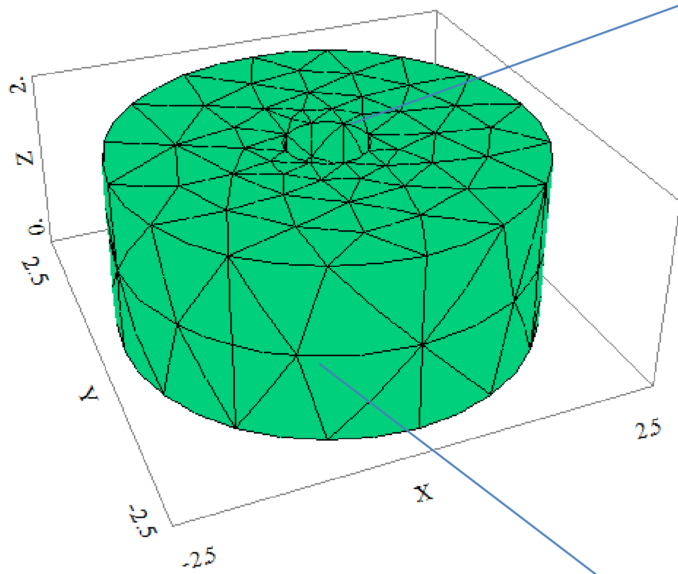
5. Simulation model



Anode

Height: 2m

External Dirichlet boundary:
H=0.5m

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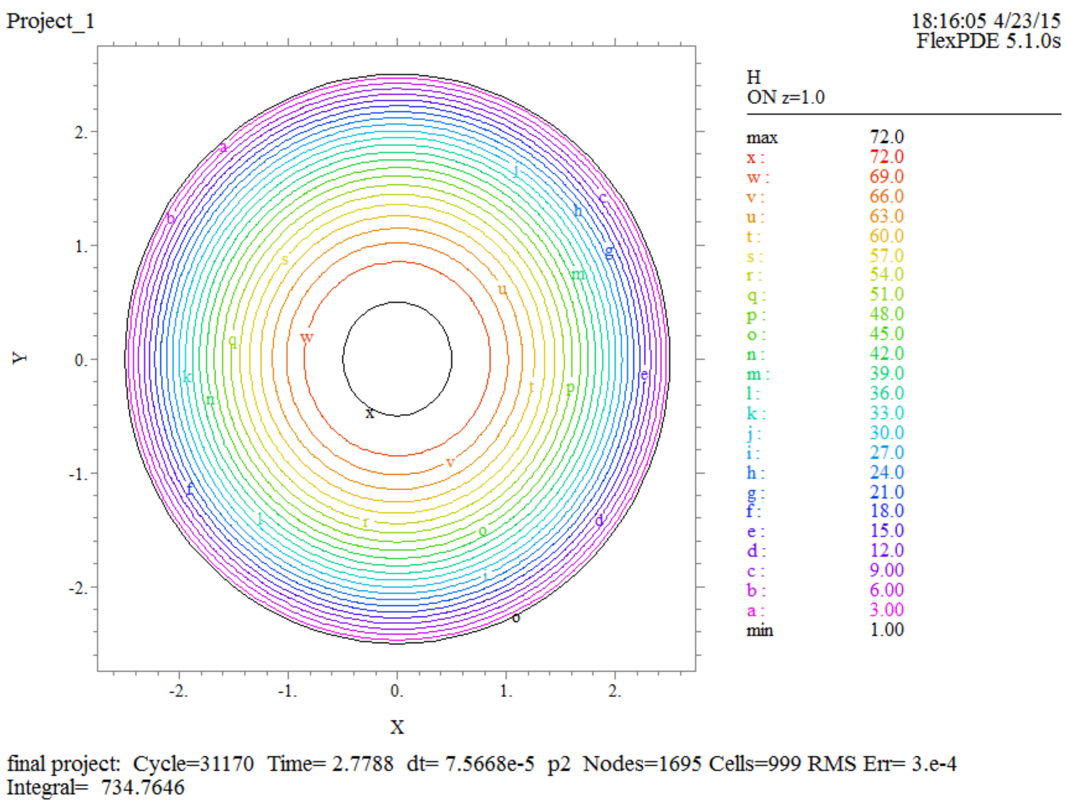
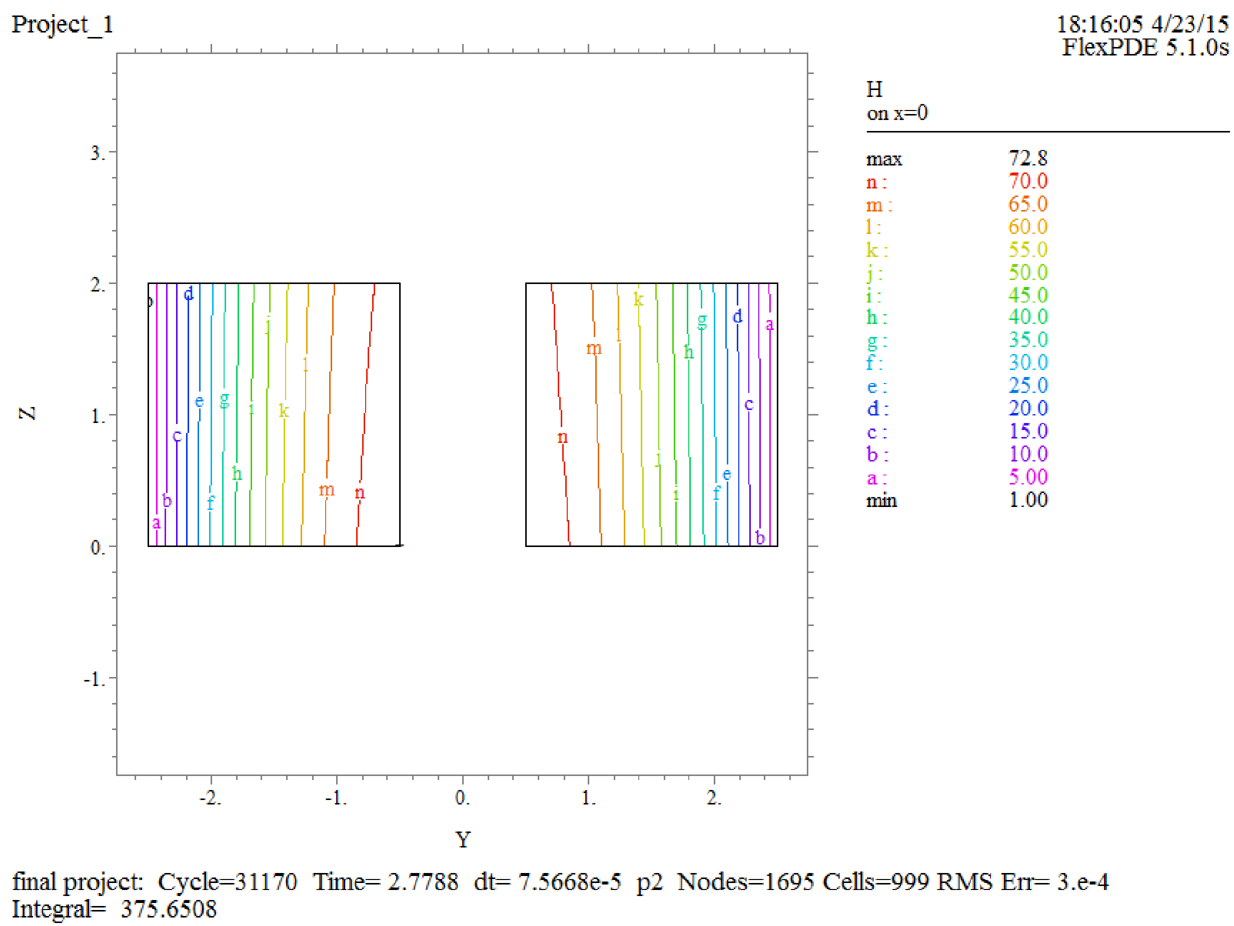
6. Simulation results

Vertical view



6. Simulation results

Cross section view



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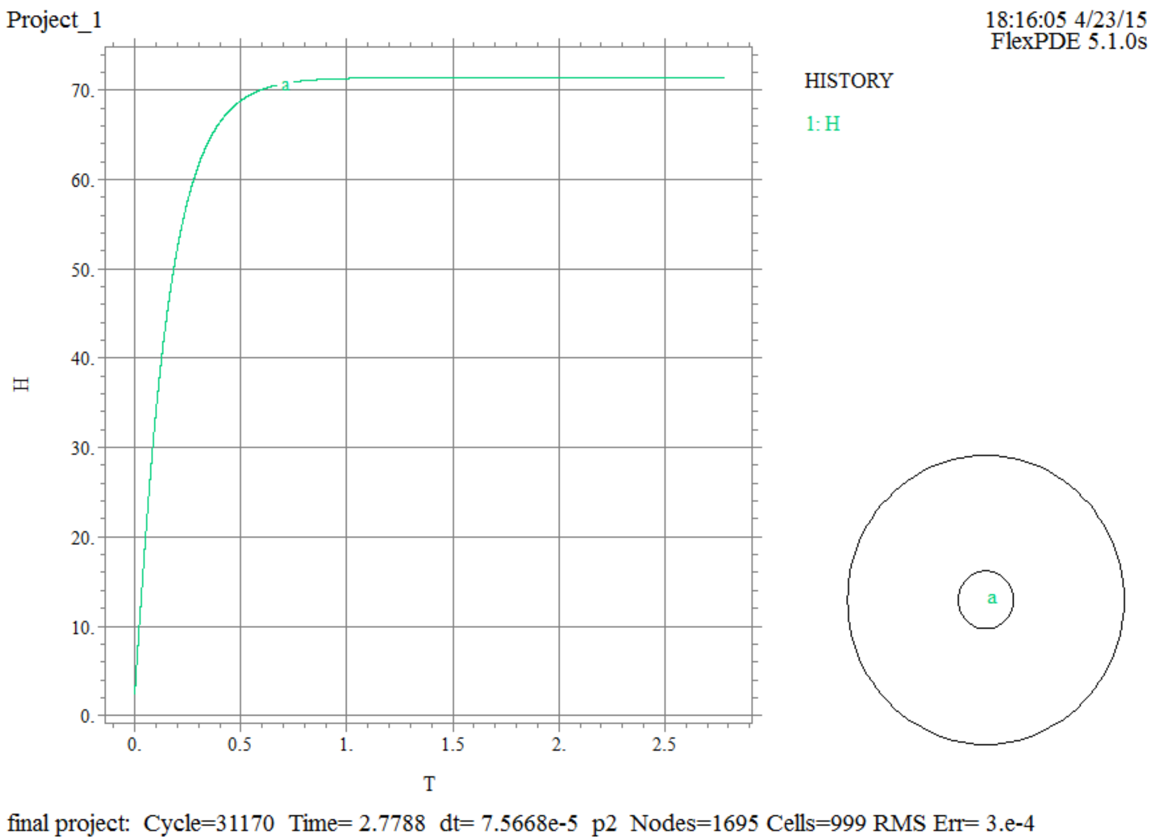
6. Simulation results

Water head around anode



Always saturated

The simulation region is not big enough

6. Summary and conclusions

- External anode has the potential to help hold water.
- The coupled electro-saturated-unsaturated water flow could be easily decoupled by defining a state variable as degree of saturation.
- In this preliminary study, many empirical equations is used which needs careful treatment.

Thank you

- Questions?