Reliability Based Design of High Capacity Micro-piles
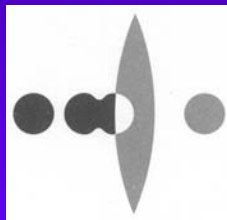
May 4th 2006

Yoshinori Otani ,P.E.jp

Hirose & Co., Ltd.

Masaru Hoshiya

Musashi institute of technology

Theme

Performance Provision Design

High-capacity
Micro Pile
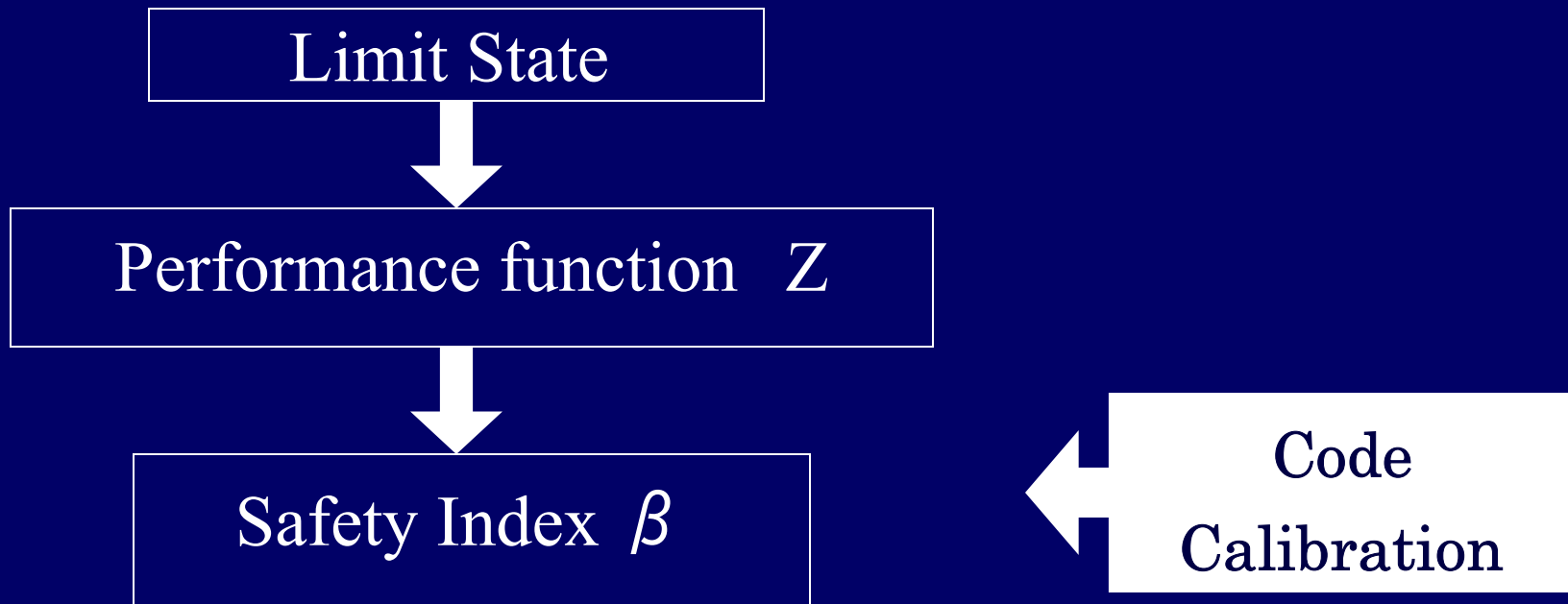
Limit State Design Method

Reliability Based Design

Allowable-stress Design Method

Problem of setting up

Limit State

↓

Performance function Z

↓

Safety Index β ← Code Calibration

Vertical Bearing Mechanism of HMP

(a)
Limit State 1

(b)
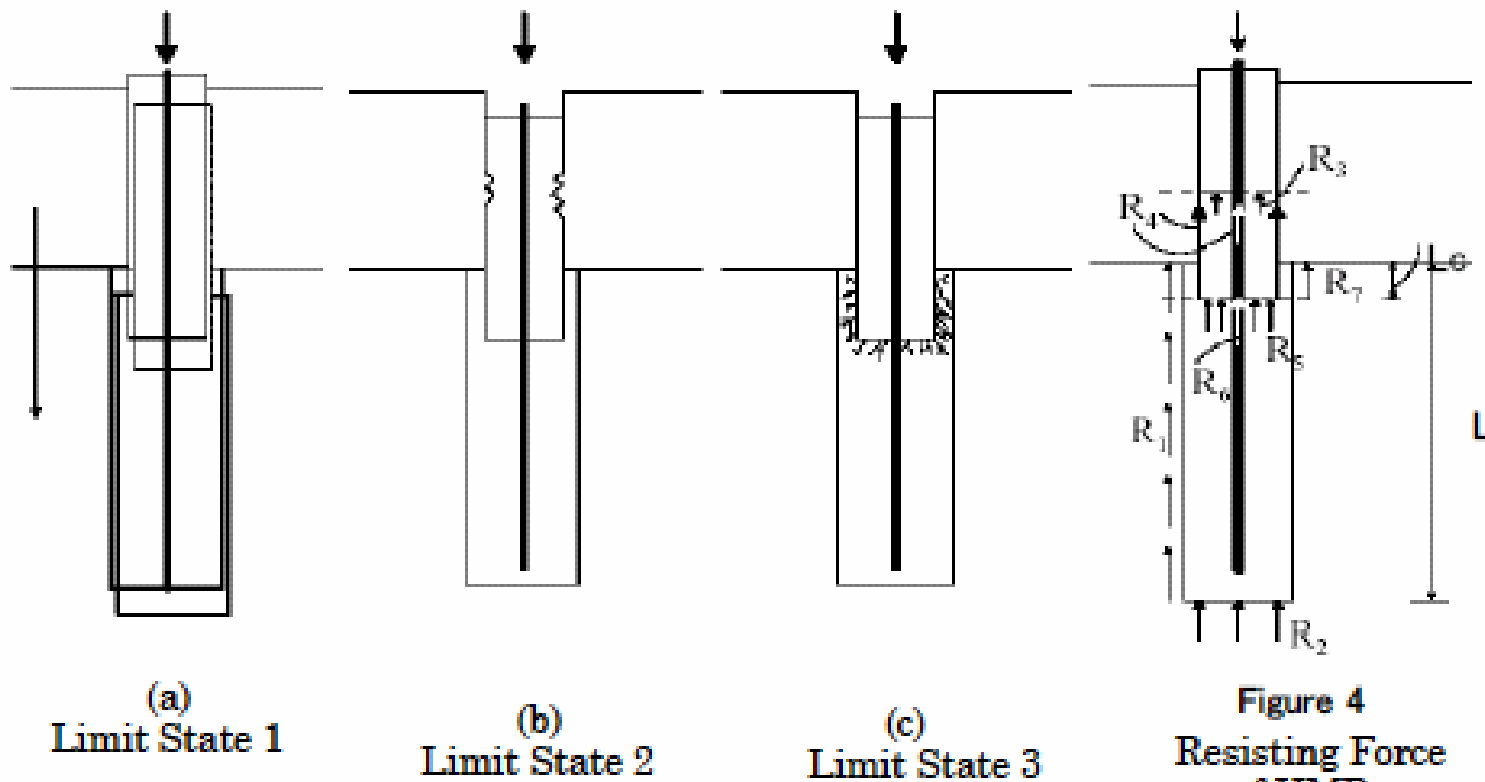Limit State 2

(c)
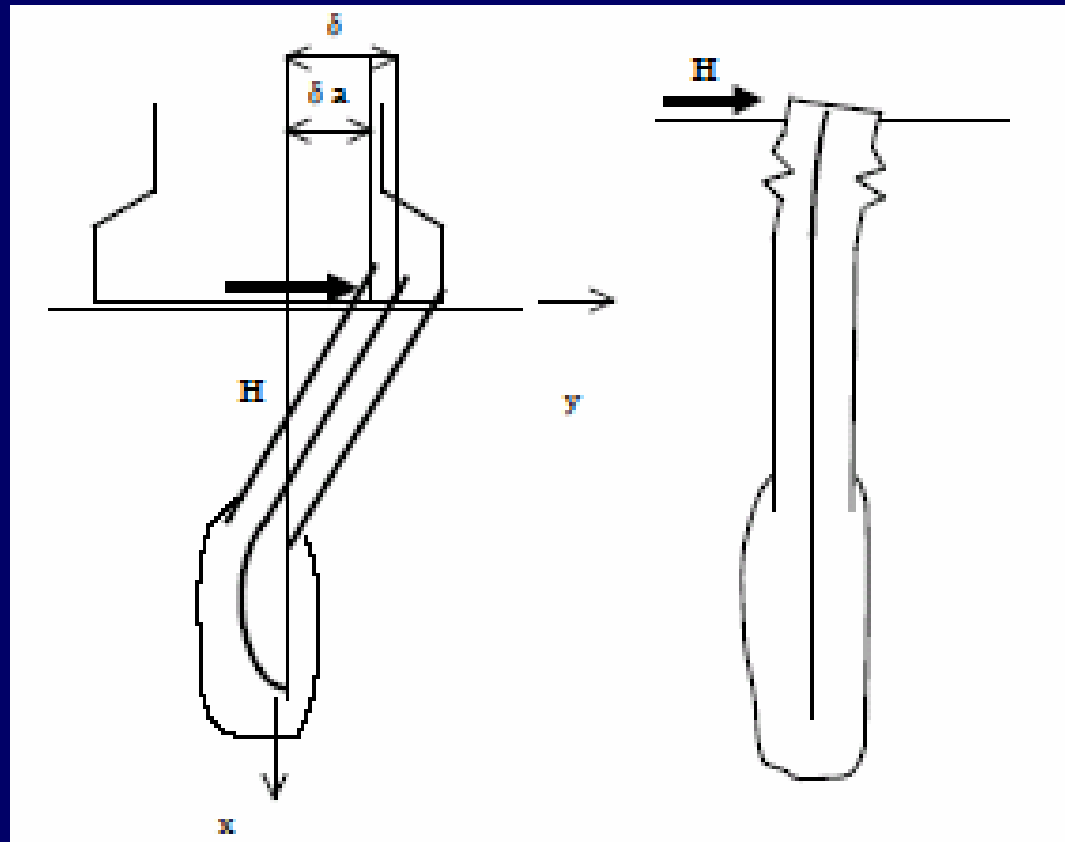Limit State 3

Figure 4
Resisting Force
of HMP

Horizontal Bearing Mechanism of HMP

Limit state 1   Limit state 2

Performance function Z i

Vertical Bearing

$$Z = \min[R_{C1}, R_{C2}, R_{C3}] - S_D - S_E$$

$$Z_1 = R_1 + R_2 - S_D - S_E$$

$$Z_2 = R_3 + R_4 - S_D - S_E$$

$$Z_3 = R_5 + R_6 + R_7 - S_D - S_E$$

Horizontal Bearing

$$Z_1 = g(H, K_H) = \delta_a - \frac{H}{4EI_{HMP}\eta_1{}^3}$$

$$Z_2 = g(\sigma_a, K_H, H, N) = \sigma_a - \frac{N}{A} - \frac{H}{2\eta_2 I_z}y$$

Computing of the Safety Index β

$$\beta_i = \frac{\mu_{Zi}}{\sigma_{Zi}}$$

43 Design examples
of HMP

- Monte Carlo simulation method
- FOSM method

Coeffcient   of variation
（Ground condition、Grout material 、Load）
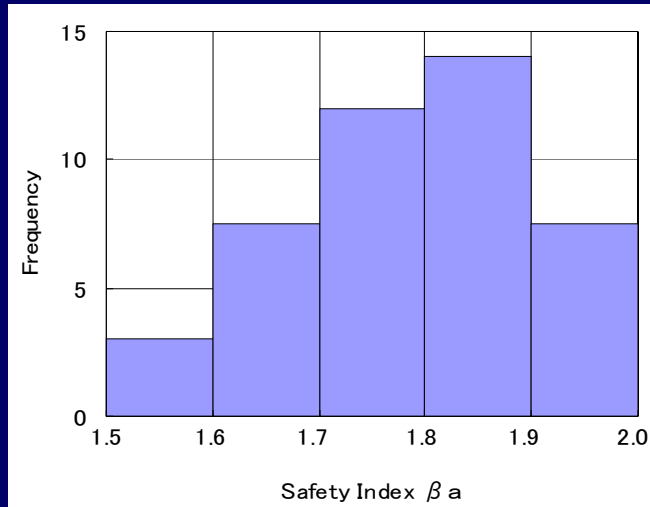
Result of Calculation(1)

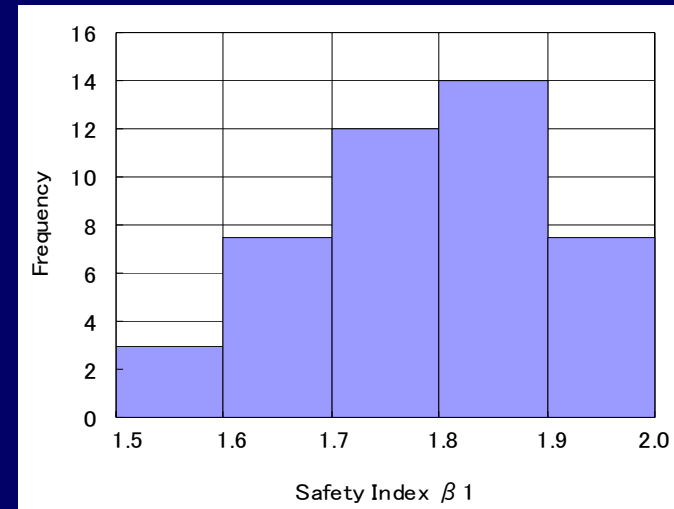Figure 1 Histogram of Overall Safety index β_a

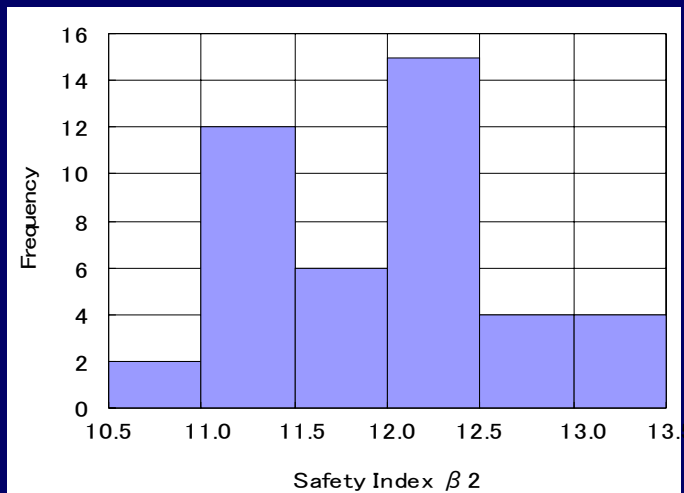Figure 2 Histogram of Safety Index β_1

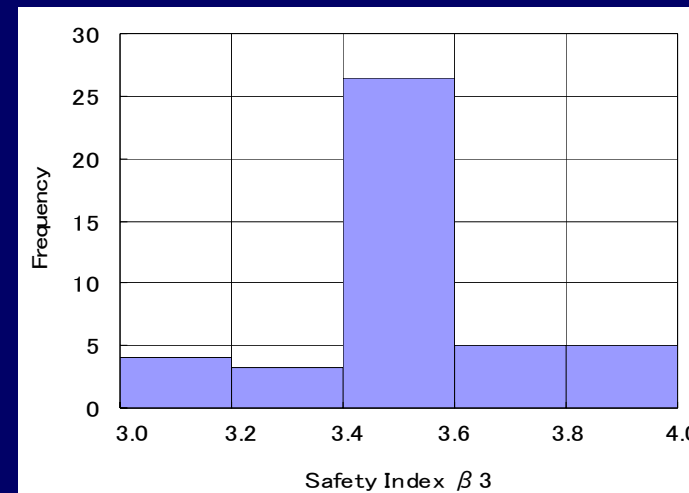Figure 3 Histogram of Safety Index β_2

Figure 4 Histogram of Safety Index β_3

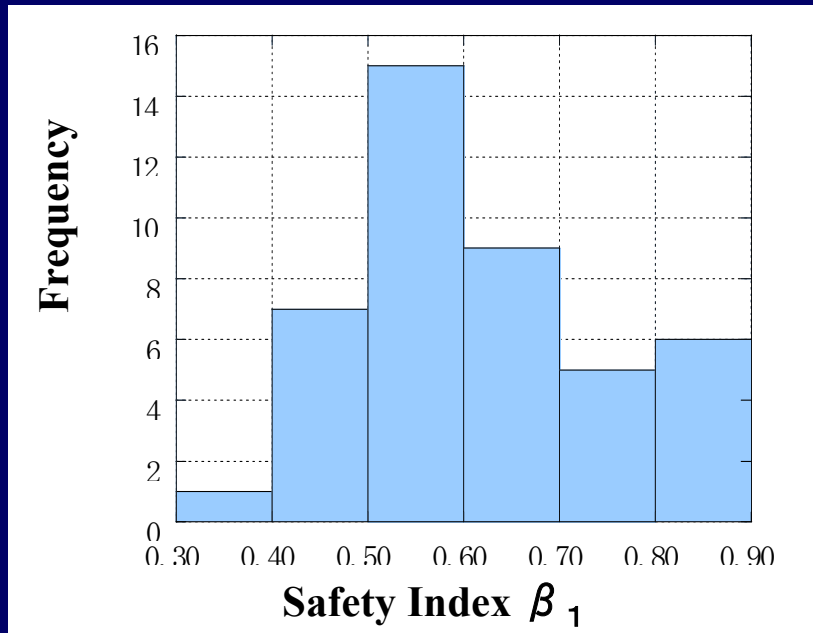# Result of Calculation(2)

Figure 5   Histogram of
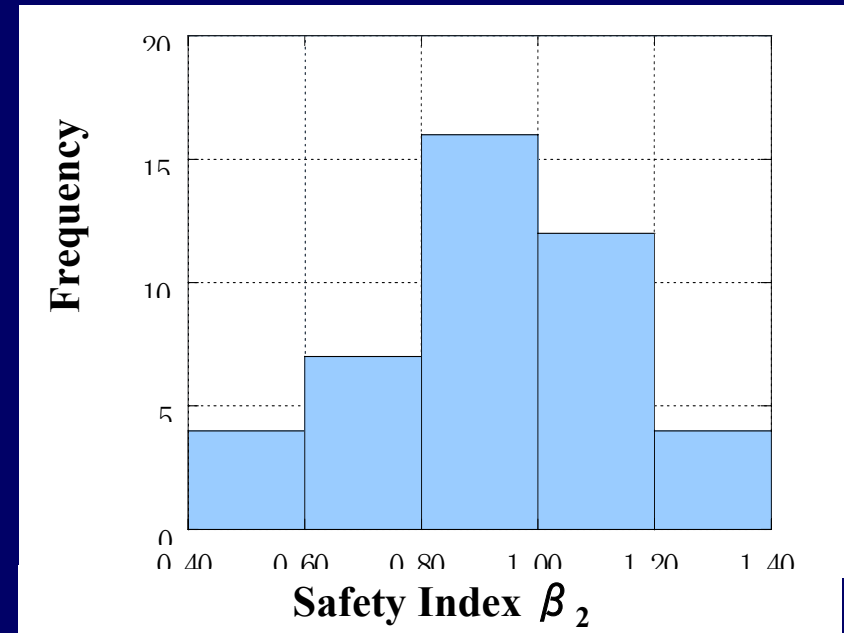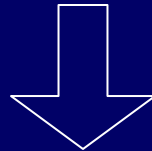Safety Index β_1

Figure 6 Histogram of
Safety Index β_2

Influence of Uncertainty

- Ground characteristic

  No uniformity, ground water

- Construction dependency of MP

  boring, grouting,

⬇

Uncertainty of Reliability Based Design

Summary

the HMP design

↑ Optimization

Statistical works
by accumulating the data

An uncertainty of
the ground characteristic
and the construction dependency of HMP