FHWA COMPASS

(Concrete Mixture Performance Analysis System)

Tennessee Concrete Pavement Conference

2009

by
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New Conditions Create New Problems

- State highway agencies are changing the rules to how they award construction projects.
  - Warranties
  - Time constraints
  - Performance specifications
- New rules = more risk for contractors

New Conditions Create New Problems

- Today, we want to know things like, "If I plan to build an 8" JPCP in July in Madison with a 5 year warranty, what properties should I design for?"
- Or, "How can I design a mix using 3 or even 4 aggregates?"
- Or, "What's the best way to get 550 flex strength at 28 days for the lowest cost, with the least cement?"

Welcome to COMPASS

- Computer-based guidelines for job-specific optimization of paving concrete
- Purposes:
  - For use by concrete pavement designers/engineers, researchers, and concrete suppliers
  - For the purpose of designing with conventional concrete-making materials
  - For JPCP, CRCP, and patch/repair mixtures

Welcome to COMPASS

- **COMPASS does 2 things:**

1. **Guides the user through the mix design process.**

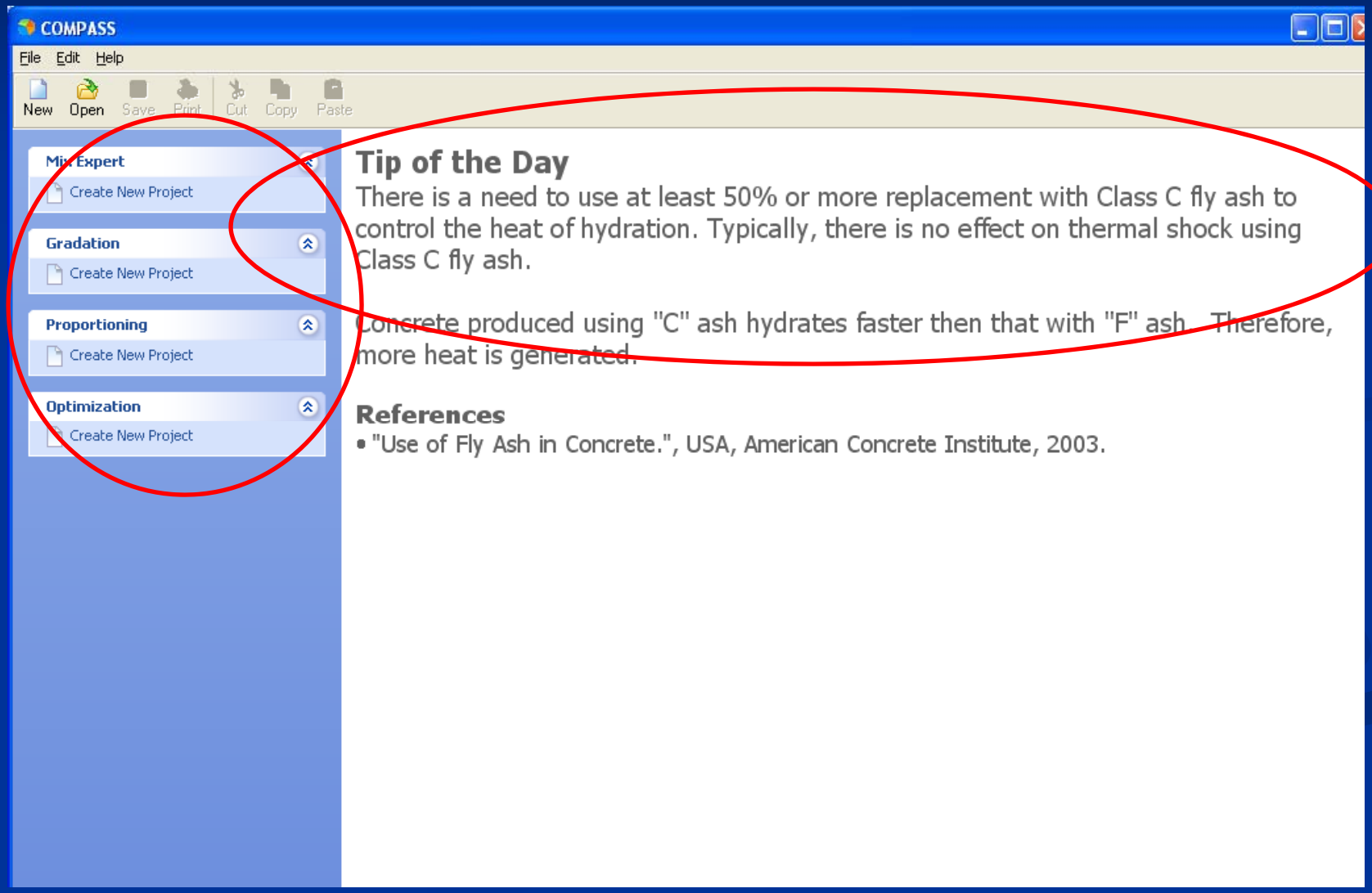
1. **Guides the user in optimizing mix designs.**

The COMPASS System

- **COMPASS has 4 tools. You can use one of them, or all of them:**

1. **Mix Expert (identifies important properties and offers materials advice)**
2. **Gradation (blends multiple aggregates for the best gradation)**
3. **Proportioning (ACI 211, with modifications)**
4. **Optimization (pick the best combination of materials for the specific criteria of your project)**

Mix Expert Module



Mix Expert Module

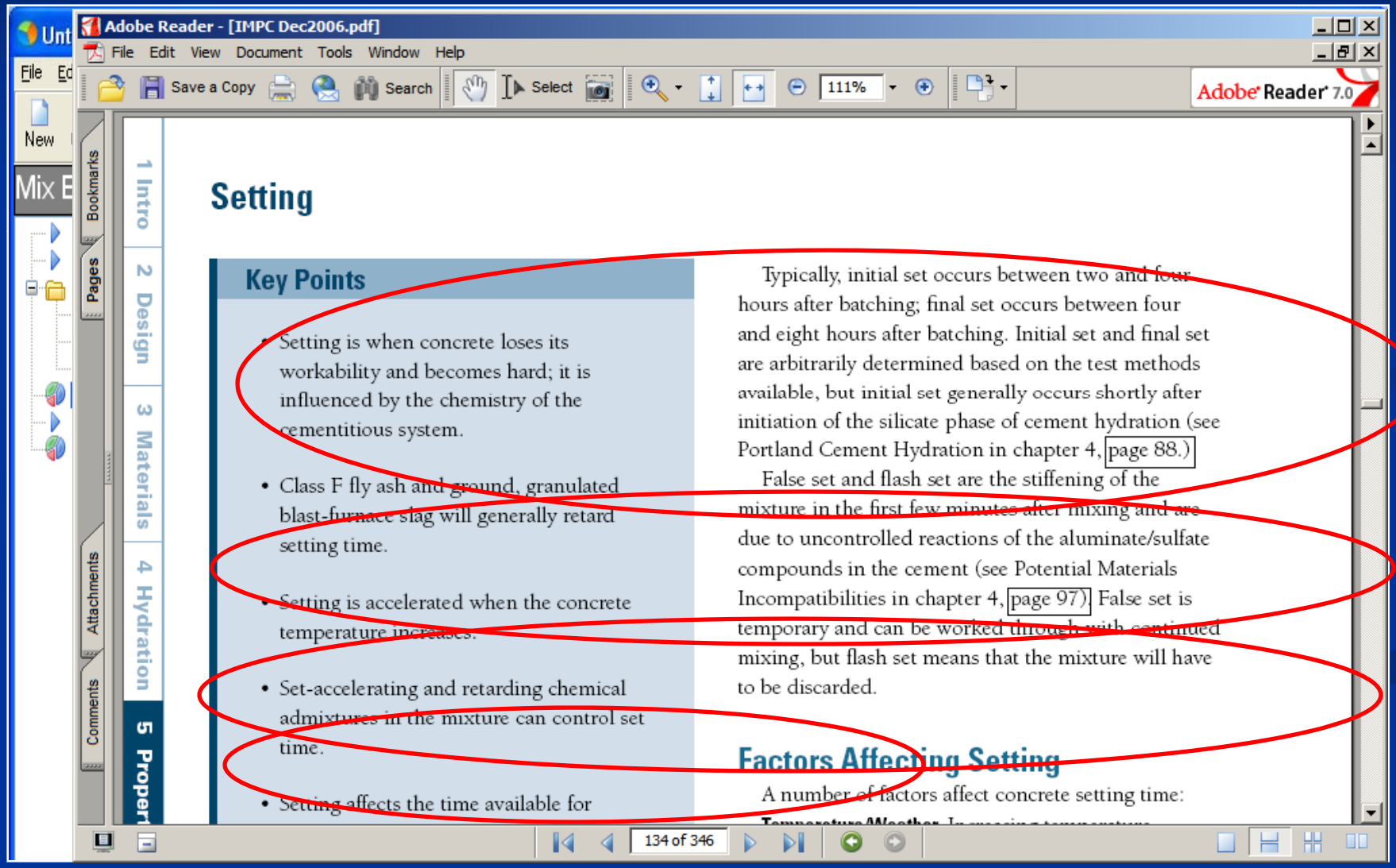
Site Specific Conditions

- Project Type
- Design & Construction Info
- Climate
- Exposure

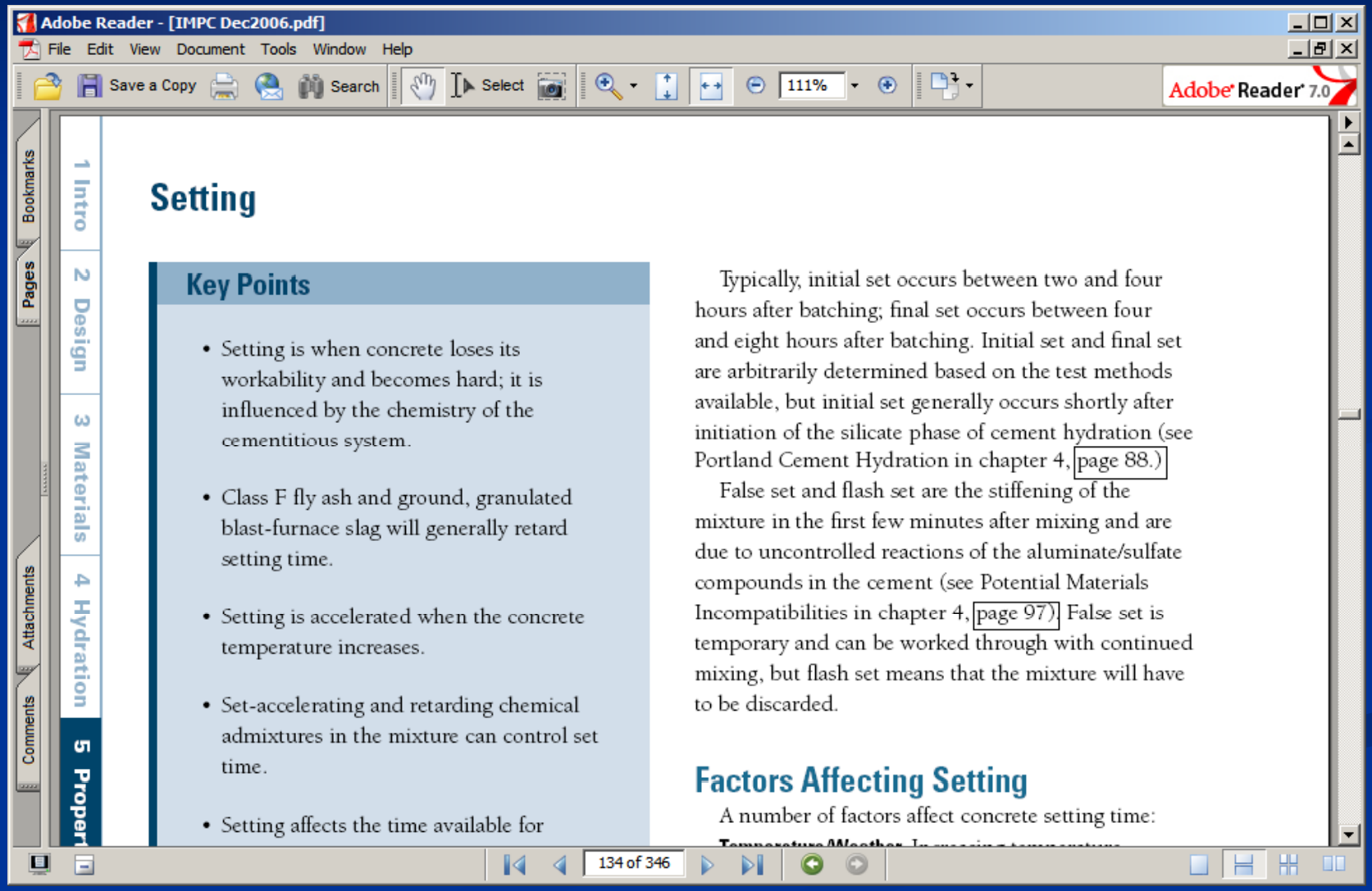
Performance Criteria Recommendations

- Important PCC Properties
- Recommended Test Methods
- General Recommendations

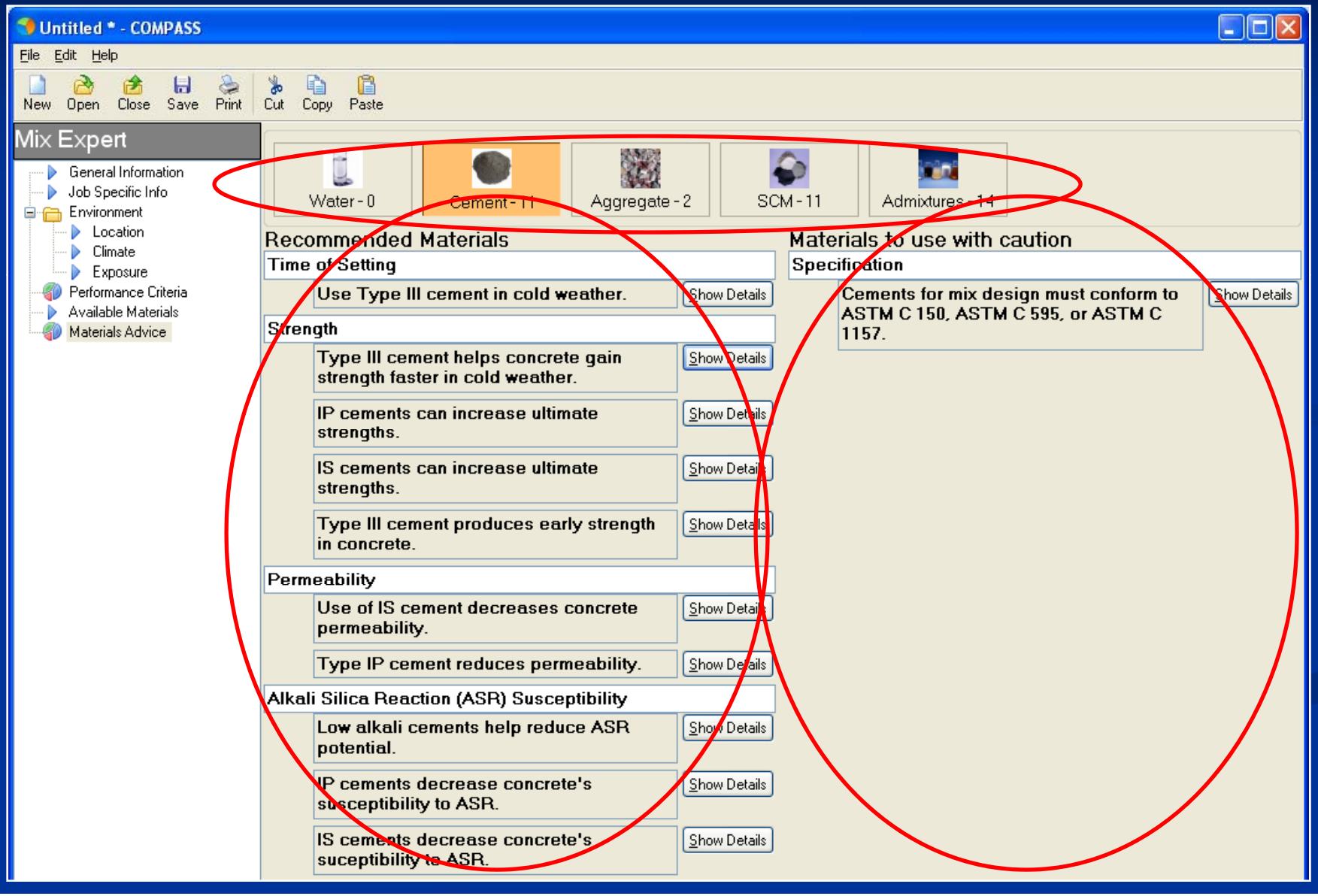
Mix Expert Module



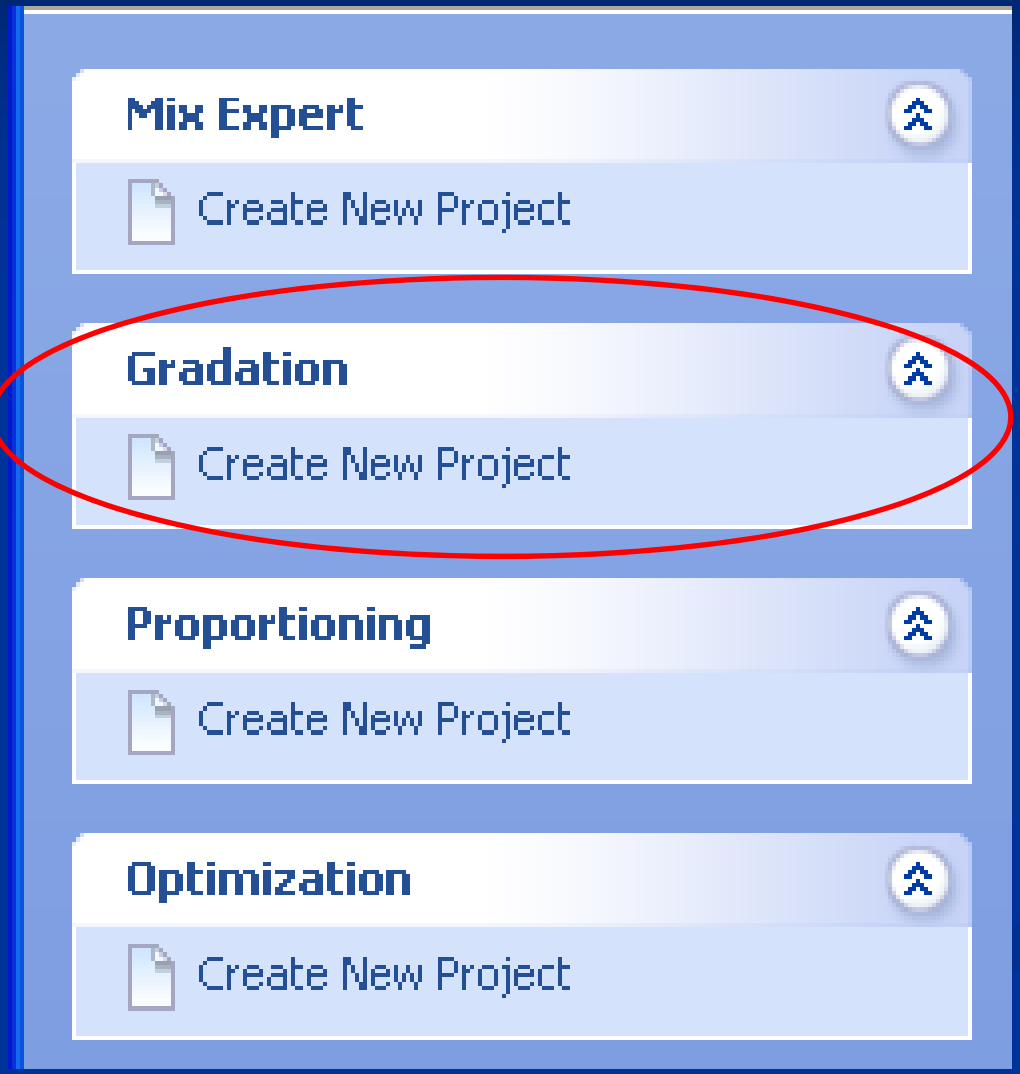
Mix Expert Module



Mix Expert Module



Gradation Module



Module purpose:

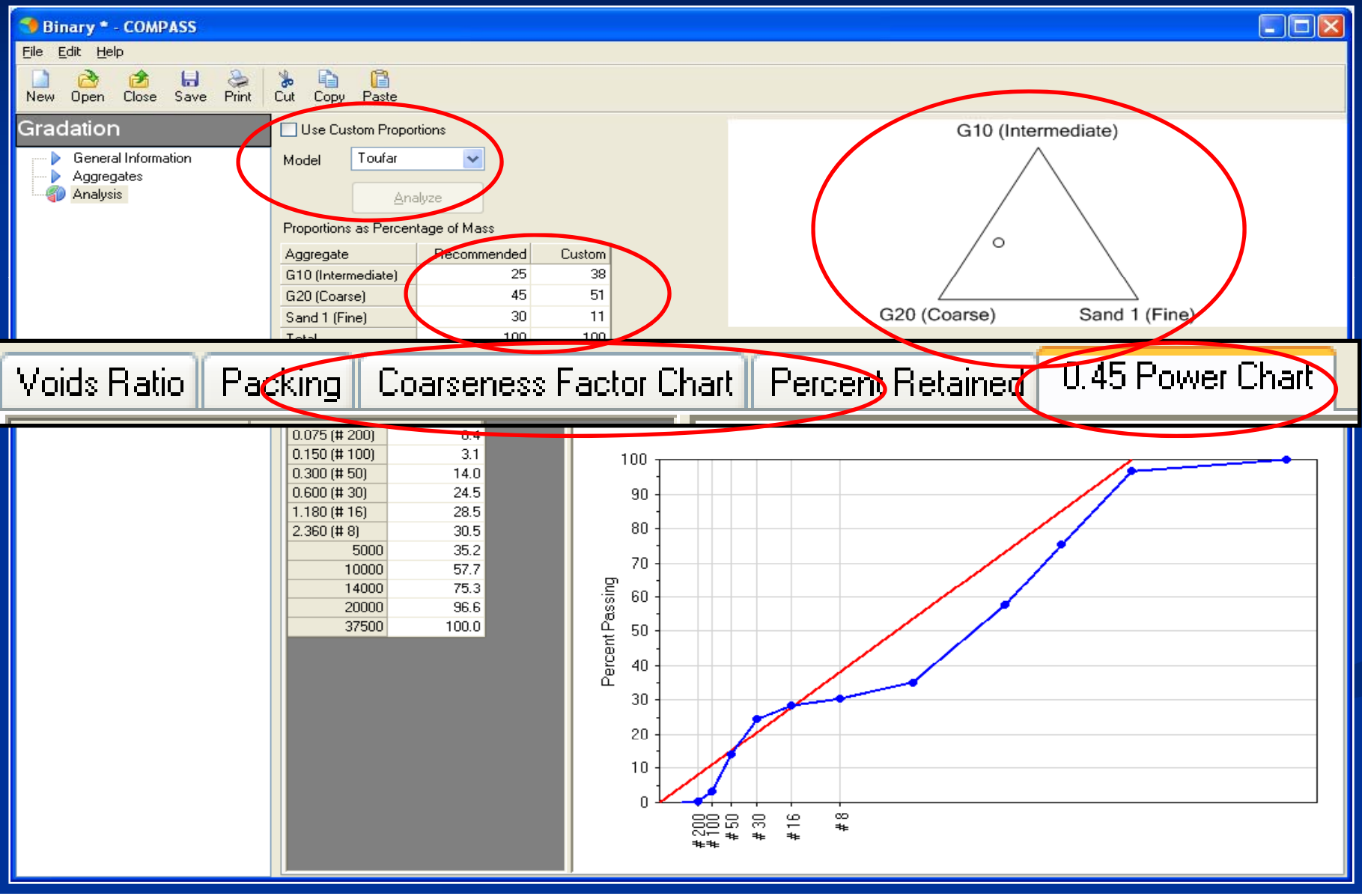
Optimize blending of aggregates for:

- Durability
- Strength (adequate not max)
- Workability, and
- Cost

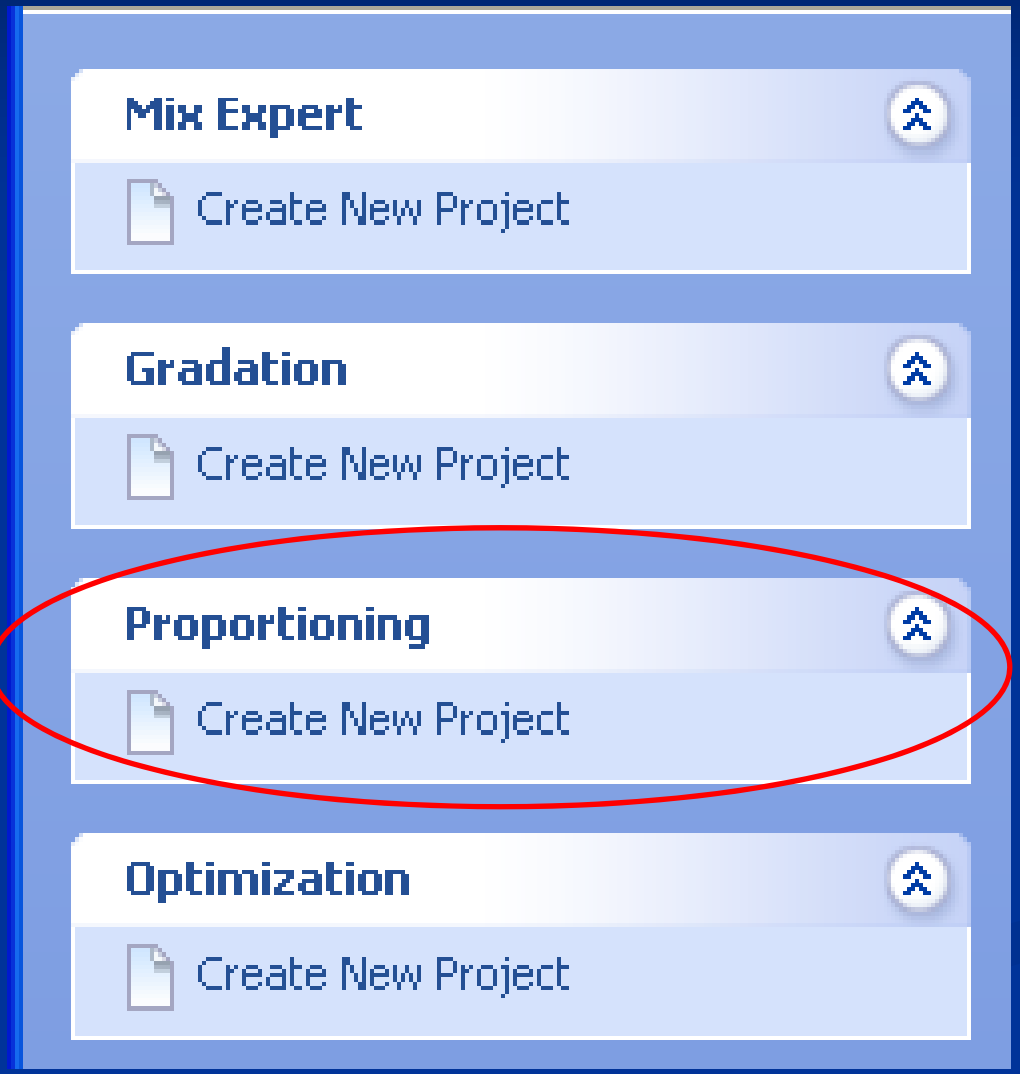
Gradation Module

- Models
  - De Larrard
  - Dewar
  - Toufar
- Plots
  - Coarseness factor chart
  - Power 0.45 chart
  - Percent Retained (8-18 chart)

Gradation Module



Proportioning Module

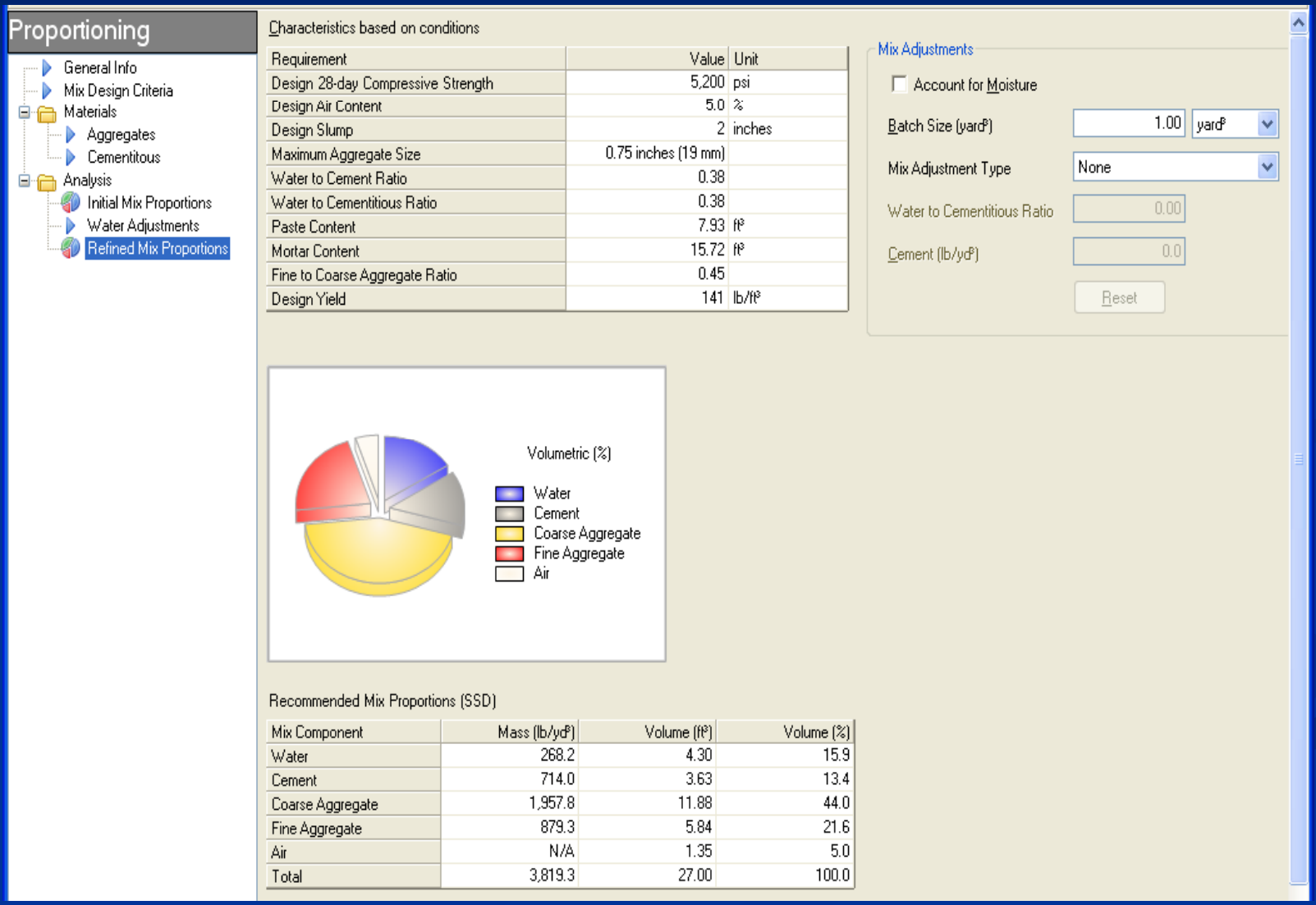


Module purpose:

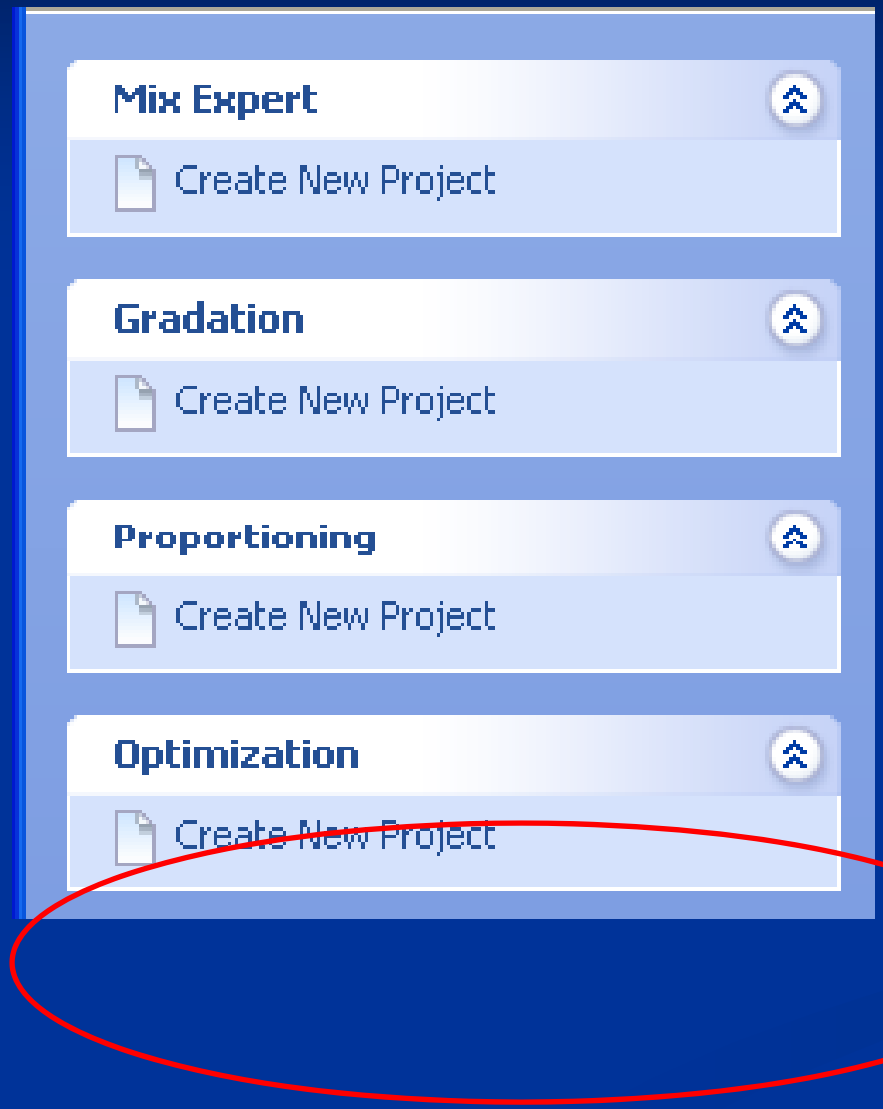
Allow user to create a mix design based on user-defined criteria. (ACI 211)

Proportioning Module

Proportioning Module



Optimization Module



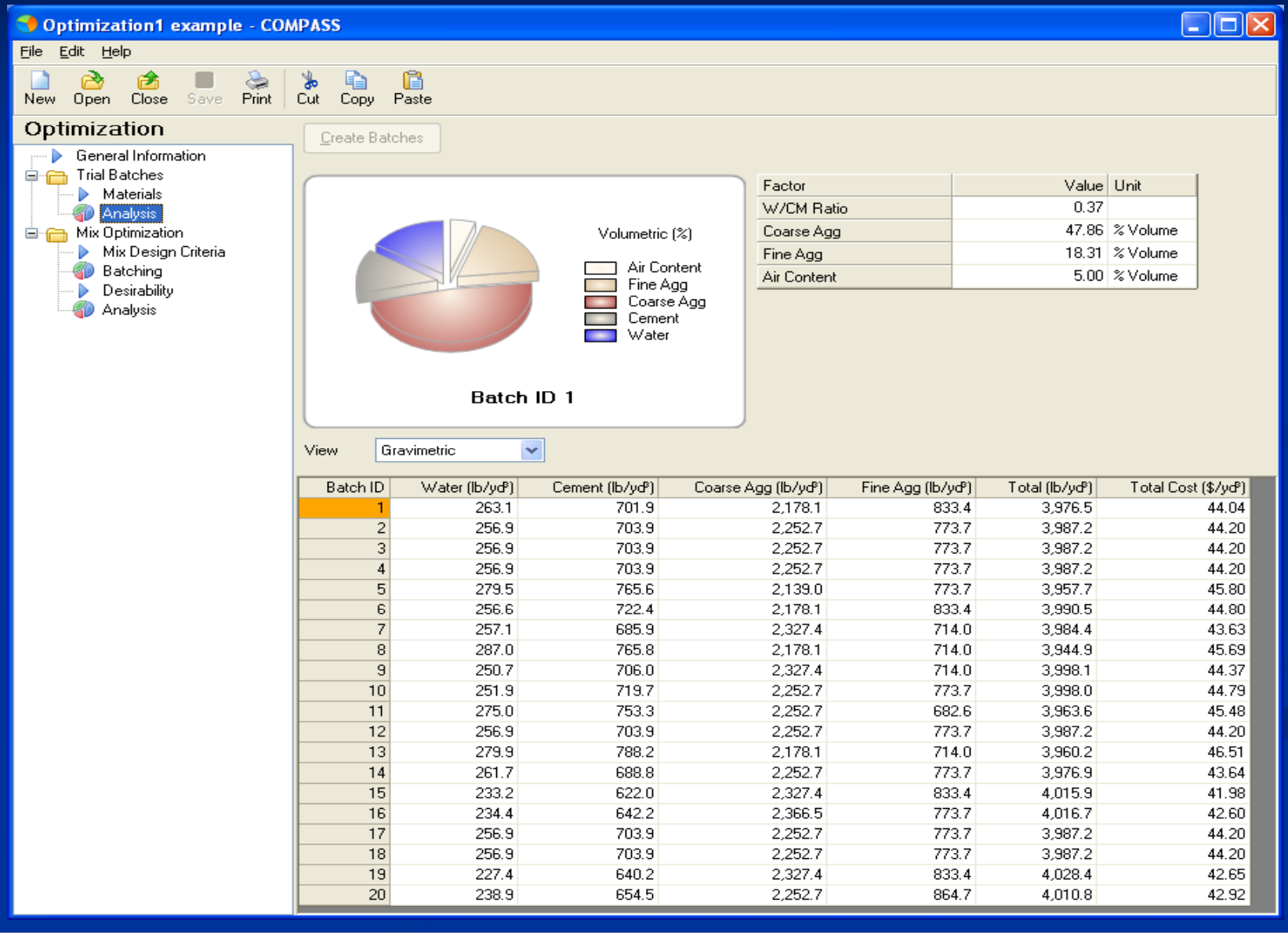
Module purpose:

To create a list of alternative mix designs that meet job-specific criteria.

Based on FHWA and NIST's COST software

Optimization Module

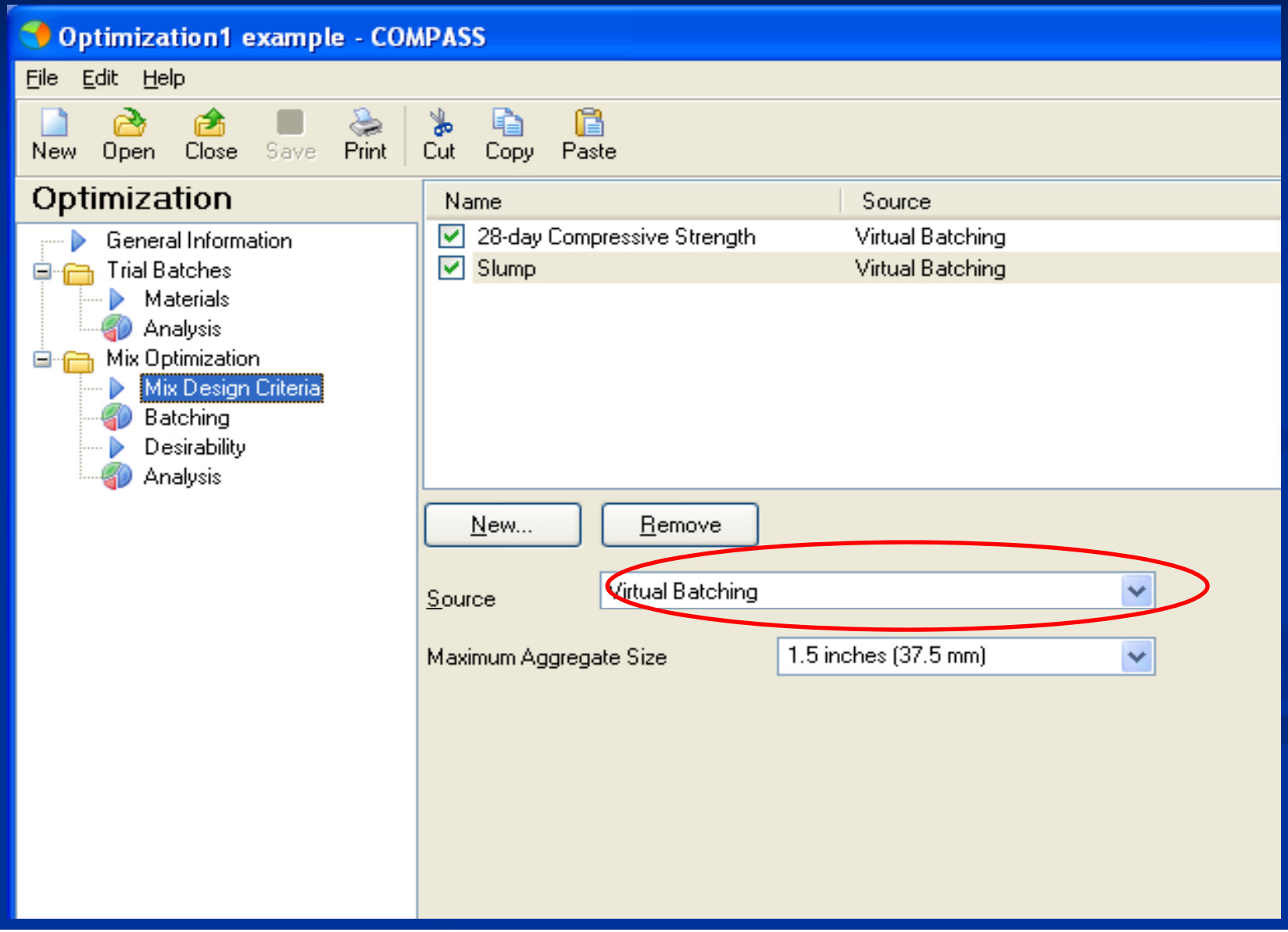
Create Trial Batches...



Batch ID	Water (lb/yd³)	Cement (lb/yd³)	Coarse Agg (lb/yd³)	Fine Agg (lb/yd³)	Total (lb/yd³)	Total Cost ($/yd³)
1	263.1	701.9	2,178.1	833.4	3,976.5	44.04
2	256.9	703.9	2,252.7	773.7	3,987.2	44.20
3	256.9	703.9	2,252.7	773.7	3,987.2	44.20
4	256.9	703.9	2,252.7	773.7	3,987.2	44.20
5	279.5	765.6	2,139.0	773.7	3,957.7	45.80
6	256.6	722.4	2,178.1	833.4	3,990.5	44.80
7	257.1	685.9	2,327.4	714.0	3,984.4	43.63
8	287.0	765.8	2,178.1	714.0	3,944.9	45.69
9	250.7	706.0	2,327.4	714.0	3,998.1	44.37
10	251.9	719.7	2,252.7	773.7	3,998.0	44.79
11	275.0	753.3	2,252.7	682.6	3,963.6	45.48
12	256.9	703.9	2,252.7	773.7	3,987.2	44.20
13	279.9	788.2	2,178.1	714.0	3,960.2	46.51
14	261.7	688.8	2,252.7	773.7	3,976.9	43.64
15	233.2	622.0	2,327.4	833.4	4,015.9	41.98
16	234.4	642.2	2,366.5	773.7	4,016.7	42.60
17	256.9	703.9	2,252.7	773.7	3,987.2	44.20
18	256.9	703.9	2,252.7	773.7	3,987.2	44.20
19	227.4	640.2	2,327.4	833.4	4,028.4	42.65
20	238.9	654.5	2,252.7	864.7	4,010.8	42.92

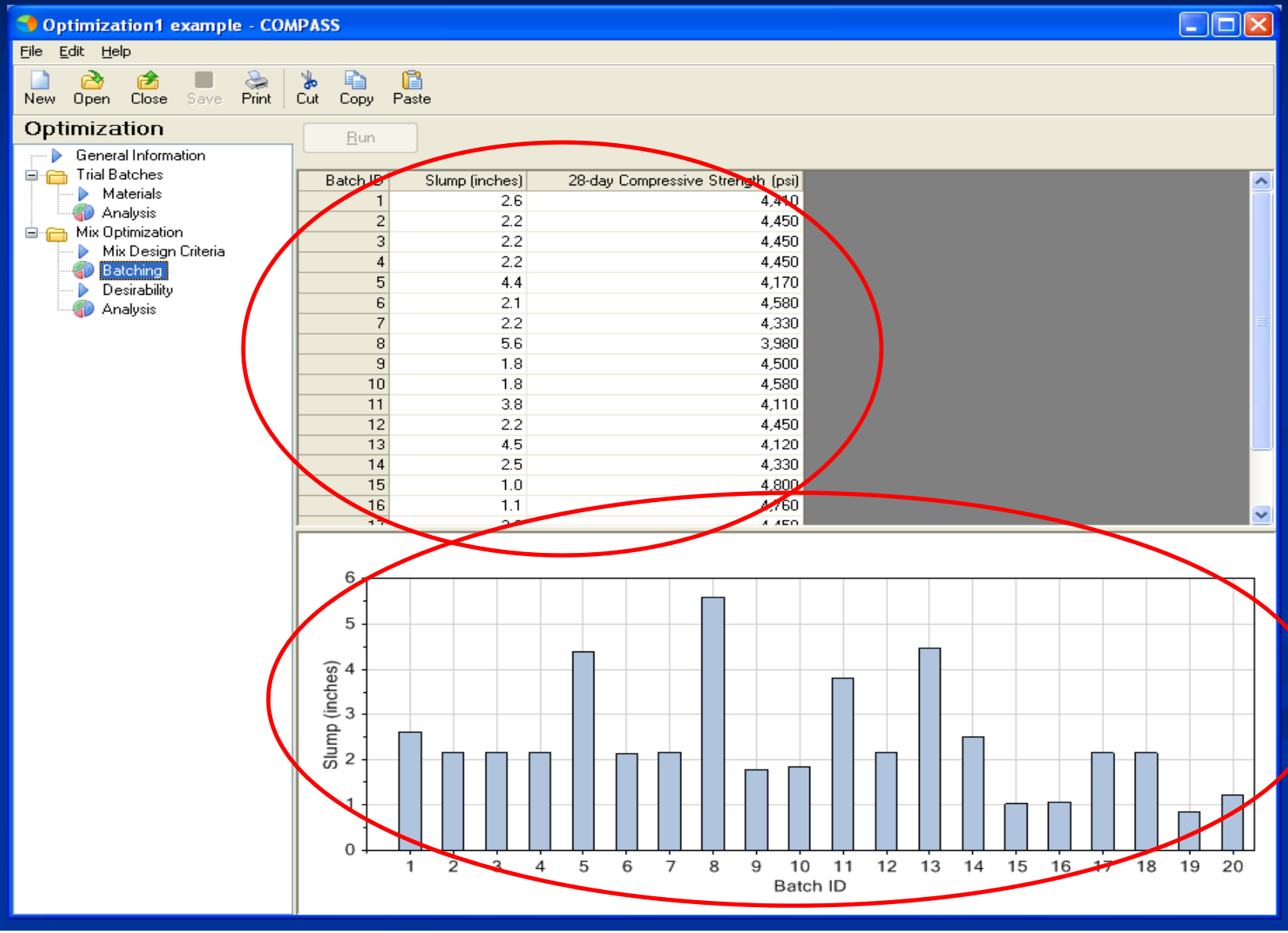
Optimization Module

Identify Criteria for optimization...



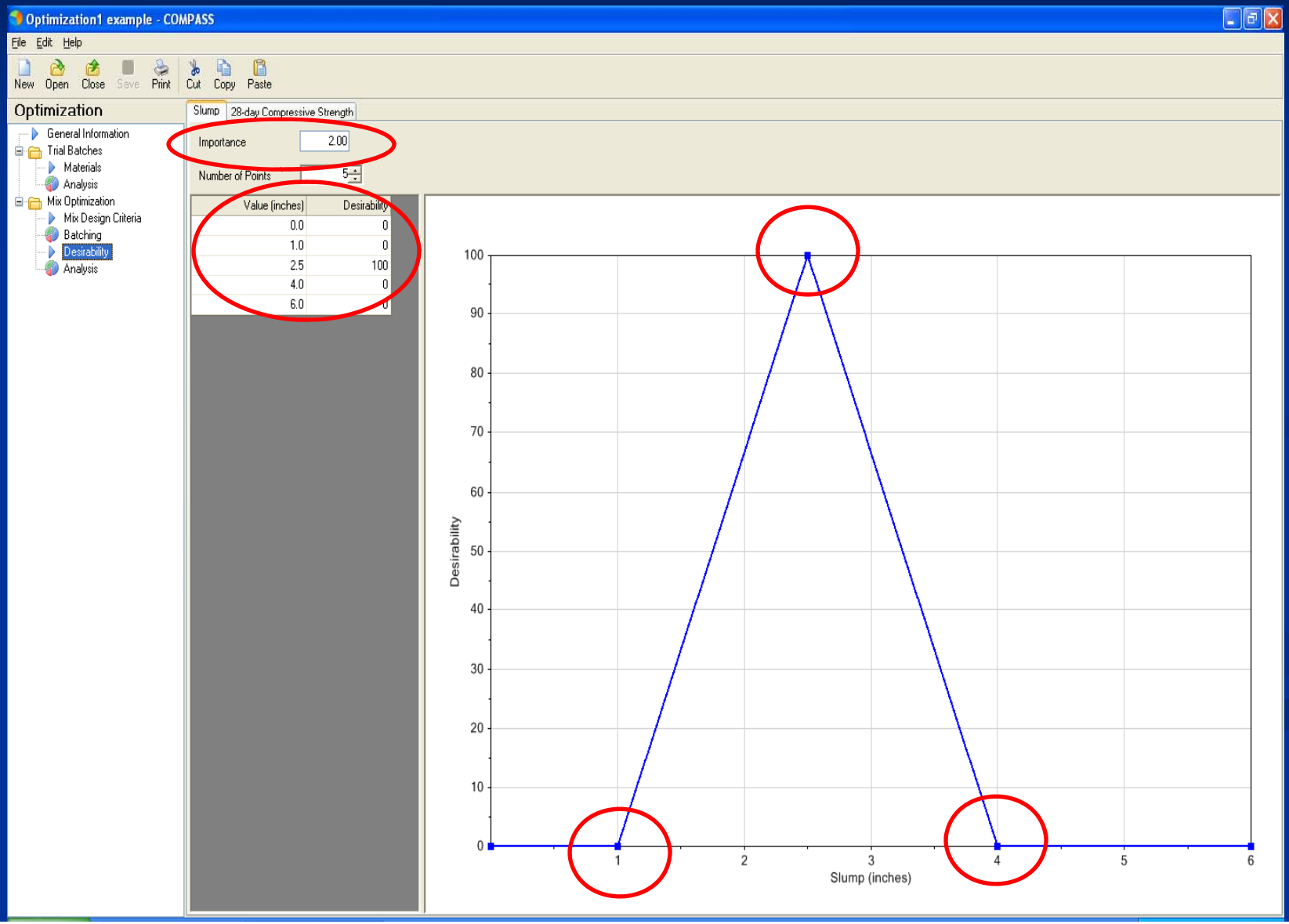
Optimization Module

Identify Criteria for optimization...



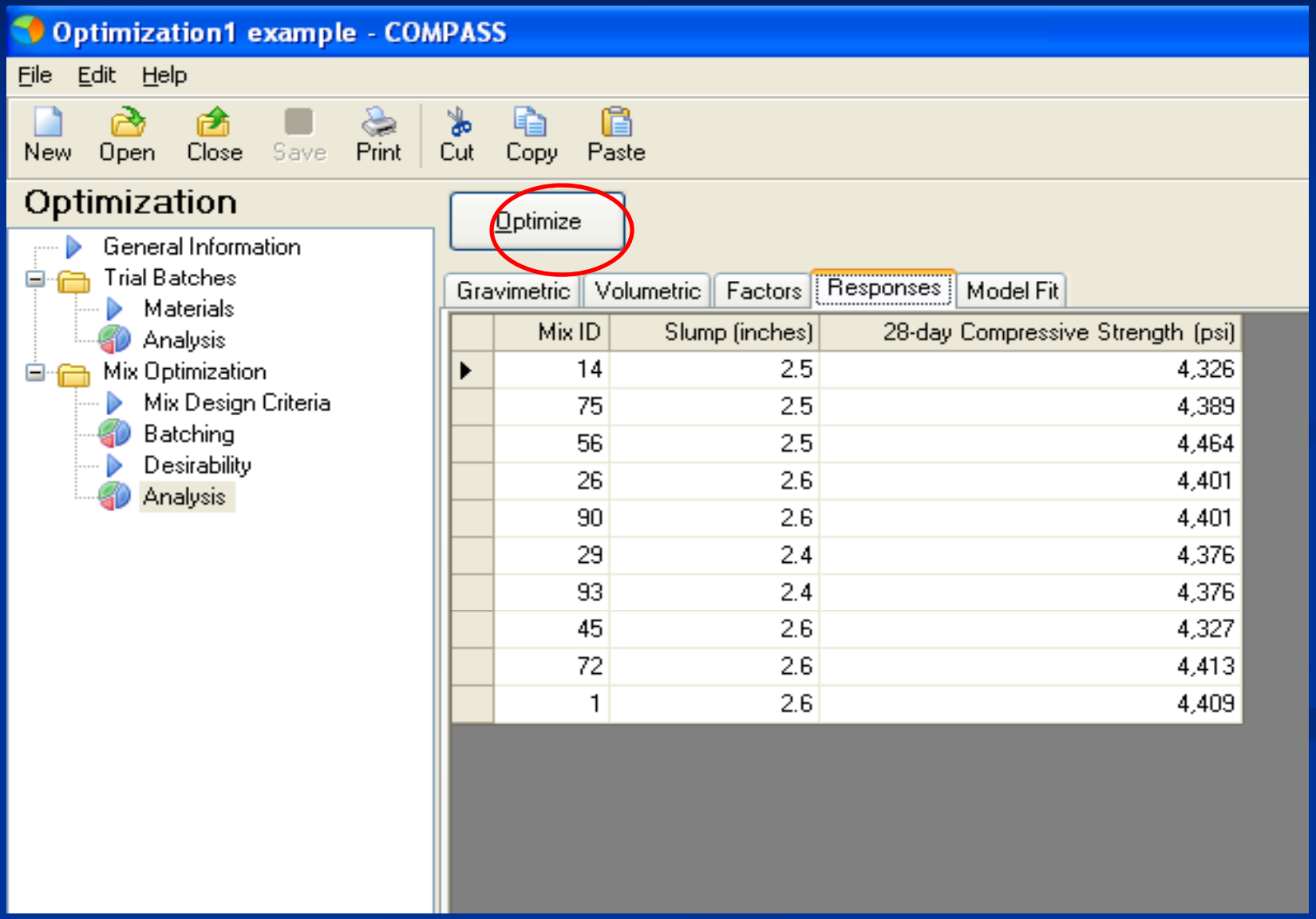
Optimization Module

Assign Desirability and Importance...



Optimization Module

Analyze for List of Alternate Optimized Mixes ...



Mix ID	Slump (inches)	28-day Compressive Strength (psi)
14	2.5	4,326
75	2.5	4,389
56	2.5	4,464
26	2.6	4,401
90	2.6	4,401
29	2.4	4,376
93	2.4	4,376
45	2.6	4,327
72	2.6	4,413
1	2.6	4,409

Summary

COMPASS consists of 4 modules

1. **Mix Expert** - first cut of material choices
2. **Gradation** - optimize aggregate blends for best packing
3. **Proportioning** - make initial attempts at mix designs
4. **Optimization** - find the best alternatives for specific criteria

The four modules can work as stand alone tools.

OR…

Used together, make a powerful optimization system.

You can download the **FREE** unofficial version of COMPASS:

www.PCCmix.com

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