Solid Stainless Steel Reinforcing Bar

Florida DOT/FHWA

July 17, 2012

Presented by Ray Schnell

Talley Metals

A Carpenter Technology Company

(843-335-7240)

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About Talley and Carpenter

- Talley Metals Technology
  - Acquired by Carpenter in 1998
  - Producer of stainless rebar since 1988
- Carpenter Technology Corporation
  - Specialty steel producer since 1889
  - Domestic producer-HQ in Reading, Pa
  - Producer of 300+ Alloys
  - Product forms- bar, wire, strip and shapes

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Stainless Steels

- Stainless must contain a minimum of approximately 12% Chromium, in order to be considered a true stainless
- Stainless steels achieve their corrosion resistant characteristics through the formation of an invisible and adherent chromium oxide (Cr_2O_3) film
- This passive oxide film is achieved by descaling (shot blasting) and acid cleaning
- This oxide forms, on the surface of the material, and it is self-healing in the presence of oxygen

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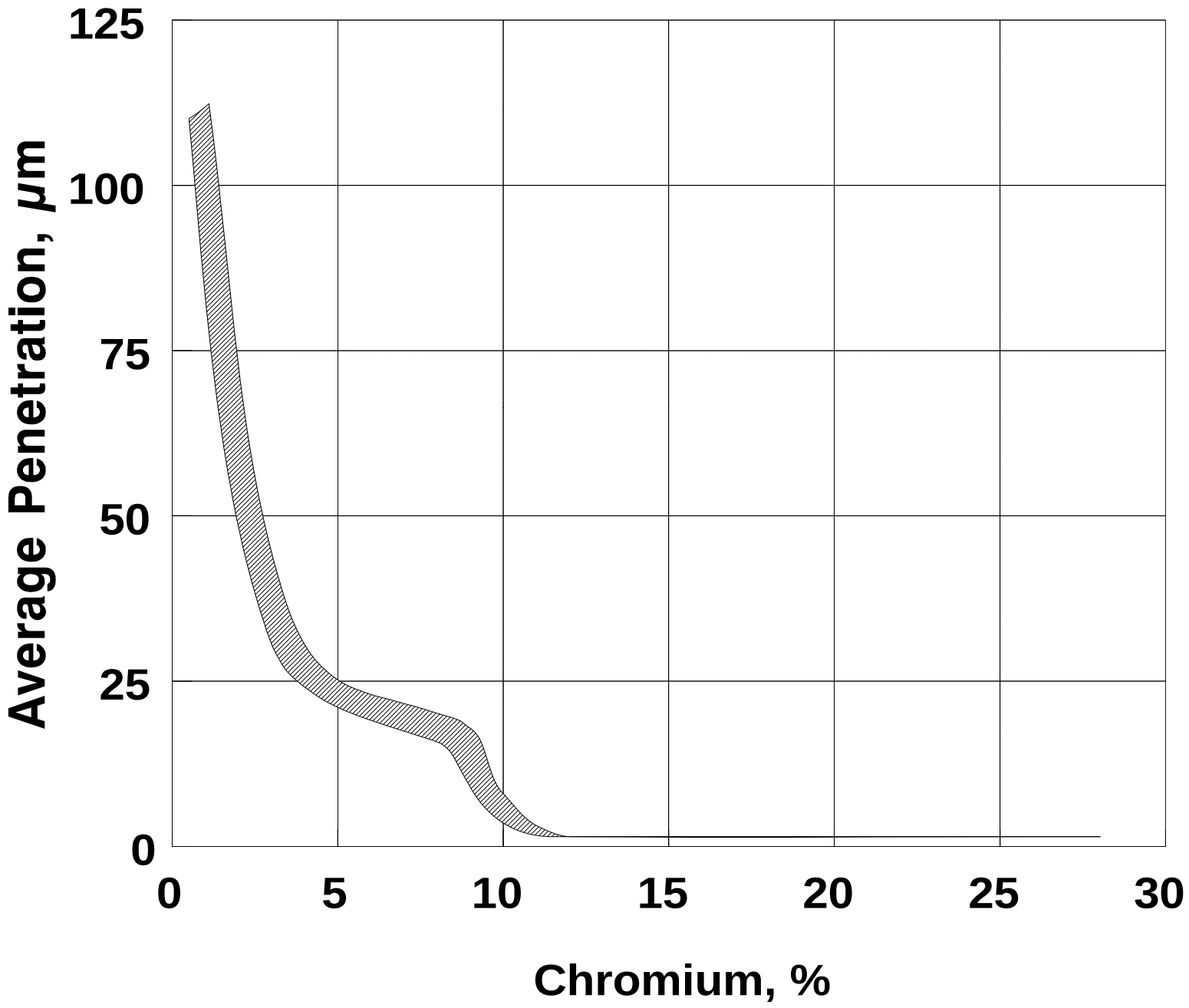
125
100
75
50
25
0
Average Penetration, μm
0
5
10
15
20
25
30
Chromium, %

Hot Rolling and Acid Cleaning

- **Product is hot worked to size on a rolling mill, prior to the deformation pattern that is added to the surface, then shot blasted and acid cleaned (pickled) to remove any scale and allow a passive oxide film to form.**

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Common Reinforcing Bar Concerns

- Structures throughout the U. S. are deteriorating due to corrosion in:
  - Salt environments in coastal regions
    - Such as here in Florida
  - Areas which are heavily de-iced with salt
    - Primarily the Northeastern U. S.
- High maintenance and repair costs
- Public inconvenience to traffic, and limited access areas
- Seismically active regions

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Pier Life Comparison

Functioning Pier

- Built over 75 years ago (1937)
- Used stainless steel - 304
- Still has an additional 30 year life expectancy

Non-functioning pier

- Built over 40 years ago
- With carbon steel rebar
- It is virtually non-existent

Progresso, Mexico piers

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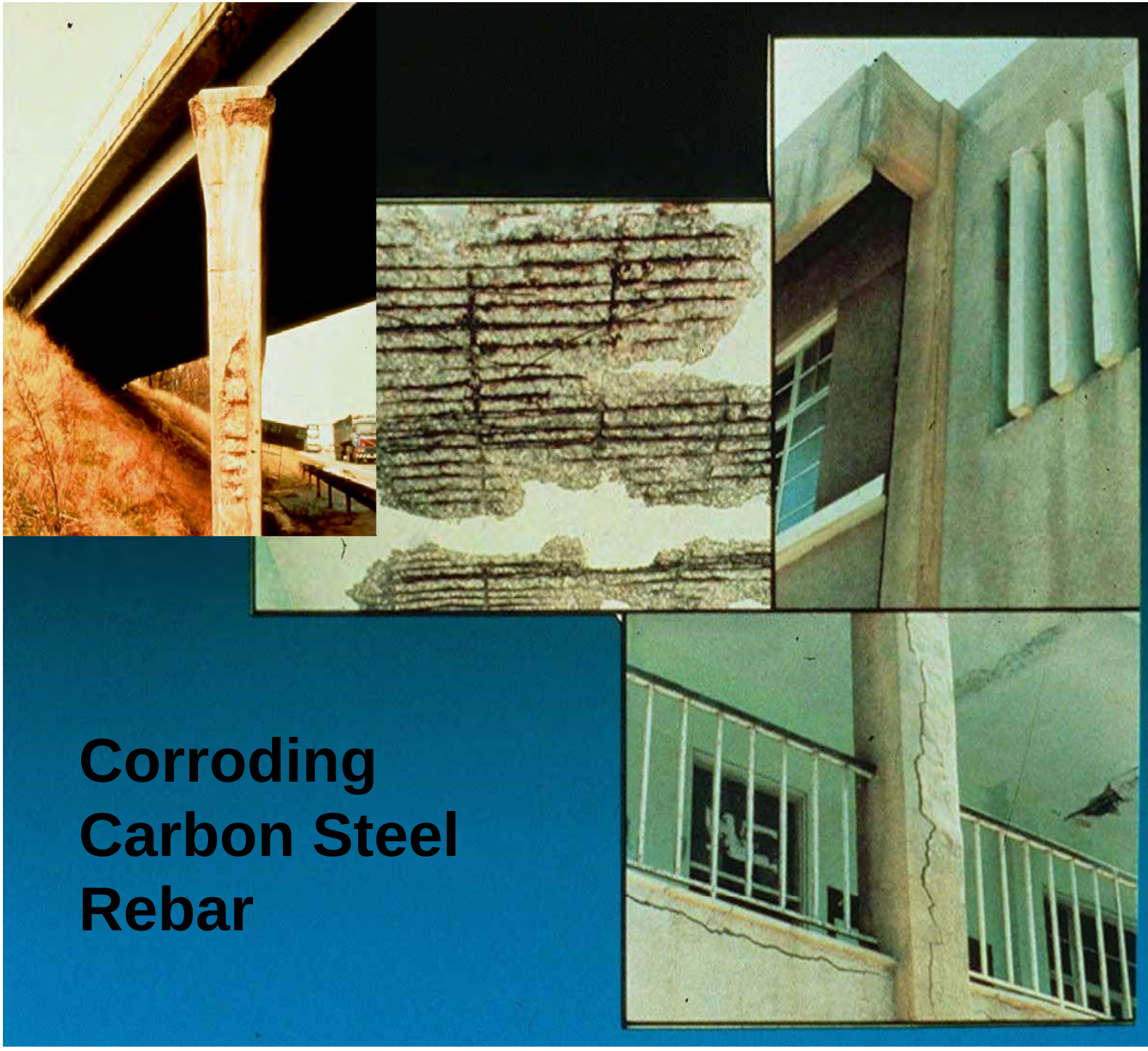

Corroding Carbon Steel Rebar

Advantages Offered by Solid Stainless Steel Rebar

- Superior corrosion resistance (chlorides)
- Superior tensile and yield strength
- Outstanding ductility
- Long life in excess of 100+ years
- Eliminates need for coatings and end caps
- Cost competitive on a life-cycle cost projection
- Easy to form and fabricate

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Additional Benefits of Stainless Rebar

- Less concrete cover with stainless
- Reduced weight on bridge structure
- Reduced cost due to a reduction in superstructure requirements
- High ductility aids in seismically active areas
- Can be recycled during concrete replacement

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Ease of Forming and Fabrication of Solid Stainless Steel Rebar

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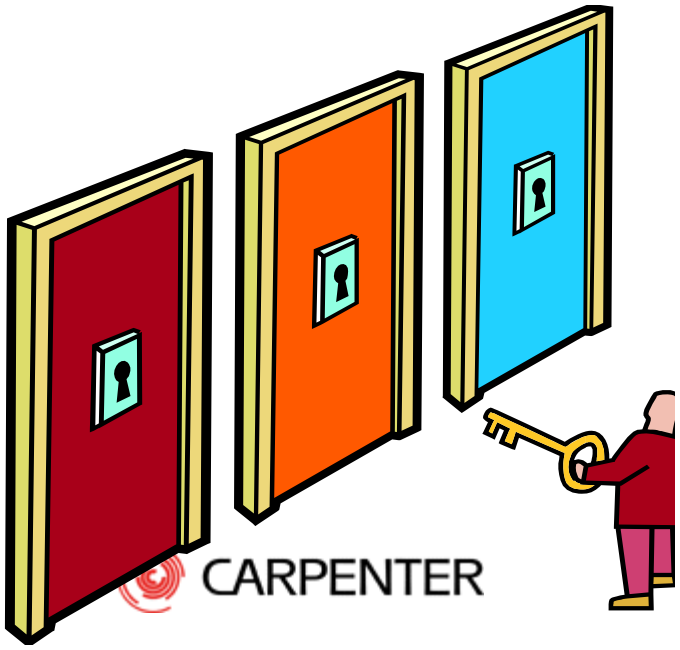
Solid Stainless Steel For Rebar
Which Grade to Choose?

- EnduraMet 2205 (UNS S31803)
- EnduraMet 2304 (UNS S32304)
- EnduraMet T316LN (UNS S31653)



Prices for Solid Stainless Rebar

GRADE	Base Price (Based on #7 Rebar)	Current Price as of June 2012 (Surcharge included) (Based on #7 Rebar)
EnduraMet 2205	$1.75	$2.62
EnduraMet 2304	$1.71	$2.35
EnduraMet 316LN	$1.88	$2.95
EnduraMet 32	$1.65	$2.02

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Typical Chemical Compositions for Stainless Rebar Alloys

Alloy	UNS Designation	% Cr	% Ni	% C	% N	% Mo	% Mn	PREN (Cr+3.3 Mo+16N)
EnduraMet 2205	S31803	22	6	<0.03	0.17	3	2	36
EnduraMet 316LN	S31653	17	10	<0.03	0.12	2.1	2	27
EnduraMet 2304	S32304	23	4	<0.03	0.17	0.3	1.5	26
EnduraMet 33	S24000	17	3.5	0.04	0.3	0.5	14	23
EnduraMet 32	S24100	17	0.7	0.04	0.3	0.5	14	22

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ASTM - A955/A955M – 12
Standard Rebar Grades

Grade	60 (420)	75 (520)
Yield Strength (min psi)	60,000	75,000
Tensile Strength (min psi)	90,000	100,000
Minimum Elongation (Percentage)	20	20

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Typical Mechanical Properties attained for Stainless Rebar Alloys

Alloy	UNS Designation	Yield Strength (KSI)	Tensile Strength (KSI)	% EL	% RA
EnduraMet 2205	S31803	95-110	130	25	65
EnduraMet 2304	S32304	85-100	120	25	60
EnduraMet 316LN	S31653	65-80	110	40	70
EnduraMet 32	S24100	85	125	45	50
EnduraMet 33	S24000	85	125	45	50

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Corrosion Testing

- **Macrocell Test Approval**
  - EnduraMet 2205
  - EnduraMet 2304
  - EnduraMet 316 LN
  - EnduraMet 33 (XM-29)
  - EnduraMet 32 (XM-28)

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Stainless Rebar Availability

- All EnduraMet alloys
  - 2205, 2304, and 316LN
- 19 different sizes
  - #3 - #16
  - Metric (10- 50 mm)
- Lengths
  - 20 to 40 Ft.
  - coils available on smaller sizes

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Thinking Beyond Initial Costs Of Stainless Rebar

- Used in critical design areas
  - Such as bridge decks, barrier walls, columns, ramps and piers
- Reduce out-of-service disruptions
- FHWA slogan
  - Get in, get out, stay out!
- Excellent durability with a life expectancy of 100+ years
- Life Cycle Considerations

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Cost Benefits

- Michael Bergmann, P.E., is a retired bridge design engineer, for the NYS DOT
- He co-authored a paper which was entitled “Improving Tomorrow’s Infrastructure: Extending the Life of Concrete Structures with Solid Stainless Steel Reinforcing Bar”
- The following two examples are from his personal experiences where solid stainless rebar was used

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Cost benefits using stainless

- **Alexander Hamilton Bridge – NYC (2205)**
  - This steel spandrel bridge carries I-95 across the Harlem River. The scope of this project was deck replacement, widening, steel rehabilitation, and seismic upgrades.
  - The increased dead load, due to these changes, would have required substantial reinforcement of the existing steel arch ribs and columns.
  - The weight savings, as a result of using less concrete cover, by using stainless steel rebar made most of this additional reinforcement unnecessary.
  - Not only was the total cost of construction reduced as a result of using stainless steel, but the construction time, was reduced by approximately six months.

Cost benefits using stainless

- **Major Deegan Expressway – NYC (2205)**
  - This 72-span expressway, carries I-87 over streets near Yankee Stadium. The scope of this project was deck replacement, widening, steel rehabilitation, and seismic upgrades.
  - The widening of the structure – required for highway geometry and for maintenance of traffic during construction – would have required 16 additional new pile-supported foundations.
  - The use of stainless steel reinforcing, and lightweight concrete in the new deck, made all of those foundations unnecessary, and also substantially reduced the cost of the seismic upgrades.

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Projects Using Talley Stainless Rebar

- Haynes Inlet Slough Bridge in Oregon
- Belt Parkway in NY City
- Garden State Parkway in NJ
- Driscoll Bridge in NJ
- Lincoln Tunnel in NY
- Woodrow Wilson Bridge (Washington, DC)
- Willis Avenue Bridge in NYC
- Major Deegan Expressway in NYC
- Deperming Piers (Norfolk Naval Yard)
- 3 Bridges in Kansas
- 1 Bridge in South Dakota
- MRI Buildings
- Various Highway Projects in Canada
- Various building projects (Parking garage, balcony, mausoleum)

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Solid Stainless Rebar

Completed Haynes Inlet Bridge - Hwy. US 101

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Stainless Steel Products for Infrastructure Applications

- Tie wire
- Prestressed 7 strand wire
- Wire mesh mats
- Dowel bars
- Splices, couplers, anchors, fasteners

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Stainless Steel Rebar with Couplers in a Bridge Deck

Solid Stainless Steel Rebar Summary

- Used in critical design areas
  - Such as barrier walls, columns, ramps, bridge decks, piers
- Requires less concrete cover
  - Reduce superstructure and foundation
- Used in seismically active areas
- Out-of-service disruptions
  - Get in, get out, stay out!
- Life expectancy of 100+ years

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Thank You for Your Time and Attention!!!

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