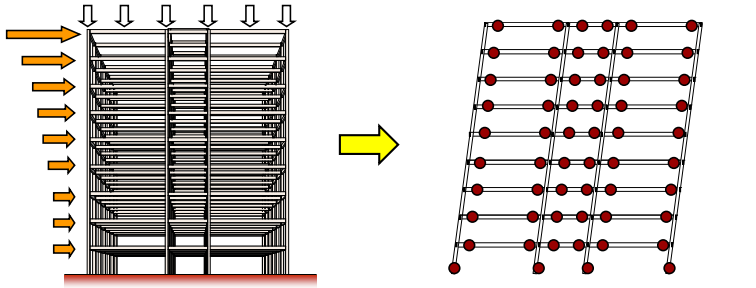
Matrix Method of Limit Analysis and Generalized Norm of Stress Field of Braced Frames Subjected to Seismic Loads

Takumi ITO, Dr. Eng., Professor
Tokyo University of Science

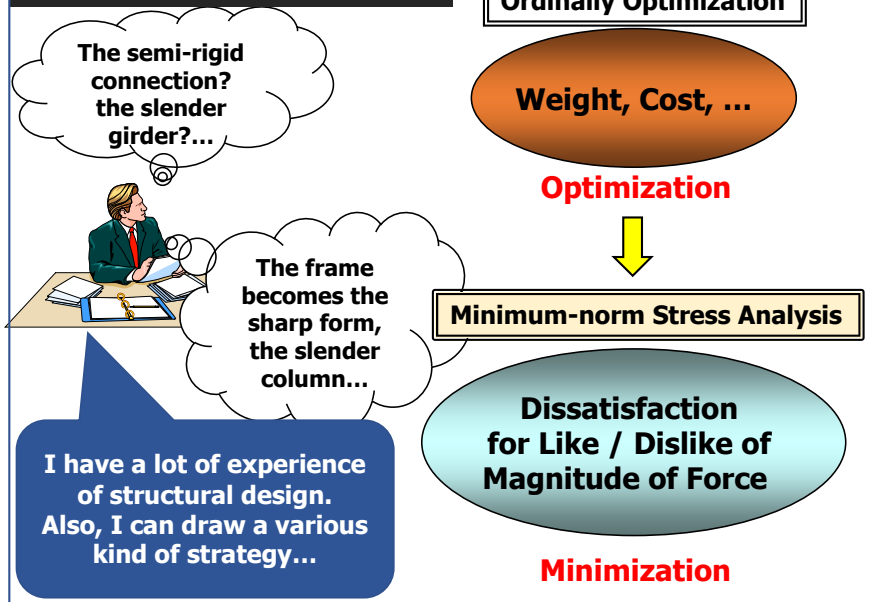
1. Ultimate Seismic Design Flow

- ✔ Calculation of **Seismic Design Load**
- ✔ Calculation of **Stress Field** by Limit Analysis
- ✔ Estimation of **Load vs. Strength** of Frame

Evaluation of Design Loads → Estimation of Ultimate State



2. Design Image & Strategy

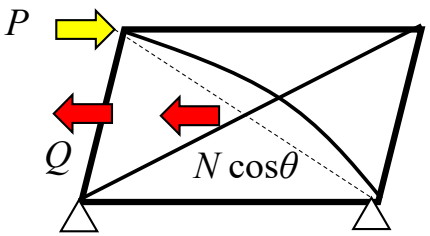


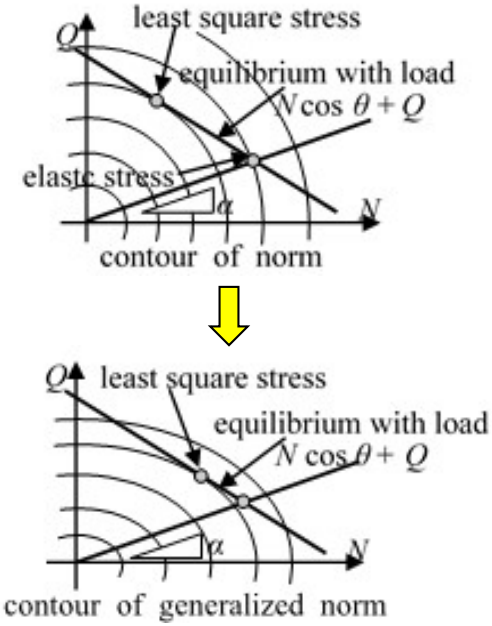
3. Minimum-norm Stress Analysis

Equilibrium $\{P\} = [C] \cdot \{M\}$

Minimization of Generalized Norm

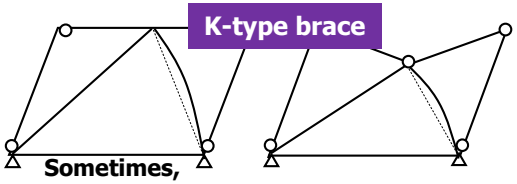
$$minimize \ \{M\}^T \cdot [D] \cdot \{M\}$$





4. Analytical Study

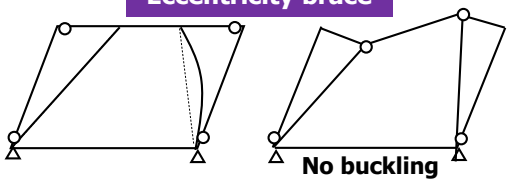
K-type brace



Sometimes, better mode

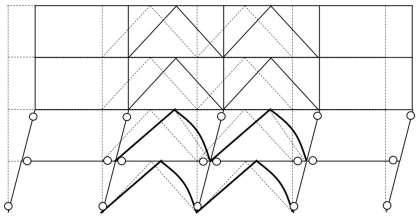
→ Large D on compression brace, & joint of beam and brace

Eccentricity brace



→ Large D on compression brace, & beam end

4 story braced frame



→ Large D on compression brace, & joint of beam and brace

5. Conclusion

- ✔ You can control the target stress using dissatisfaction weight D
- ✔ When you want to apply small stress, you use the large dissatisfaction weight