UNIVERSITY OF MARYLAND
Department of Fire Protection Engineering

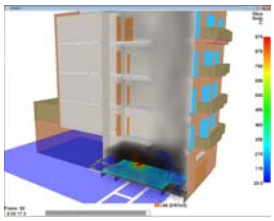
Engineering Methods for Fire Safety Design

Engineering Methods-Agenda

- What are engineering methods?
- Types
- Examples

Engineering Methods

- Tools used to help evaluate and incorporate aspects of designs



Engineering Methods-Uses

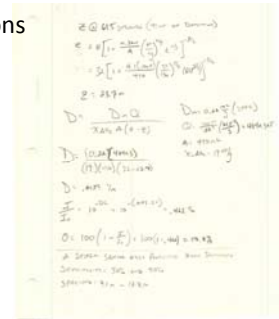
- Determine system capability
- Determine analysis data
- Evaluate hazards
- Determine designs
- Validate designs
- Review risks

Engineering Methods-Types

- Hand calculations
- Fire tests
- Models
  - CFD
  - Egress
  - Acoustic

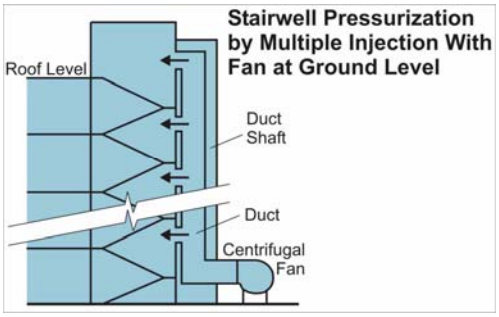
Hand Calculations

- Simple calculations
- Define approx. conditions



Hand Calculations - Example

- Stairwell Pressurization System



Hand Calculations - Example

IL Allovlable Height Limit

The maximum allowable height lirnit, Hm, is given as:

$$H_m = K_m \left[\Delta P_{max} - \Delta P_{min} \left[1 + \left(\frac{A_B}{A_{BO}} \right)^2 \right] \right] \left[\frac{1}{T_O} - \frac{1}{T_B} \right] \quad \text{[Eq 10.19. Klote and Milke 2002]}$$

\\'here:

H_m = maximum allowable height limit

K_m = constant, 0.131

ΔP_{max} = maximum allovved pressure difference, 0.35 in. H_2O

ΔP_{min} = 1inimum allowed pressure difference, 0.0 in. H_2O

TO = absolute te1nperature of outside air: 22 or - 12 + 459.67 °R

Ts = absolute temperatu re of air in stair: 70 + 459.67 °R

A_{58} = leakage from stairwell to buildin g, 0.399 ft2.
(Using average leakage factor for walls and loose leakage factor for doors)

ABo = leakage fro1n stairwell to building, 1.03 ft^2.
(Using average leakage factor for walls, doors and windows)

Fire Tests

- Small vs. Full Scale
- Input for designs
- Validation of designs and models

Modeling Methods and Programs

- Can be used for:
  - Fire Scenarios
    - FDS
    - CFAST
  - Smoke Control
    - FDS
    - CONTAM
  - Evacuation and Egress
    - Exodus
    - Pathfinder
  - Acoustic
    - EASE Evac

NIST

the UNIVERSITY of GREENWICH

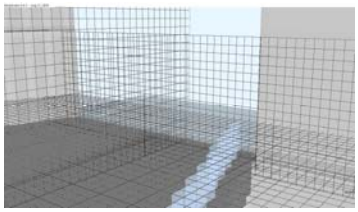
HUGHES ASSOCIATES

EASE Evac

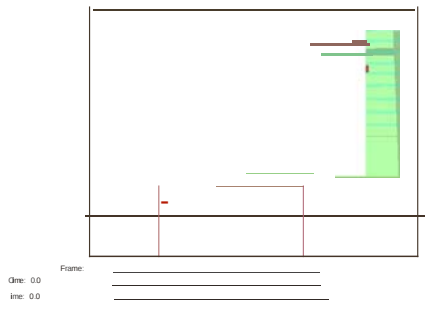
Example of Evaluation Method

- Computational Fluid Dynamics (CFD) Modeling

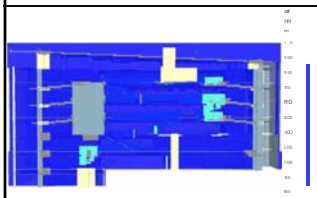
  Fire Dynamics Simulator – Developed by NIST
  - Simulation of heat and smoke transport
  - Divide domain into rectilinear numerical grid



FDS Simulation



FDS Simulation



No Exhaust

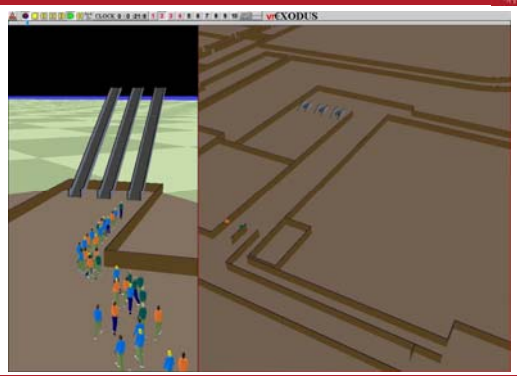
With Exhaust

Example of Egress Analysis

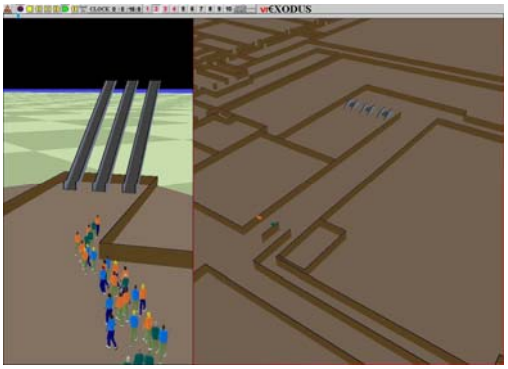
Timed Egress Analysis

Egress Time + Safety Factor < Time to Hazard?

Exodus Simulation



Exodus Simulation



Summary

- Engineering methods help you evaluate fire safety concepts
- Types includes
  - Models,
  - Hand calculations and
  - fire tests
- Uses include
  - Demonstrate design
  - Validate approach

Discussion Topic

- How do fire protection engineers decide what level of fire safety should be provided in buildings?
- What roles do regulations and codes provide in setting fire safety requirements?
- What engineering methods are available as decision aids in determining what fire protection systems to include in buildings?