Application of High Strength Reinforcing Bars in Earthquake-Resistant Structure Elements

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ICRMCE 4

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Introduction

conventional

400 MPa

VS

cost-effective

500 MPa

POSITIVE

1.Reduce **amount** of Reinforcing Steel Bars

2. Saves material, delivery, placement **cost**

3. Eliminate reinforcing bars **congestion**

Higher DEMAND for Shear & Bond Stress

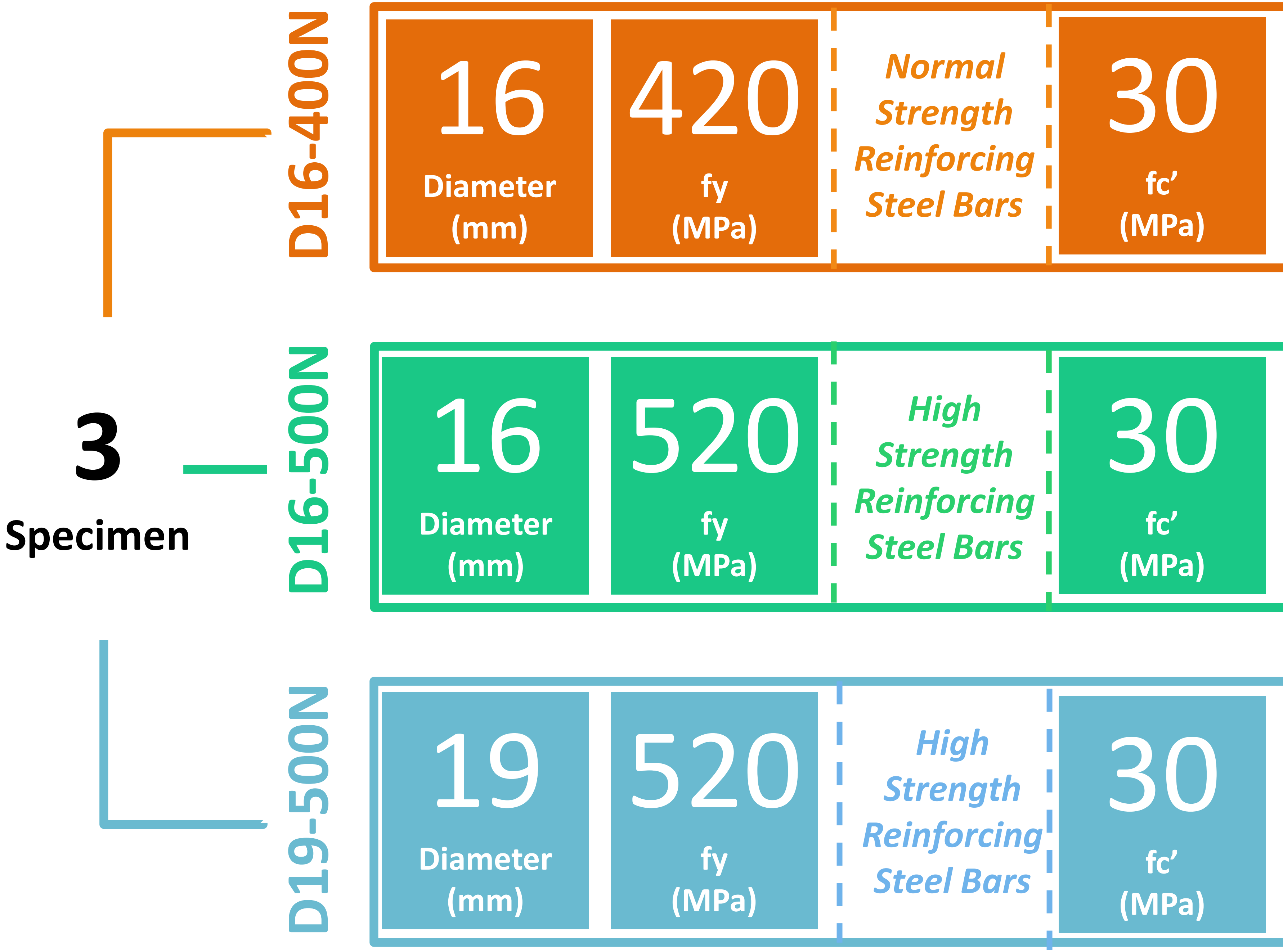
How bad is it?

NEGATIVE

Objective:

Study the use of high strength reinforcement steel bars by comparing the post-elastic behavior beetwen reinfoced concrete (R/C) with conventional reinforcing steel bar and R/C with high strength reinforcing steel bars


BEAM
COLUMN
JOINT


3
Specimen
D16-400N
16
Diameter
(mm)
420
fy
(MPa)
Normal Strength Reinforcing Steel Bars
30
fc'
(MPa)
D16-500N
16
Diameter
(mm)
520
fy
(MPa)
High Strength Reinforcing Steel Bars
30
fc'
(MPa)
D19-500N
19
Diameter
(mm)
520
fy
(MPa)
High Strength Reinforcing Steel Bars
30
fc'
(MPa)

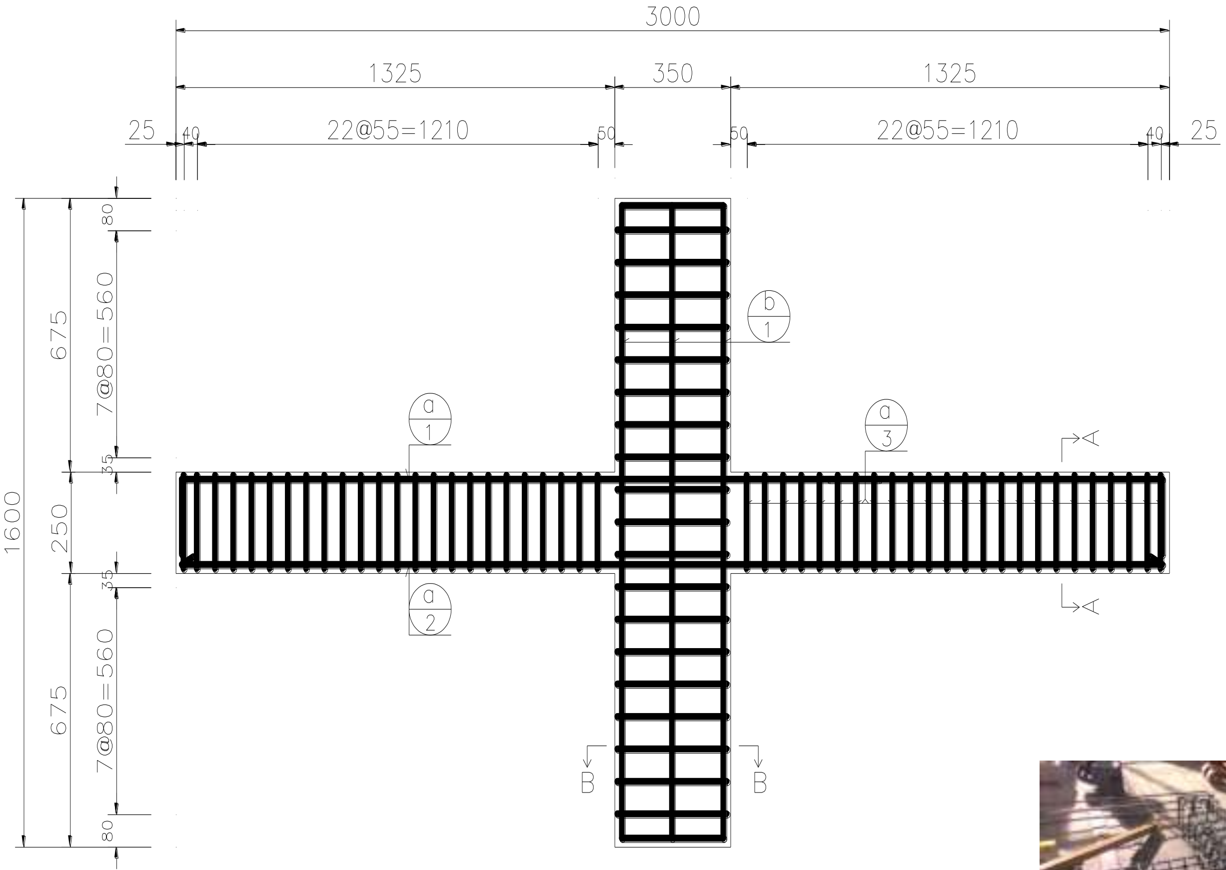
Mechanical Properties

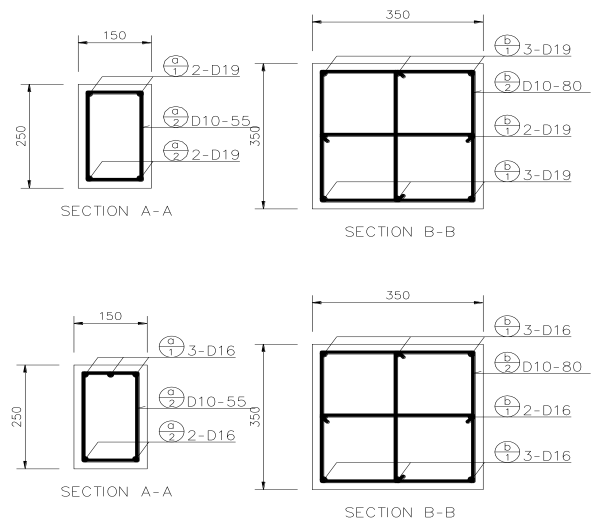
All Specimens

Material	Reinforcing Bars				Compressive Str. (MPa)
	Sectional Area (mm^2)	Yield Str. (MPa)	Tensile Str. (MPa)	Young Modulus (Gpa)	
D16-400N	201.06	434.1	577.4	198.1	31.0
D16-500N	201.06	485.2	630.9	207.9	32.7
D19-500N	283.53	503.9	674.9	195.7	31.7

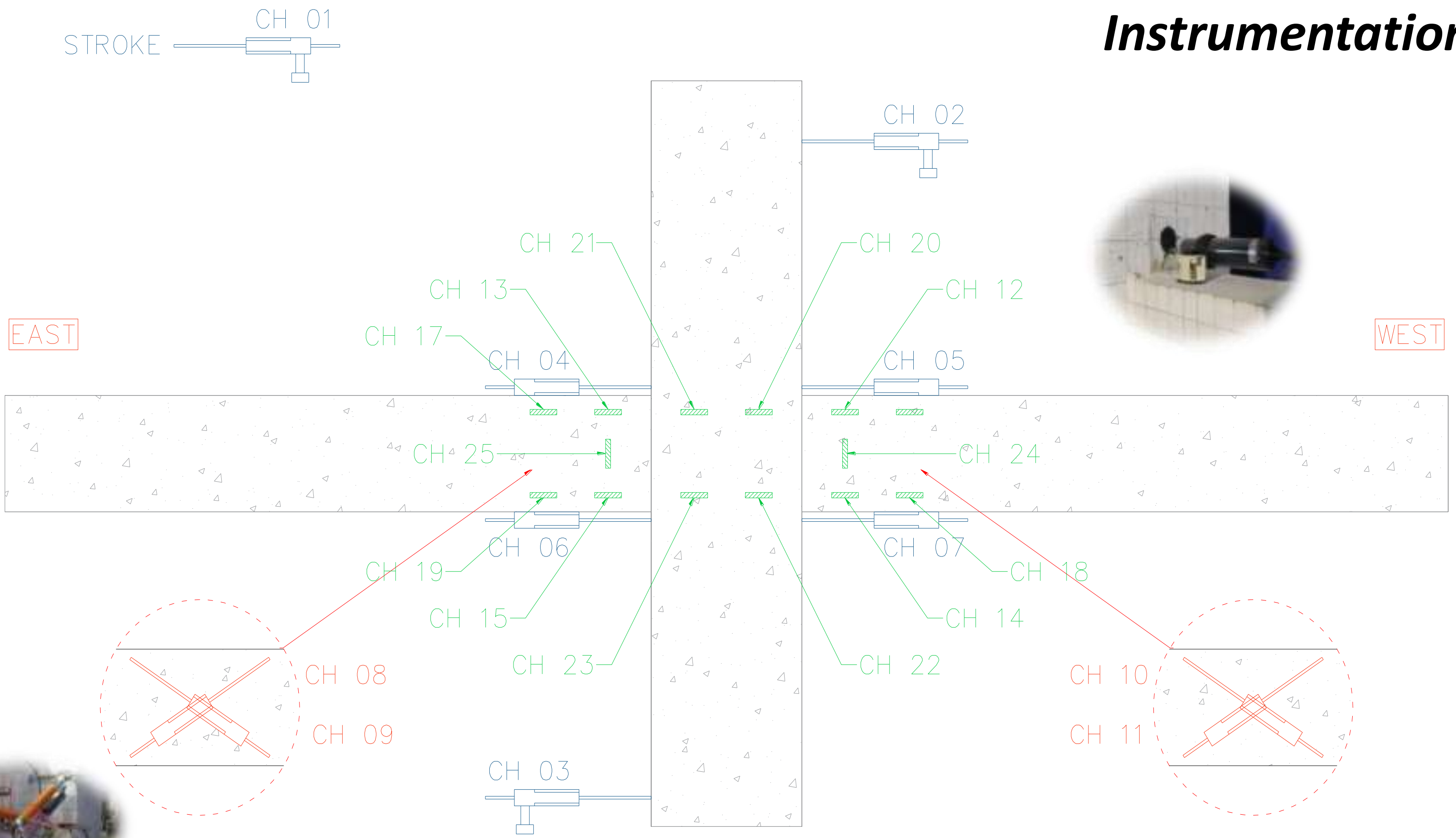
Specimen Design

SNI 2847





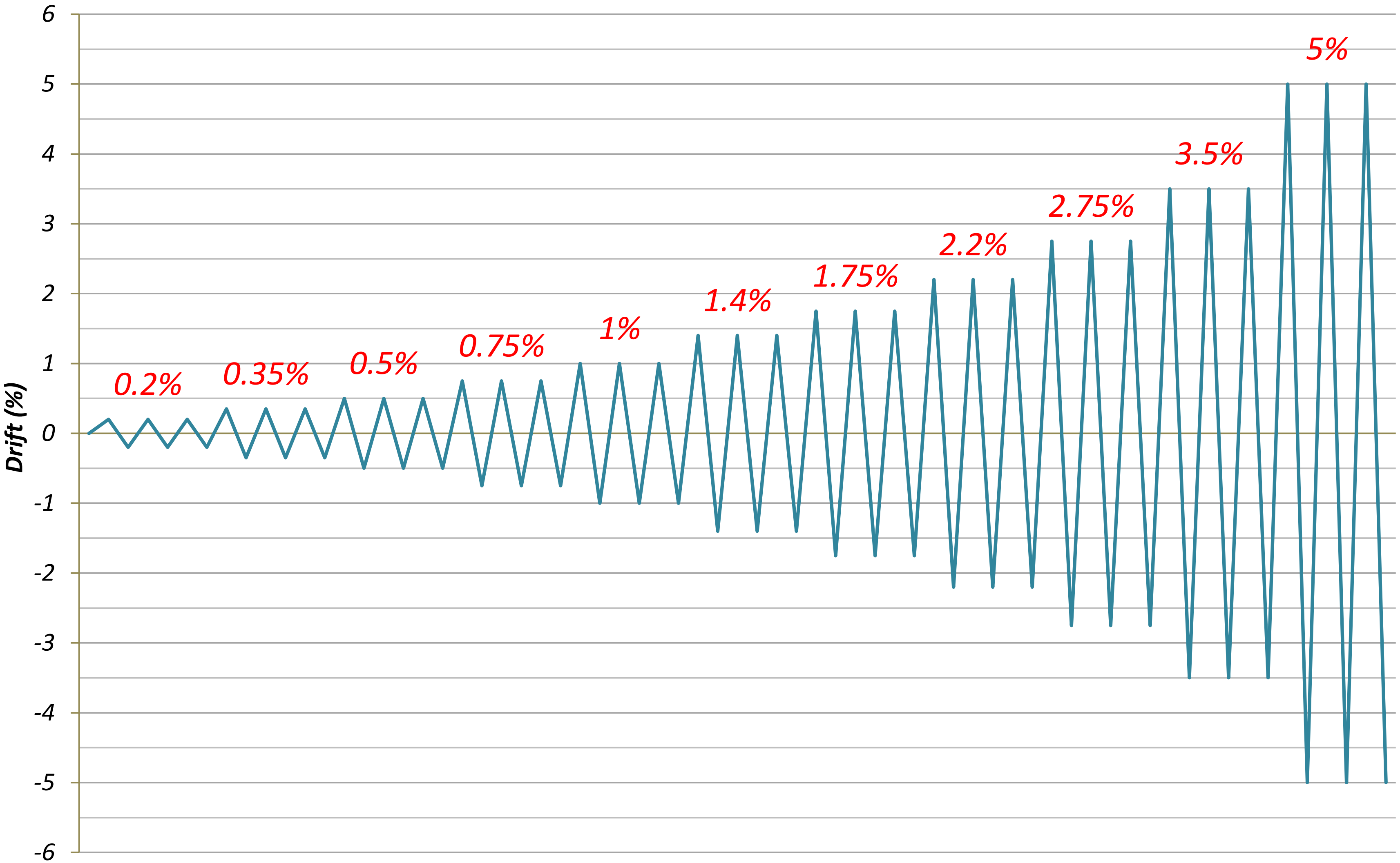
Instrumentation



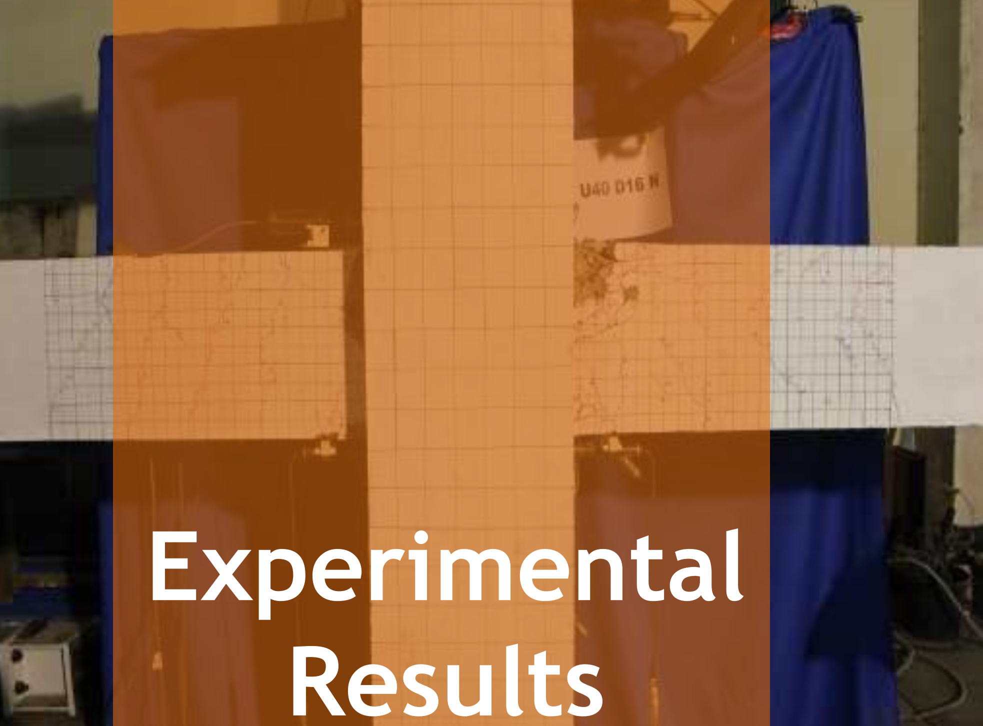

U40 D16

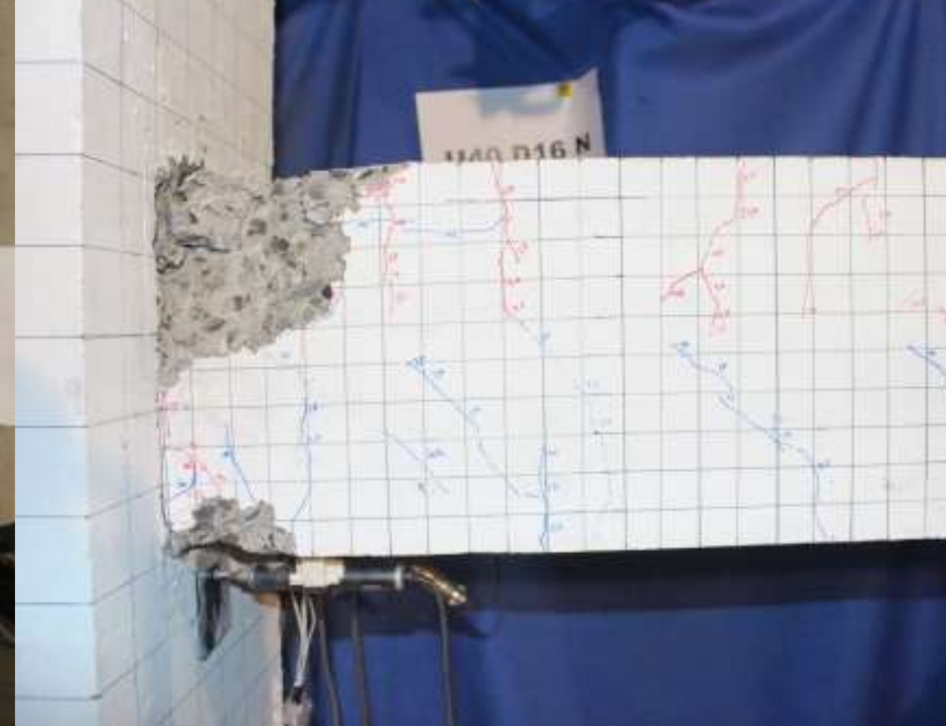
Loading Protocol

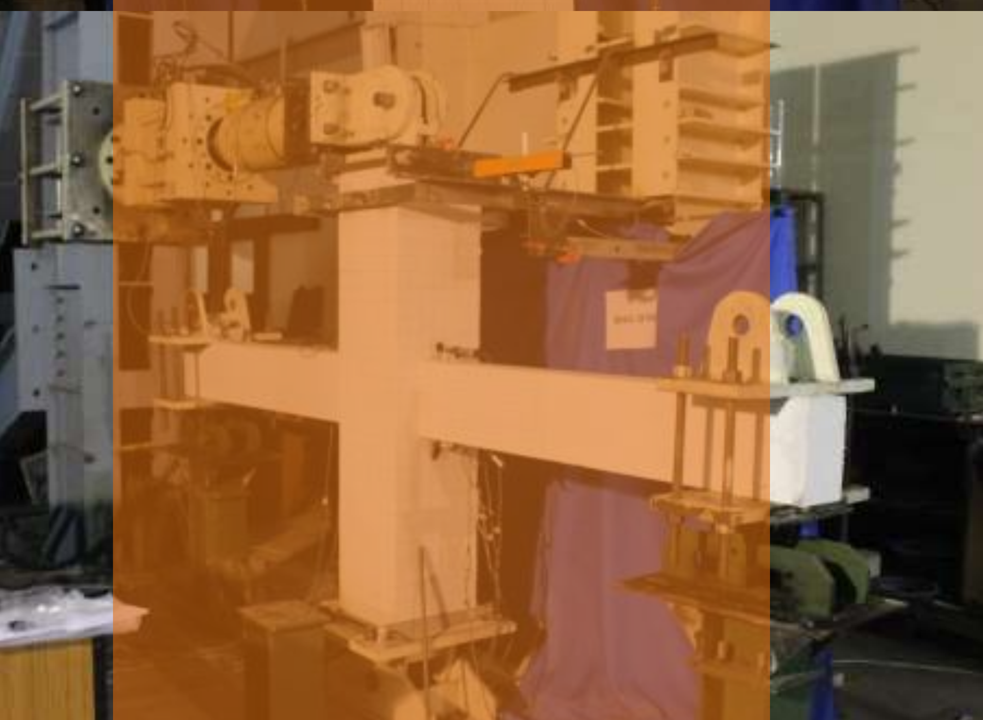
According to ACI 374.2



Experimental Results





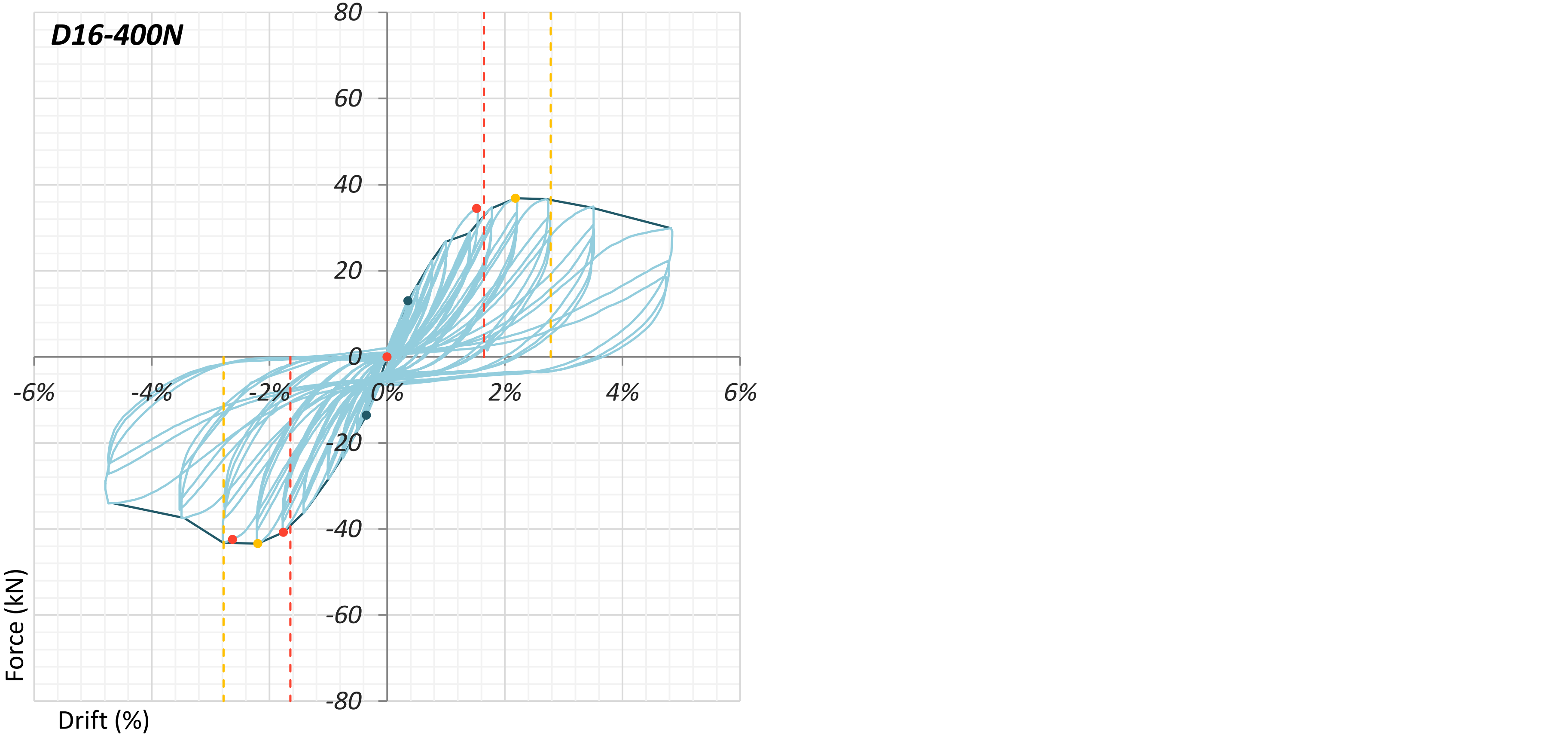


Analysis 1:

Hysteretic Curve & Backbone Curve

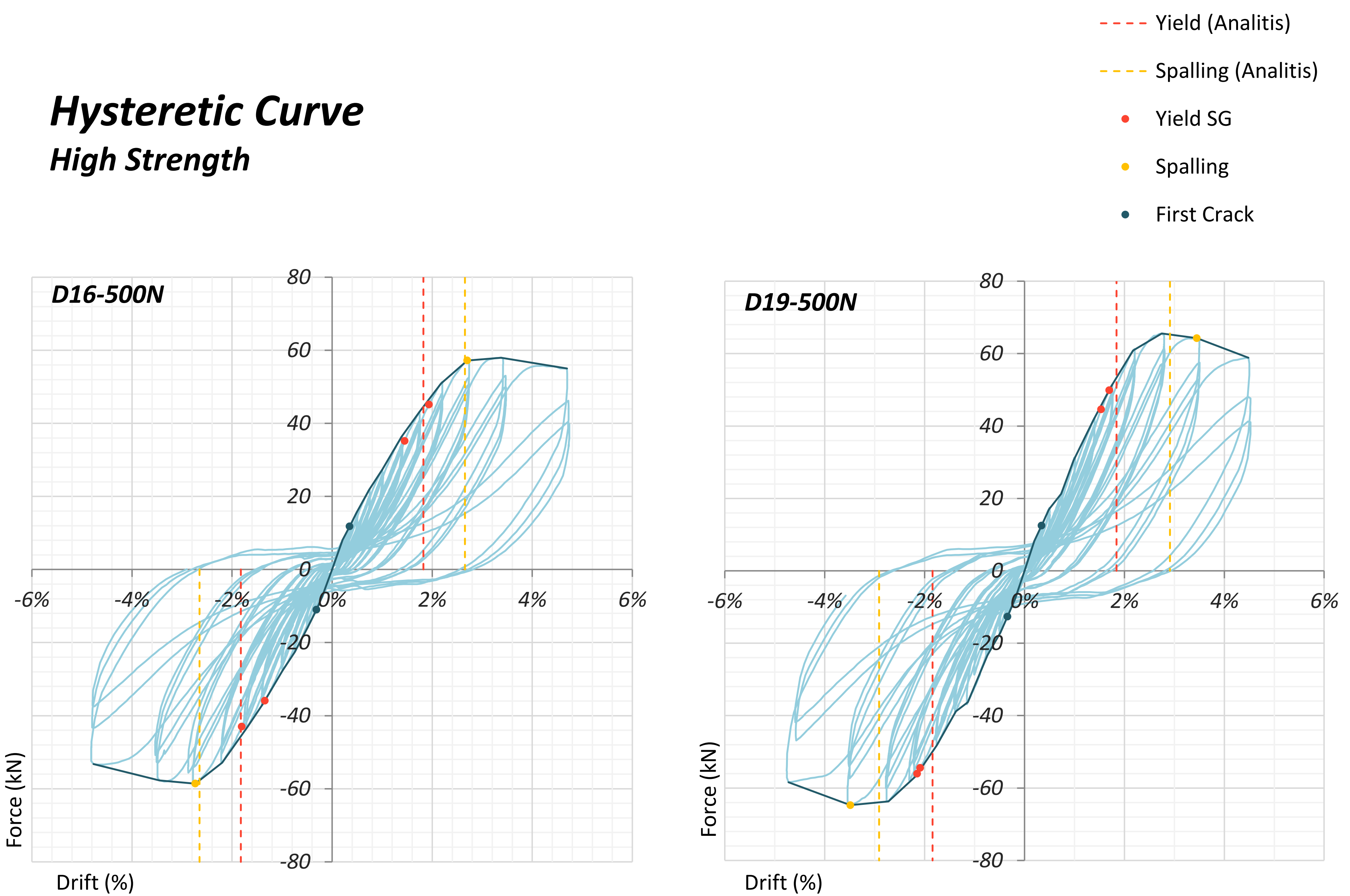
Hysteretic Curve

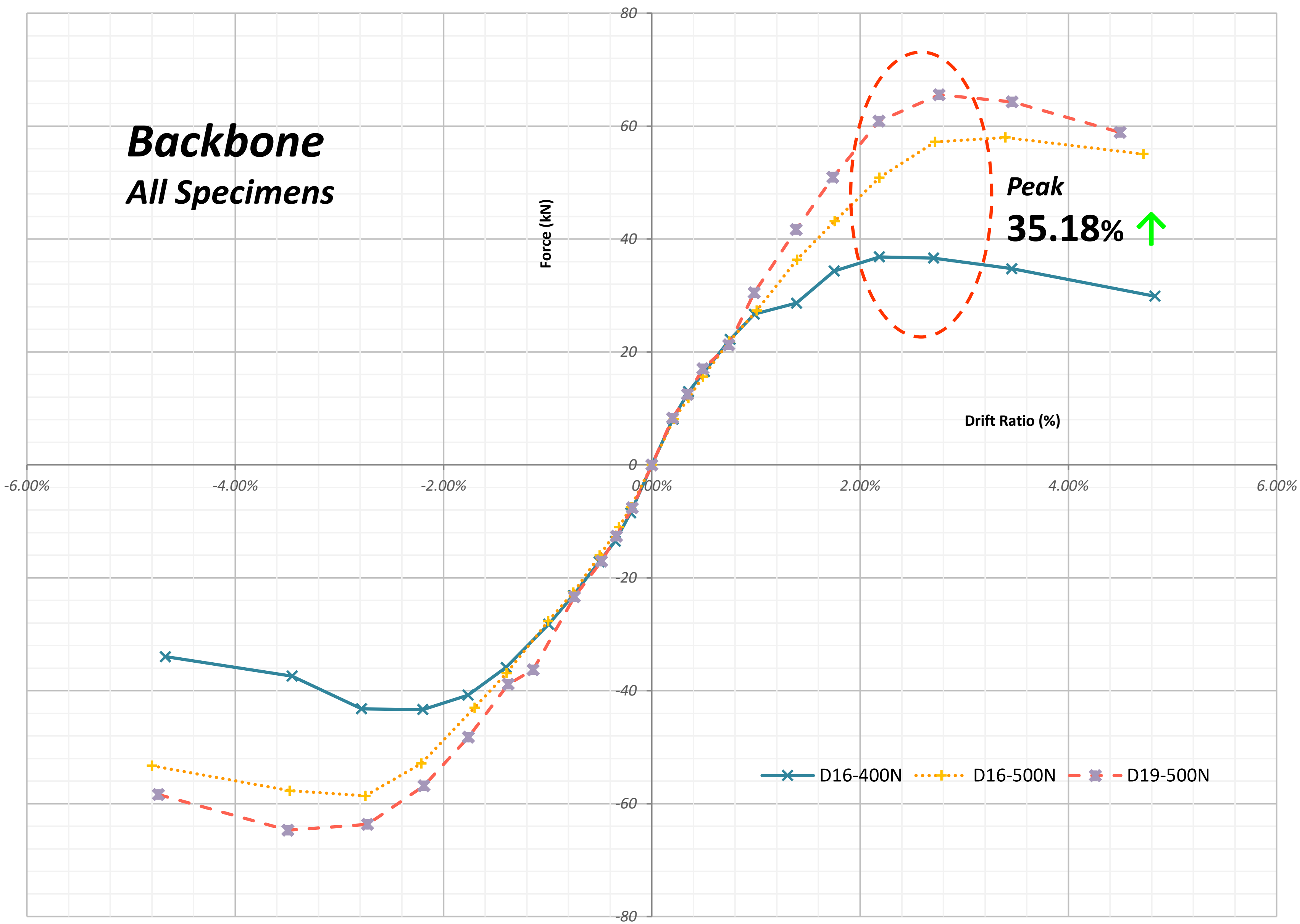
Normal Strength



Hysteretic Curve

High Strength

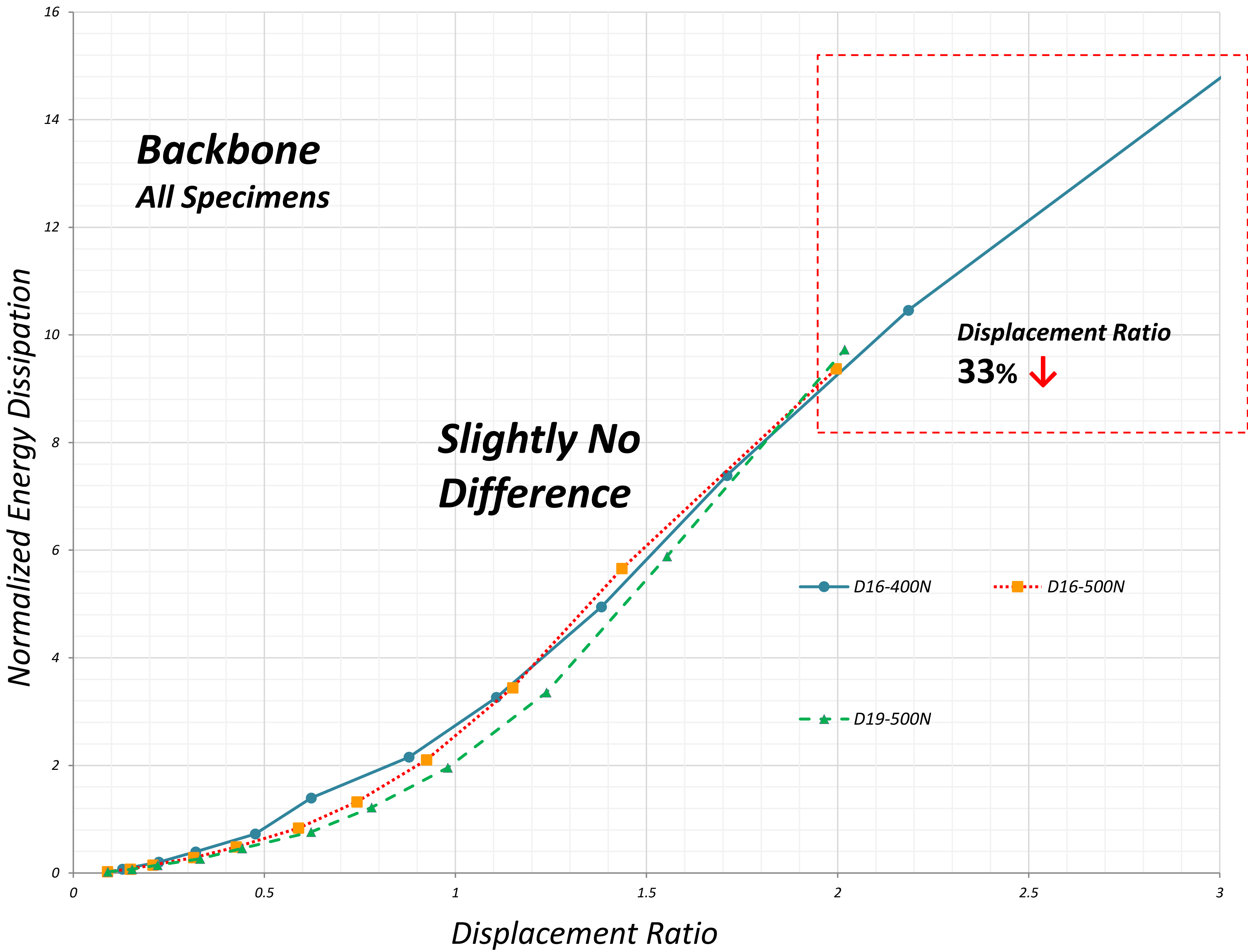




Backbone
All Specimens
Peak
35.18%
Force (kN)
Drift Ratio (%)
80
60
40
20
0
-20
-40
-60
-80
-6.00%
-4.00%
-2.00%
0.00%
2.00%
4.00%
6.00%
D16-400N
D16-500N
D19-500N

Analysis 2:

Energy Dissipation


Backbone
All Specimens
Slightly No
Difference
Displacement Ratio
33%
D16-400N
D16-500N
D19-500N
Normalized Energy Dissipation
Displacement Ratio
0
2
4
6
8
10
12
14
16
0
0.5
1
1.5
2
2.5
3

Analysis 3:

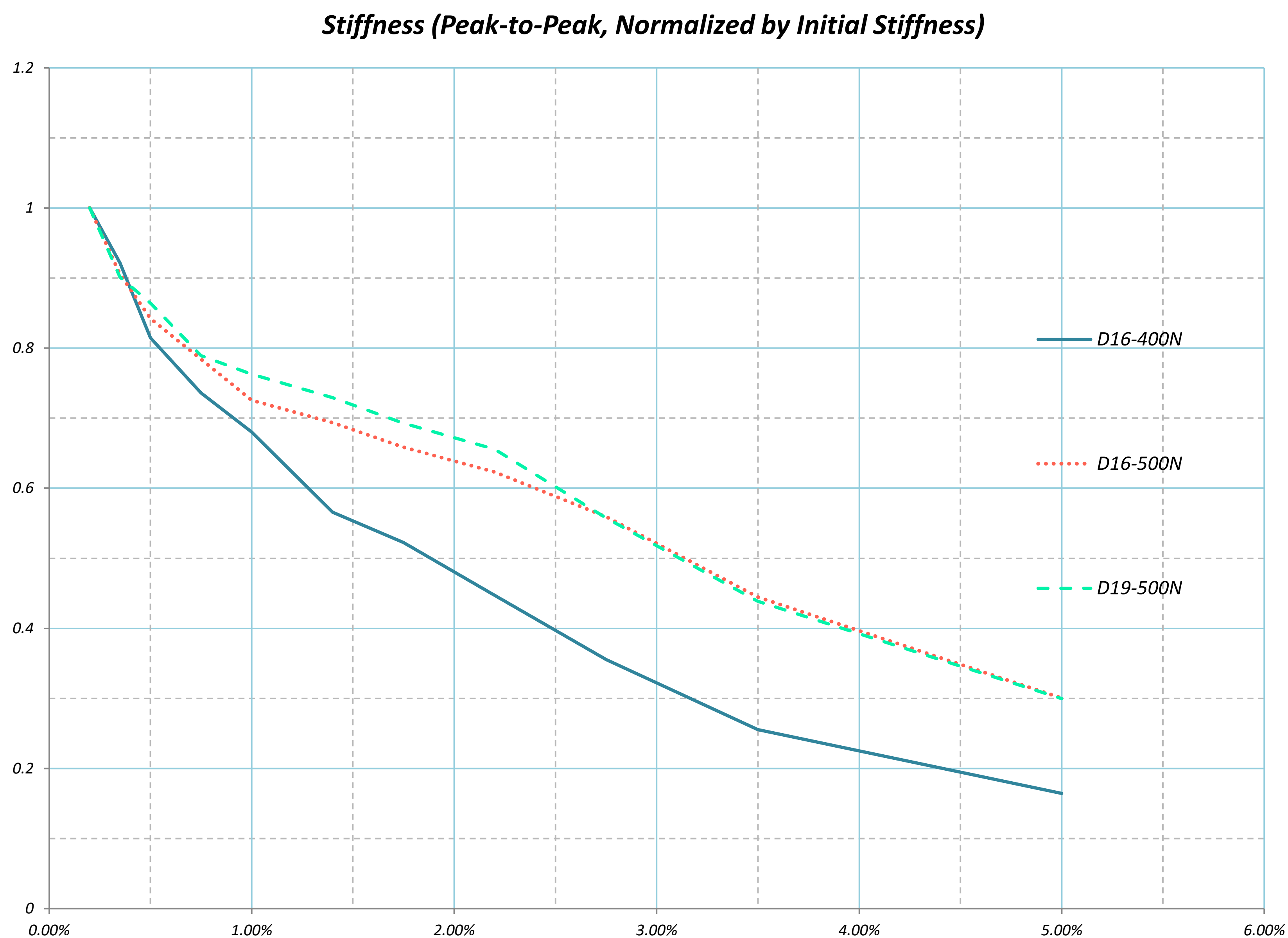
Deformability

Deformability
According to ASCE 7.10

Specimen	δ_{limit} (mm)	$\delta_{ultimit}$ (mm)	Deformability	Remark
D16-400N	16.689	83.045	4.976	High
D16-500N	28.361	133.828	4.719	High
D19-500N	29.989	104.157	3.473	Limited

Analysis 4:

Stiffness



Stiffness (Peak-to-Peak, Normalized by Initial Stiffness)
1.2
1
0.8
0.6
0.4
0.2
0
0.00%
1.00%
2.00%
3.00%
4.00%
5.00%
6.00%
D16-400N
D16-500N
D19-500N

Conclusions

Conclusions

1. Normalized energy dissipation for all specimens is relatively the same, but specimens with high strength reinforcing bars have smaller displacement ratio than that of specimens with normal strengh reinforcing bars
2. Specimens with high strength reinforcing bars tend to have smaller deformability than that of specimen with normal strength reinforcing bars.
3. Specimens with high strength reinforcing bars tend to have smaller stiffness degradation than normal strength reinforcing bars.
4. High strength reinforcing bars can be used as alternative for earthquake-resistant building

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THANK YOU

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