Institute of Energy and Sustainable Development

FOUNDATION HEAT EXCHANGER RESEARCH

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GSHPA Research Seminar

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What is a Foundation Heat Exchanger?

- A novel horizontal closed loop heat exchanger for residential buildings
- Minimises cost by making the most use of foundation/basement excavations and service trenches
- Horizontal loops are fixed to the outside of the excavations before they are backfilled.

FIRST PHASE FHX DEVELOPMENT

- Early trials in Tennessee monitored by Oak Ridge National lab
- Trial designs were dictated by site conditions and building form – no design tools were available and no optimisation was possible

- Trials were successful but questions remain:
  - Long term performance?
  - Sensitivity to building form and occupancy patterns?
  - Feasibility in other climates?
  - Design and simulation methods need to be development

THE CURRENT PROJECT

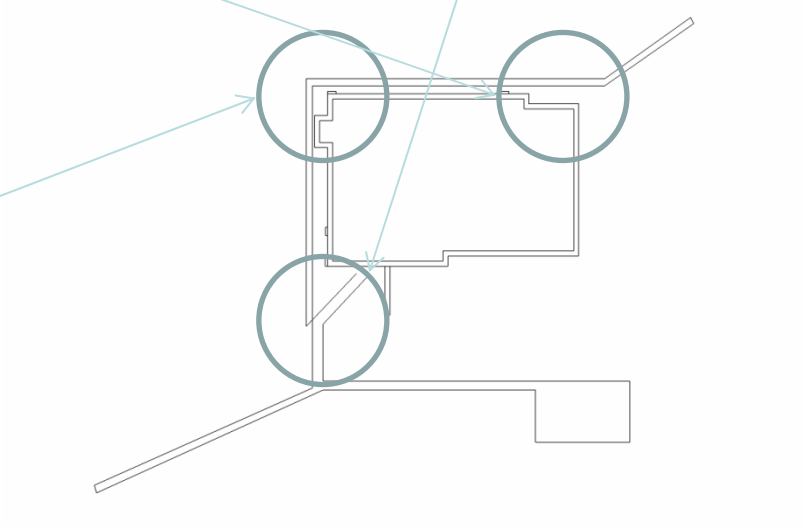
"FOUNDATION HEAT EXCHANGER DESIGN TOOL DEVELOPMENT AND VALIDATION"

- US Department of Energy funded project in partnership with Oklahoma State University and Oak Ridge National Lab
- The novel heat exchanger has been installed in two experimental low energy houses in Tennessee
- Oklahoma State University is working on design tool development
- DMU is working on implementation of a numerical model in the building simulation tool EnergyPlus

EXPERIMENTAL HOUSING

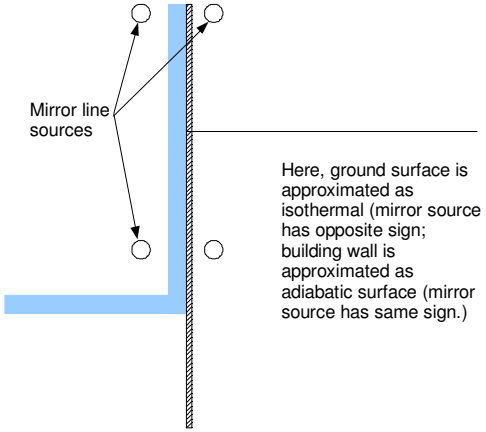
- Two Low Energy houses have been instrumented in Oak Ridge Tennessee – SIPS and advanced framed construction
- FHX is installed around two sides of the basements and in the service trenches
- Soil thermal conductivity and undisturbed temperatures have been measured
- Wall heat fluxes and system, wall and soil temperatures are being collected over a 2 year period for model validation

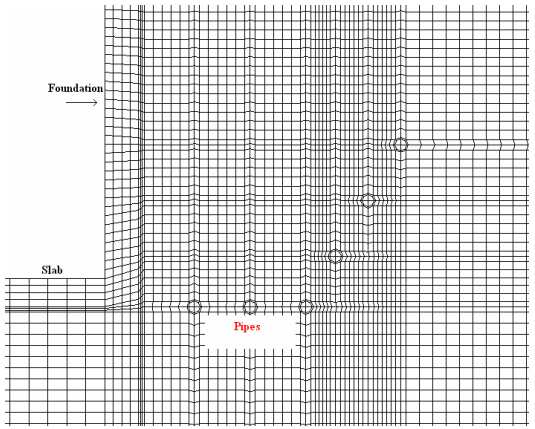
FHX INSTRUMENTATION



DESIGN TOOL DEVELOPMENT

- OSU are studying two approaches to design tool development:
  - Superposition of responses calculated using an analytical "line-source" solutions
  - A course-grid 2D finite difference model



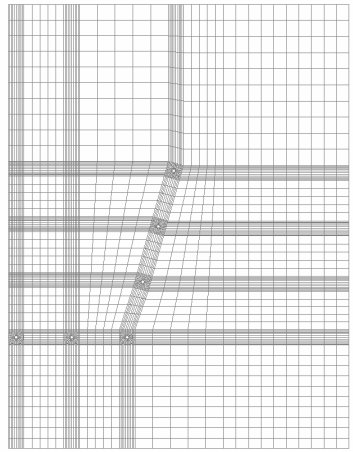


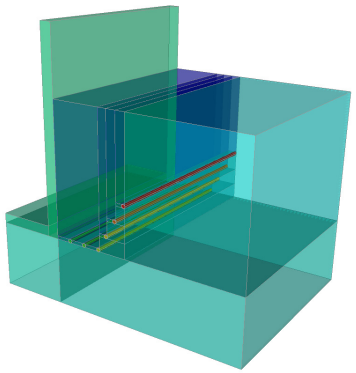
NUMERICAL MODEL DEVELOPMENT

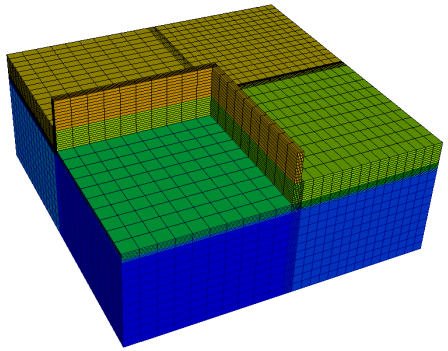
- A detailed FHX model is being developed using the GEMS3D Finite Volume Method code and will be used to:
  - Model the system in the experimental buildings in 3D
  - Form a reference for comparison with simpler models
  - Incorporate a component model in the building simulation program EnergyPlus (probably 2D)
- The code has been validated using the IEA Annex 43 BESTEST analytical and inter-model test suite for ground coupled buildings

2D OR NOT 2D: THAT IS THE QUESTION?

- A tool has been developed to generate 2D computational meshes from basic design parameters. This is essential for a robust model suitable for routine building simulation tasks.
- A 2D representation may be good enough but three-dimensional effects (e.g. corners) are known to be significant in predicting slab and basement heat transfer
- Currently a 3D model is probably too slow for annual simulation tools
- The limitations of 2D models are being explored – a 2 ½ D model is conceivable







RESEARCH QUESTIONS

- Coupling between the FHX and building zone models
- Interactions between the FHX and the basement
- System feasibility and scalability:
  - Building form
  - Fabric design
  - Internal heat gains
  - More extreme climates

QUESTIONS

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