Interior, Exterior & Structural Applications

Design Considerations

- Is the environment
  - Interior controlled climate?
  - Sheltered exterior environment?
  - High or low traffic?
    - Scratching, denting, graffiti, urine
- Type 304 - most interior applications
- Type 316 - coastal and polluted exterior locations
- Use an appropriate finish and visual standard
- One supplier per finish

DG Bank Headquarters

Berlin, 2001

Type 304 conference room exterior and structural components

Architect: Gehry Partners

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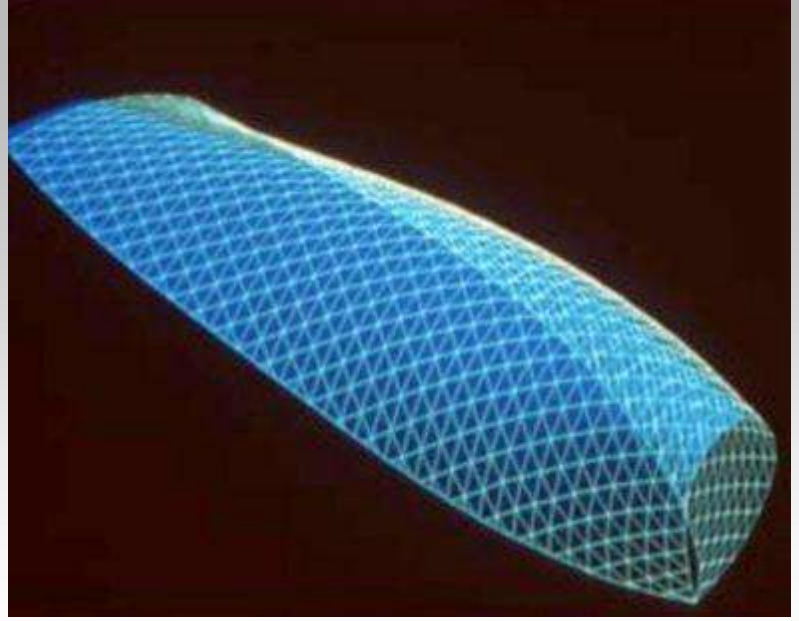

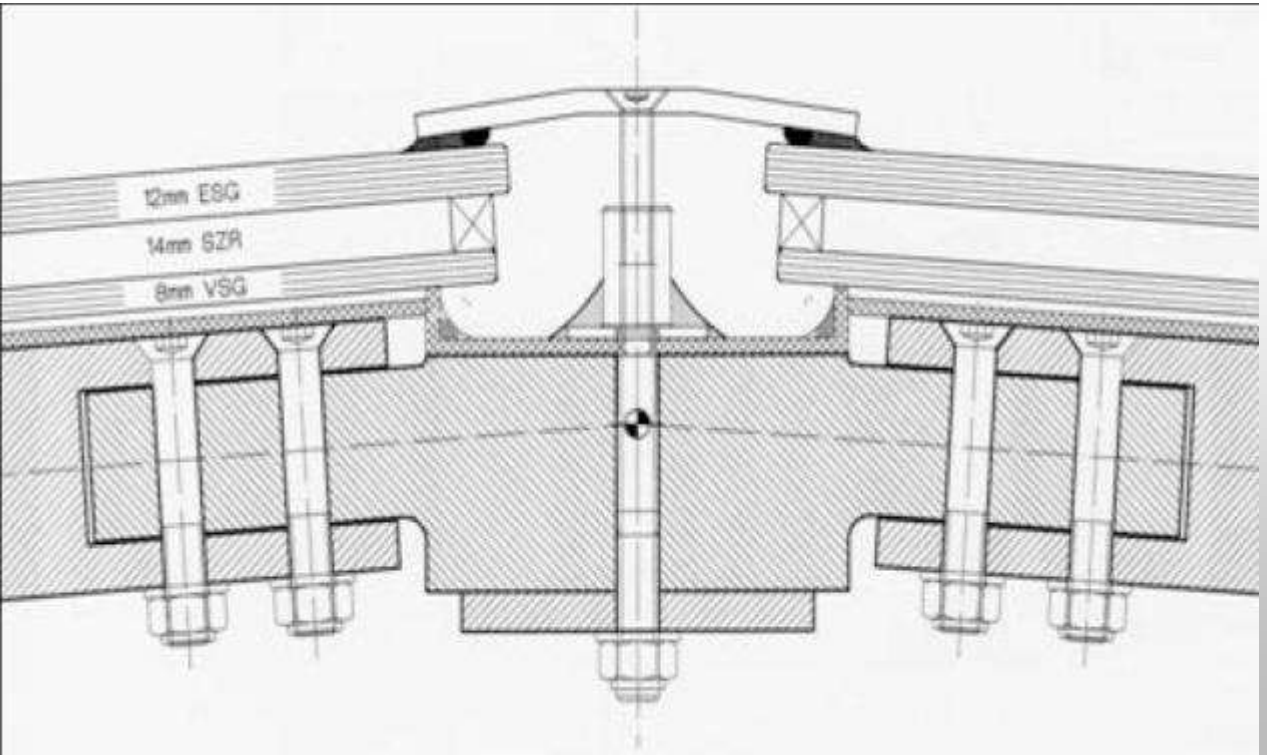

DG Bank Skylights

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Bibliothèque François Mitterand

Woven stainless on walls, draped from ceilings and over windows

Bibliothèque François Mitterand

Woven stainless steel mesh on the building exterior

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September 11 Museum Building, New York

- Situated between the sites of the two towers
  - Perforated Type 316 roof and wall sunscreen cladding
  - Two finishes to create texture
    - Glass bead blasted and mirror polished
- Other park applications
  - Type 316 park benches, water feature components, lighting, subway station canopy
  - 2205 walkway gratings

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Hunter Museum Lobby

Type 304
Vibration finish on wall panels and ceiling
Softly diffuses light and hides scratches

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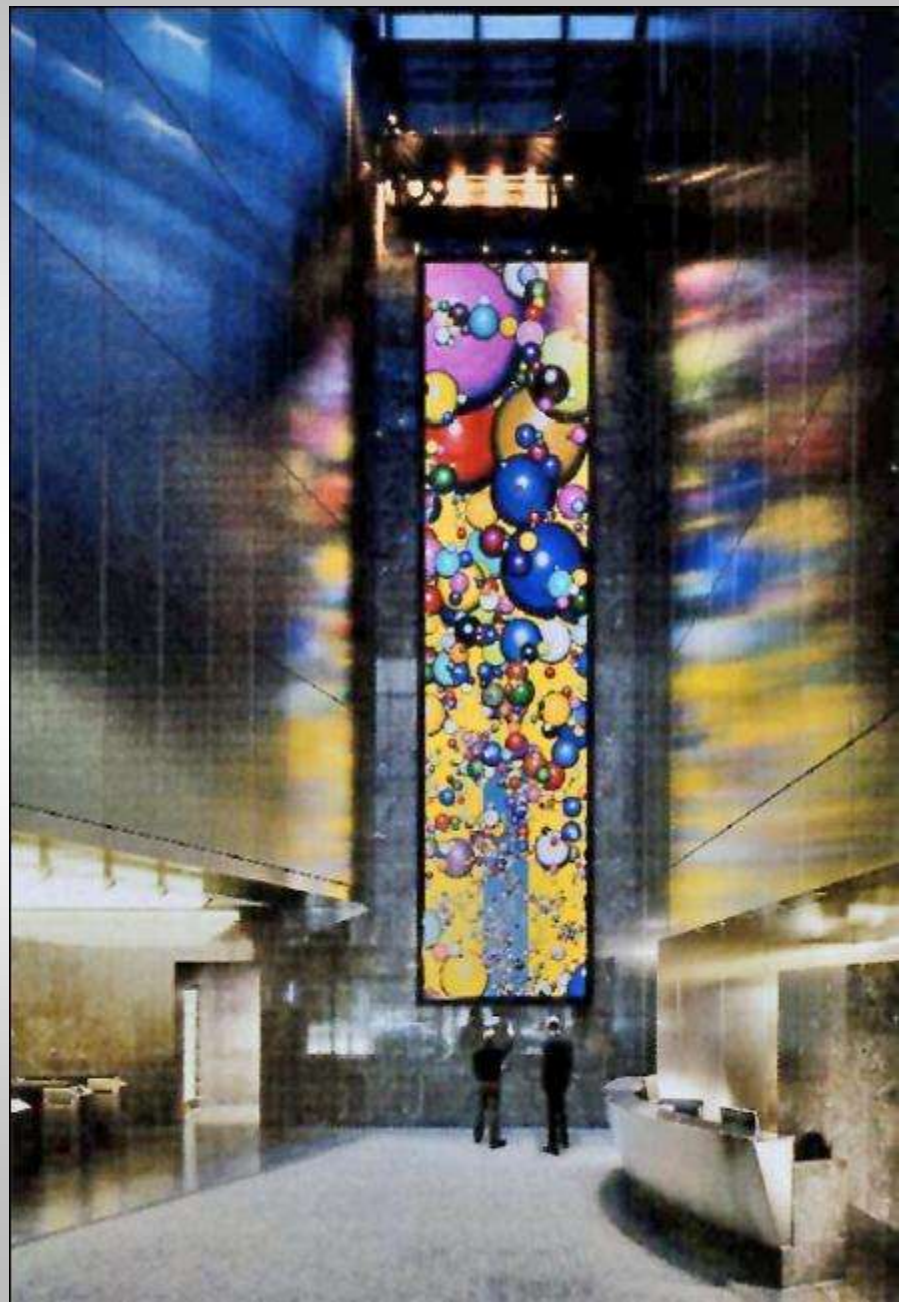
Hyatt Center

S. Wacker Dr., Chicago
Pei Cobb Freed
Type 316 exterior/ Type 304 interior panels
Soft embossed finish highlights
British artist Keith Tyson's art



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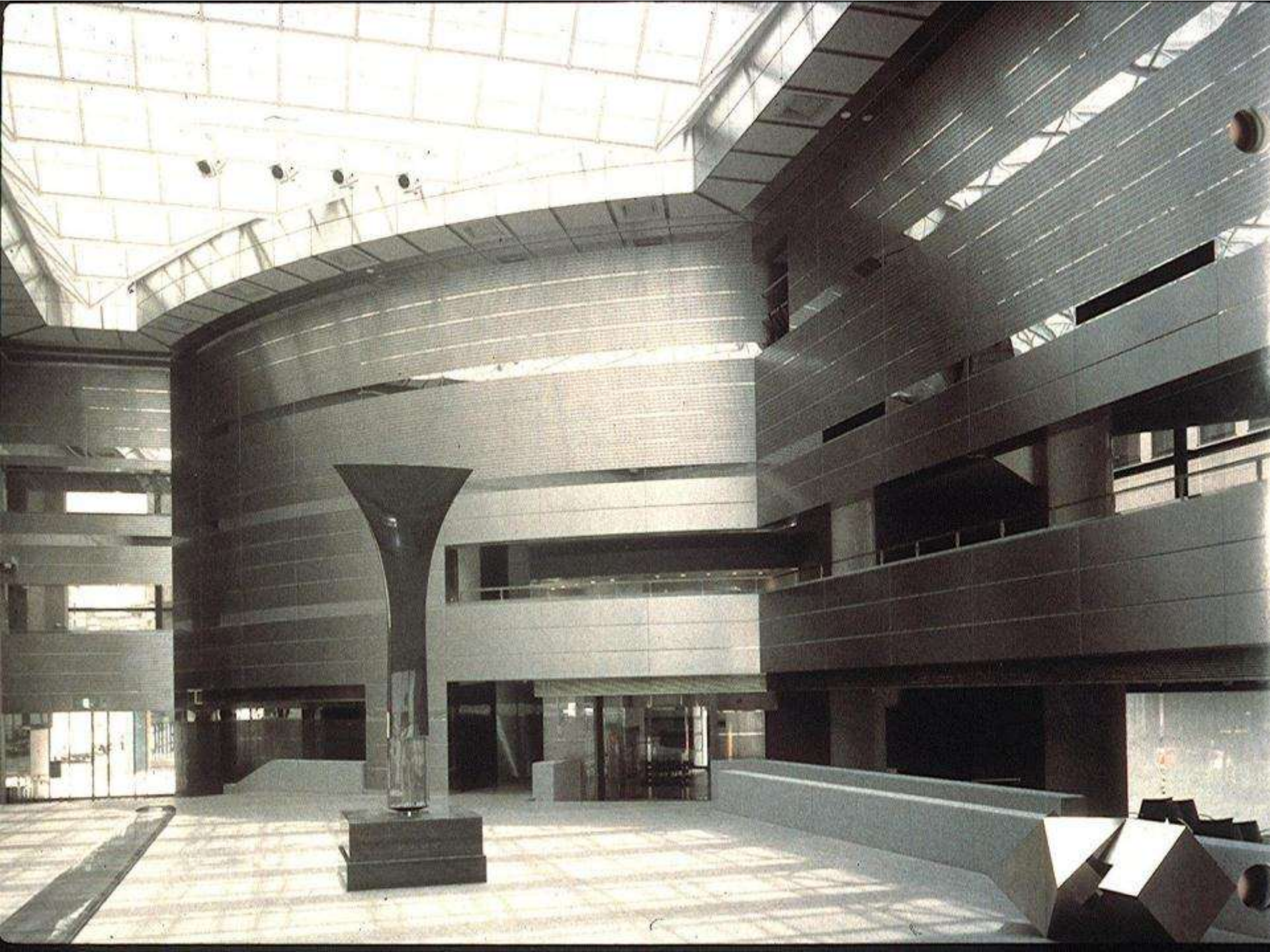
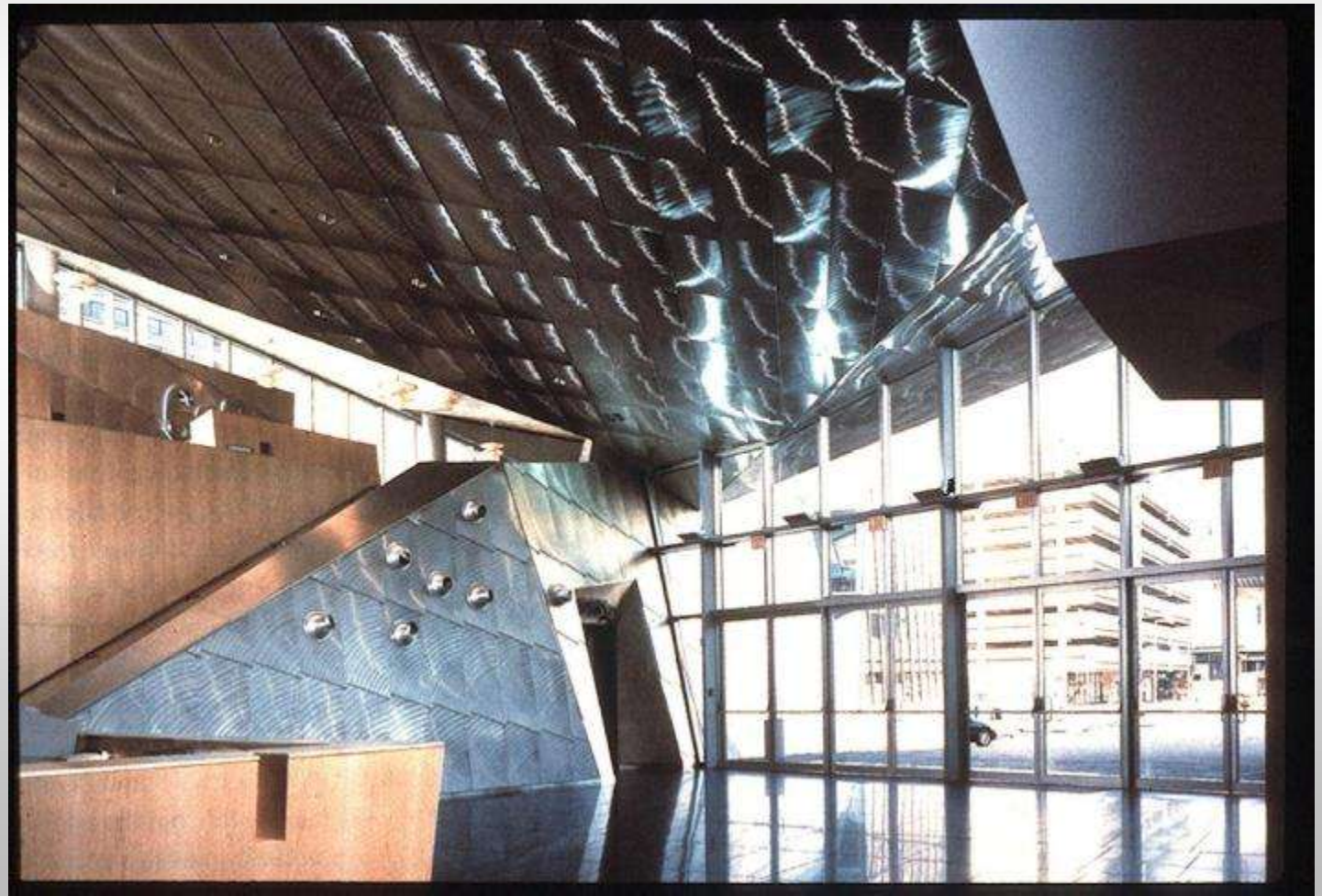


New England Aquarium

Overlapping Type 304 shingles

Ground finish simulates fish scales



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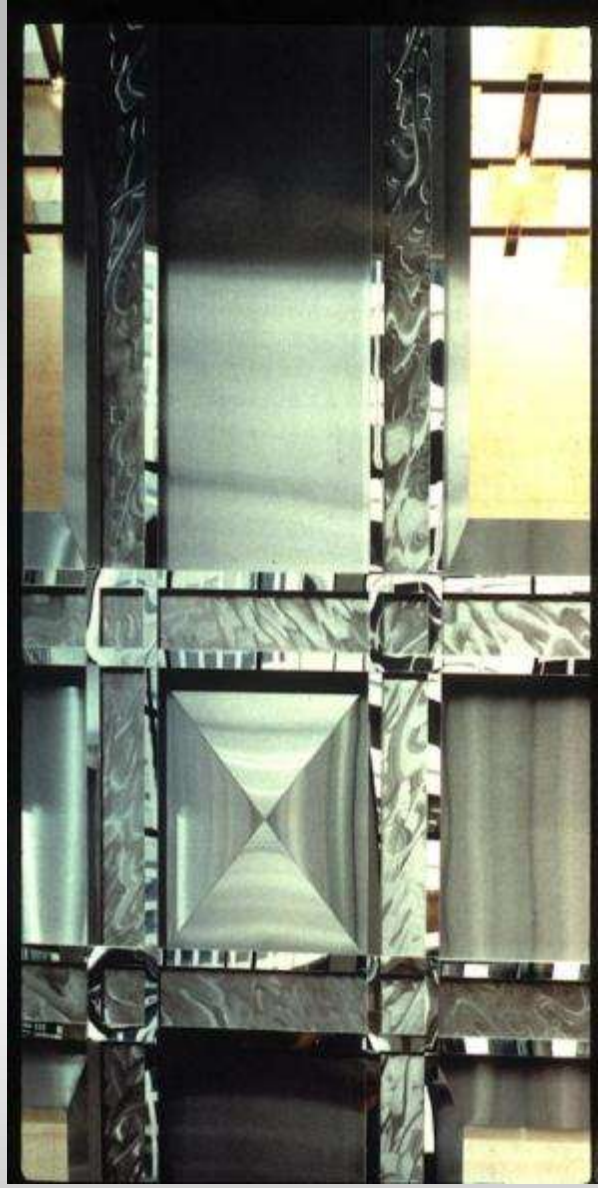

Sears Tower lobby, Chicago, DeStefano & Partners Architects
Hairline and swirl finishes

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Custom stainless steel table

David Curry, designer
ferromobius innovative designs

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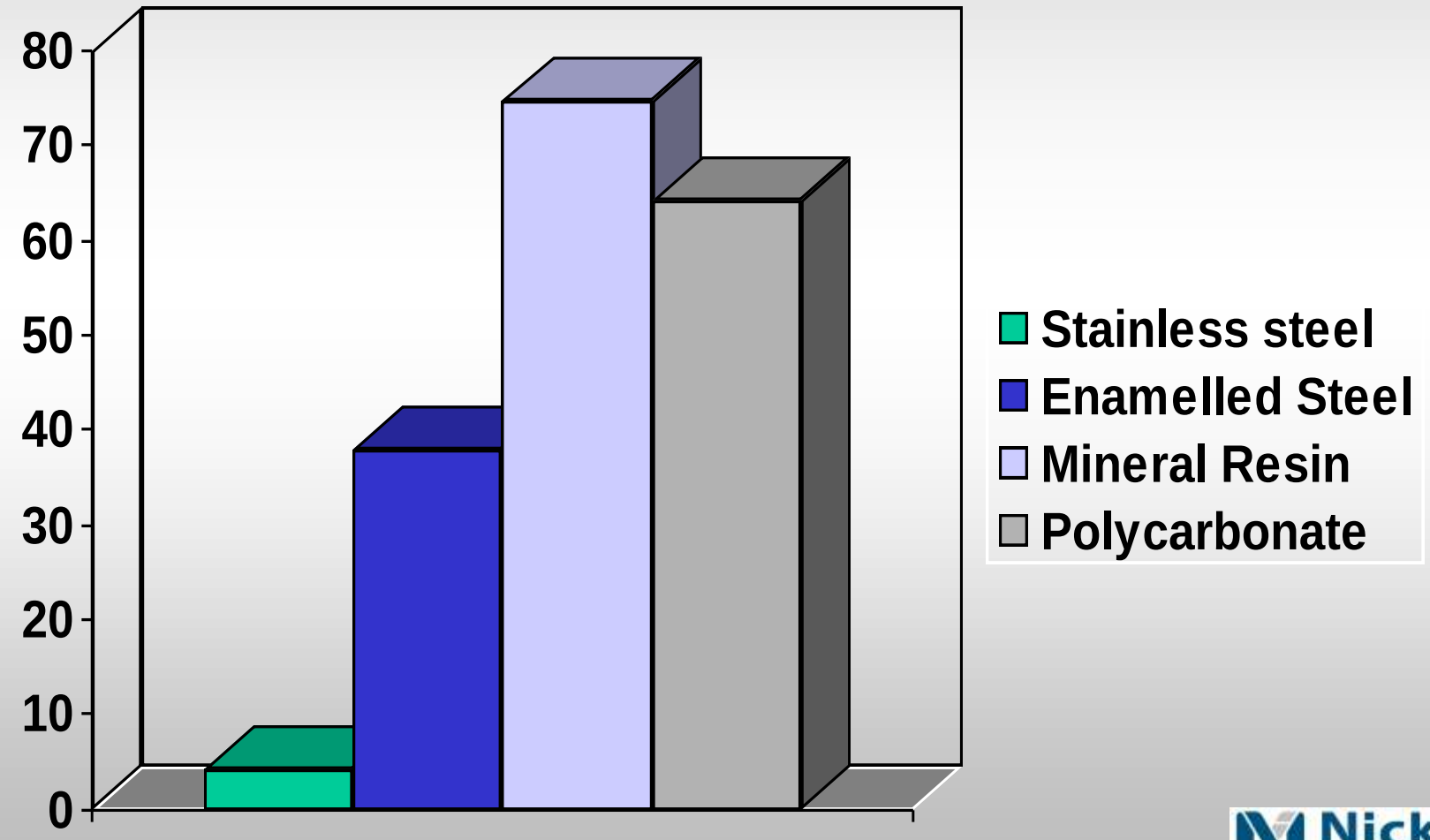
Mean Bacteria Count After Cleaning

10 Seconds - Abraded Sink Surfaces (x 10^4 cfu/cm^2)



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Stainless Steel Kitchen Cabinets & Custom Table Base

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Corrosive Indoor Public Transit

- Corrosiveness increased by
  - Exposure to coastal or deicing salt
  - Urine exposure
- Type 316 and smooth finishes for locations with salt or urine exposure
- Fire safety also important

Southwark Station, London

***Architectural Record* magazine, March 2000**

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Washington National Airport elevators

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Embossed and polished column cover Miami International Airport

Etched Column covers Tokyo International Airport, 2nd terminal

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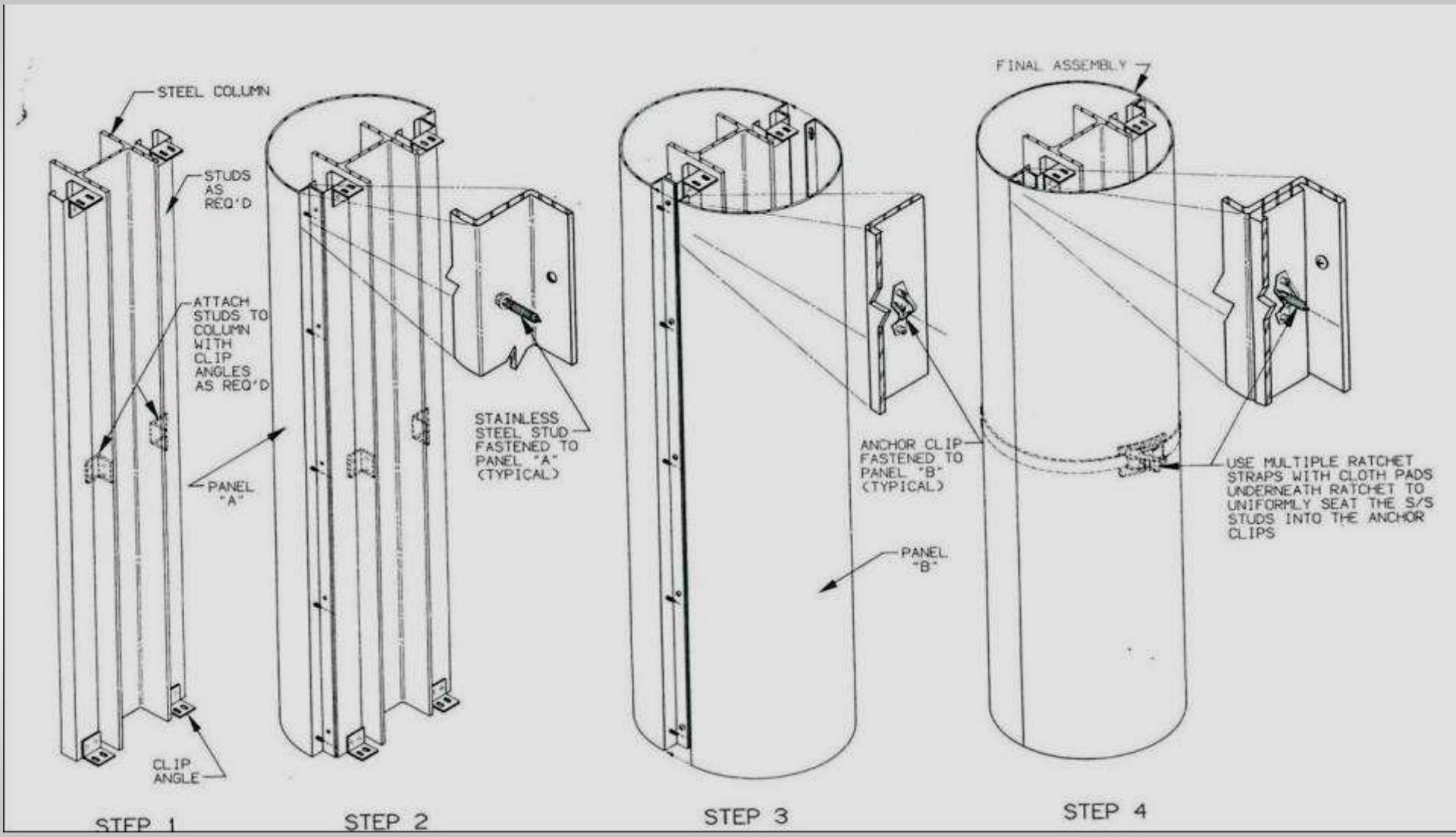
Column Cover Details



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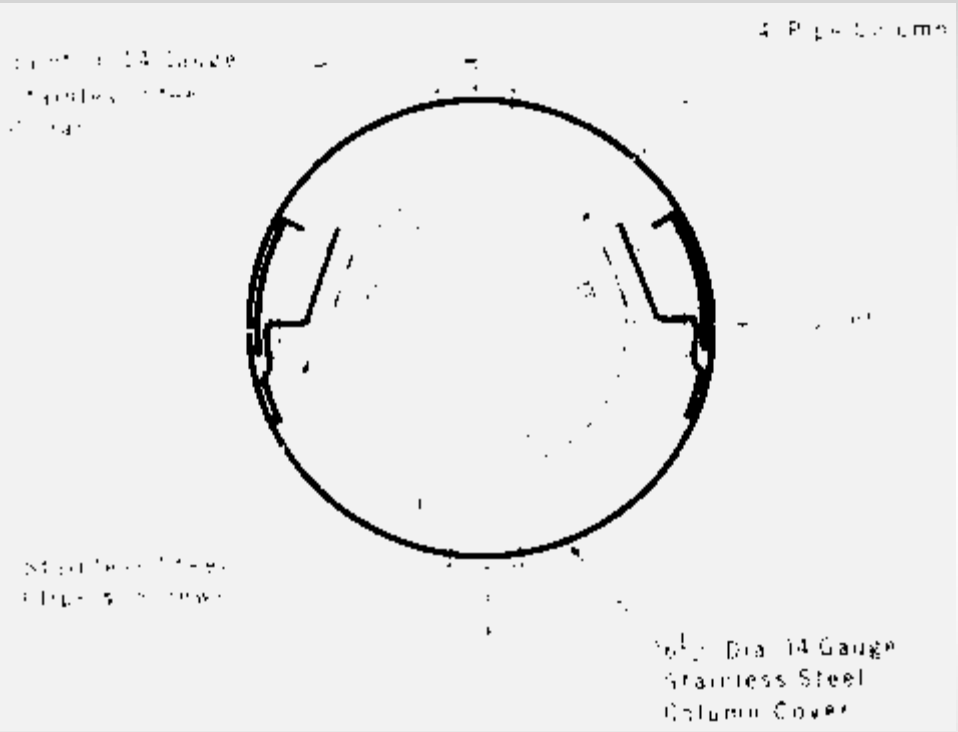

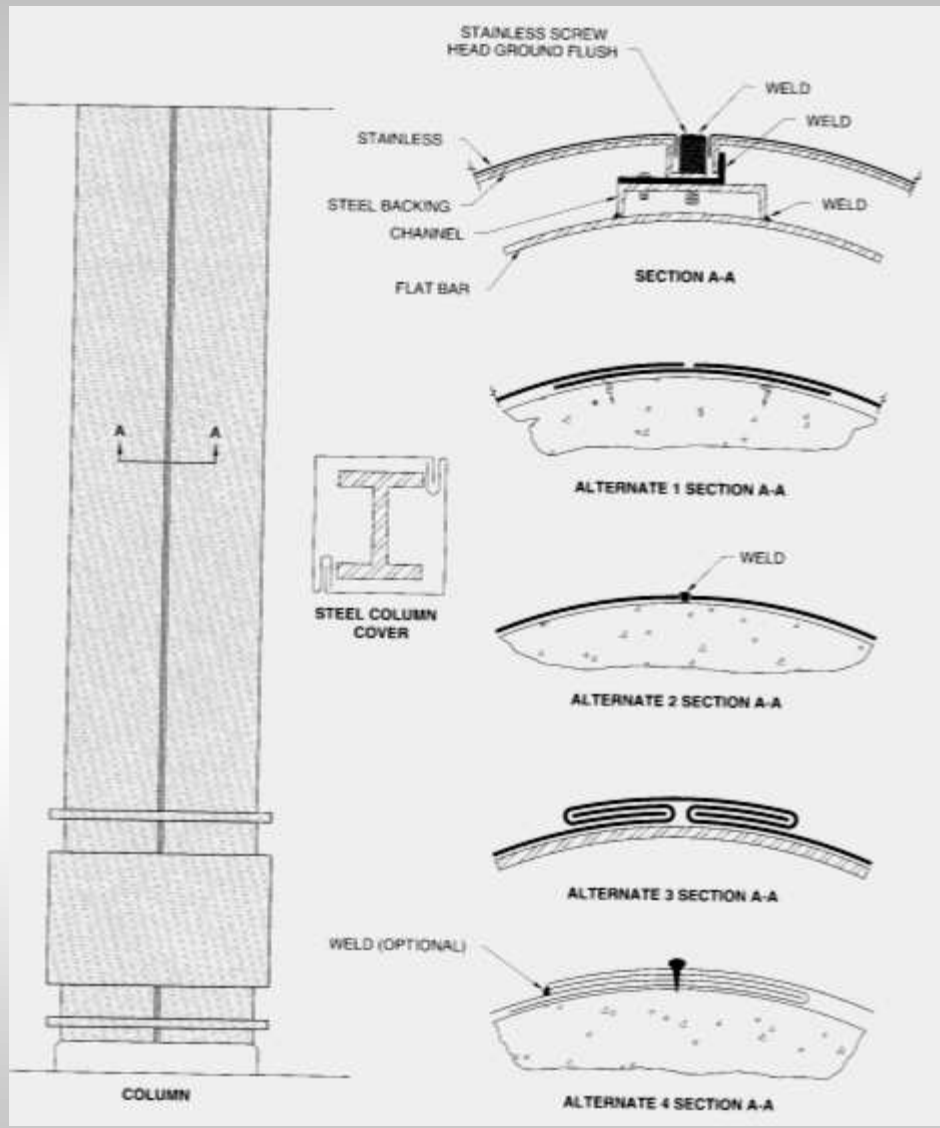
STAINLESS SCREW
HEAD GROUND FLUSH
WELD
WELD
STAINLESS
STEEL BACKING
CHANNEL
WELD
FLAT BAR
SECTION A-A
A
A
STEEL COLUMN
COVER
ALTERNATE 1 SECTION A-A
WELD
ALTERNATE 2 SECTION A-A
ALTERNATE 3 SECTION A-A
WELD (OPTIONAL)
COLUMN
ALTERNATE 4 SECTION A-A

Petronas Towers

Kuala Lumpur, Malaysia

Cesar Pelli & Assoc.

Stainless: Type 316
Height: 88 stories
1,483 feet (452 m)

Flat panels:
0.098 in., (2.5 mm),
Cambric finish

Tubular panels:
0.118 in. (3.0 mm),
No. 4 polish

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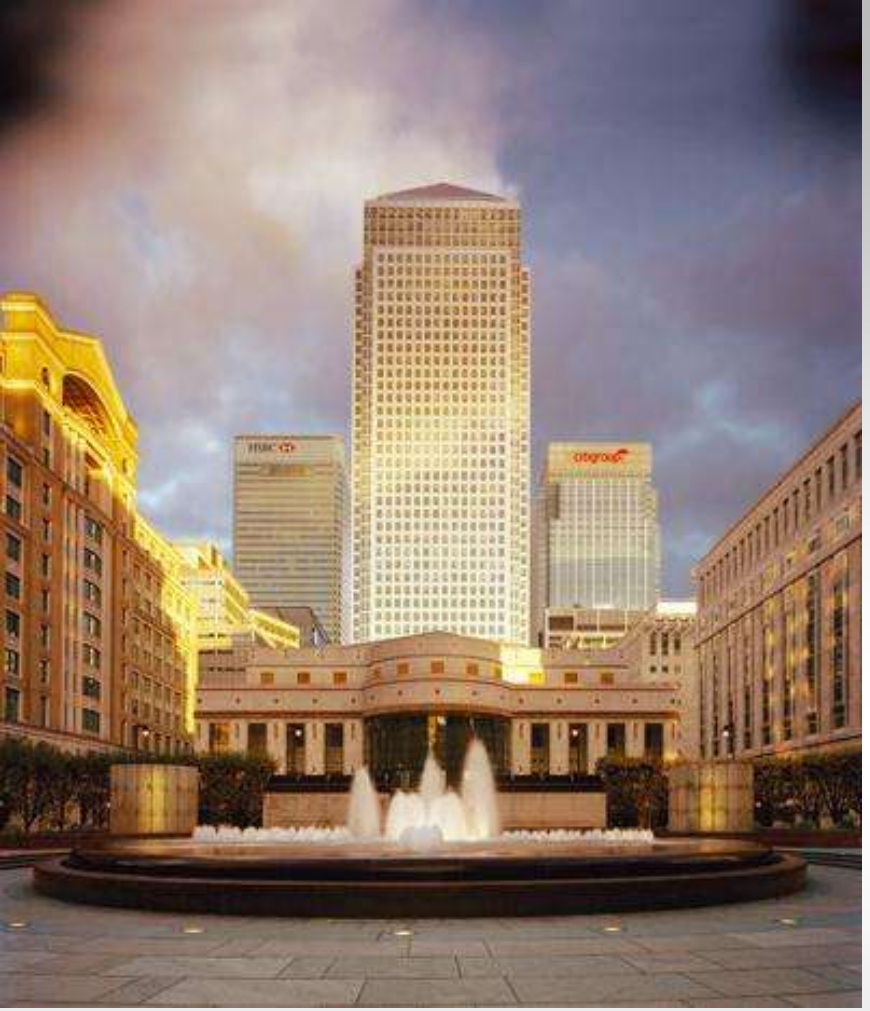


One Canada Square, Canary Wharf,London

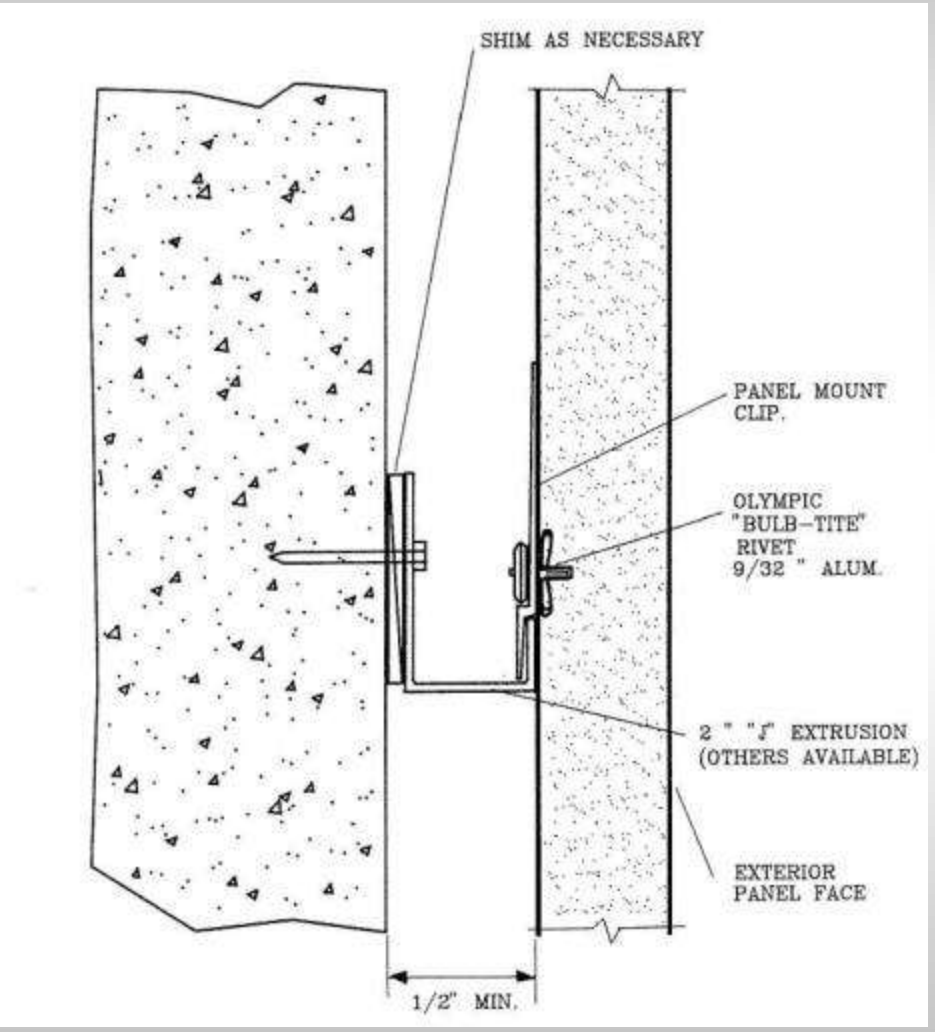
Cesar Pelli & Assoc.

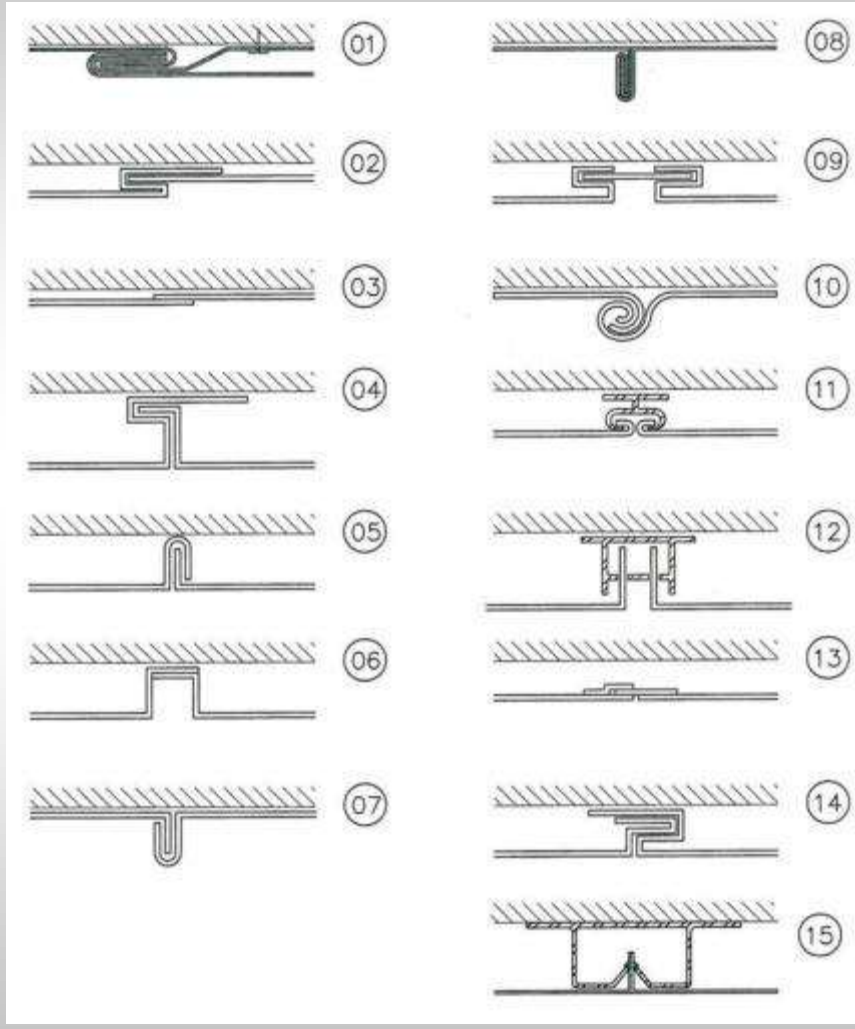
Type 316

HyClad Cambric finish

Fine No. 4 finish details

Examples of Traditional Wall Panel Joints and Attachment to Concrete Wall





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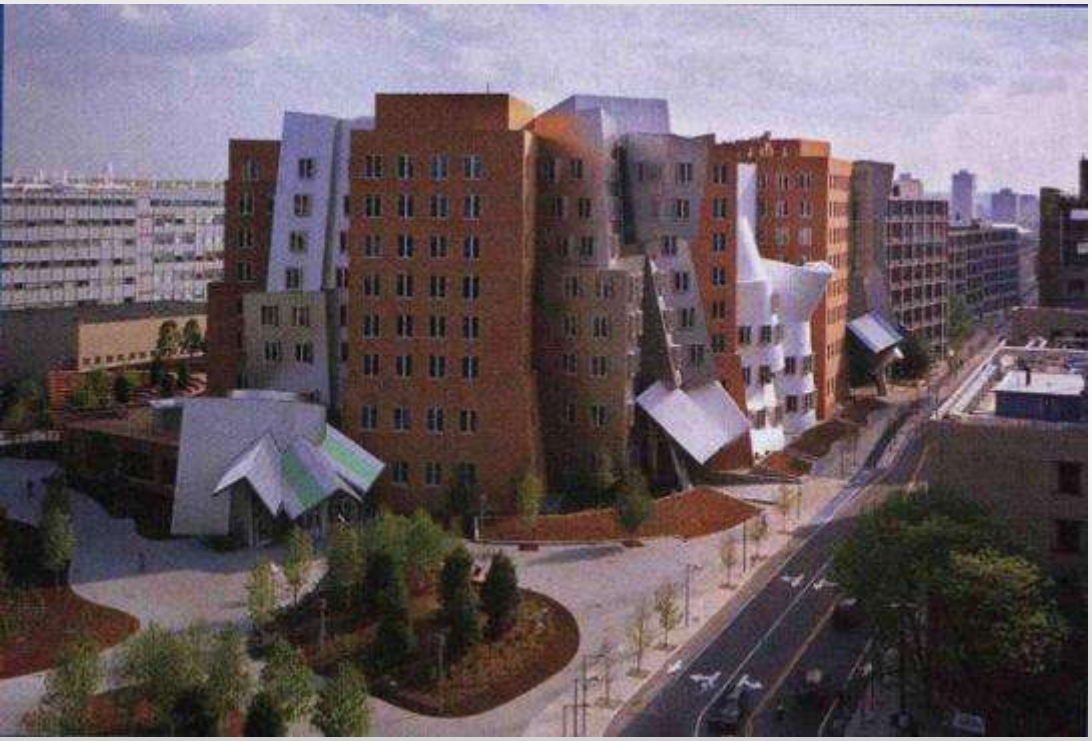
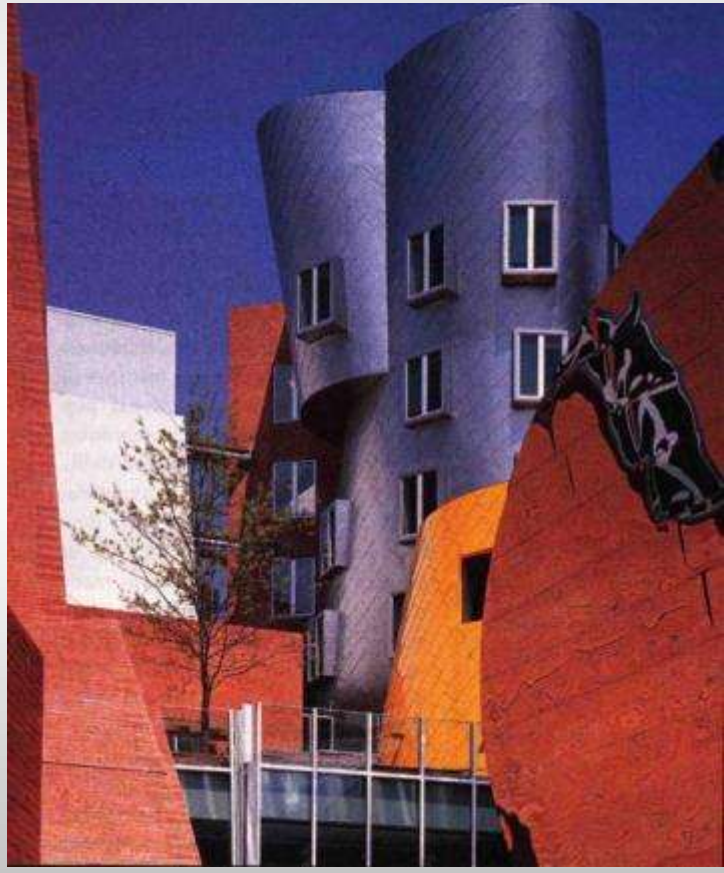
Ray and Maria Stata Center for Computer, Information, and Intelligence Sciences

Massachusetts Institute of Technology, Boston





Type 316 overlapping shingles
Non-directional finish
Gehry Partners

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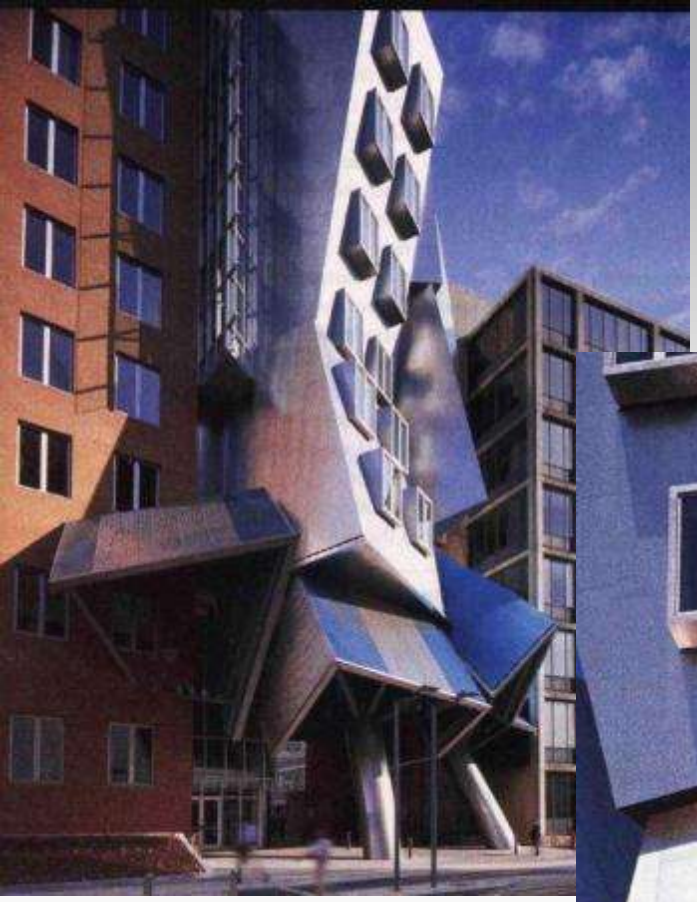

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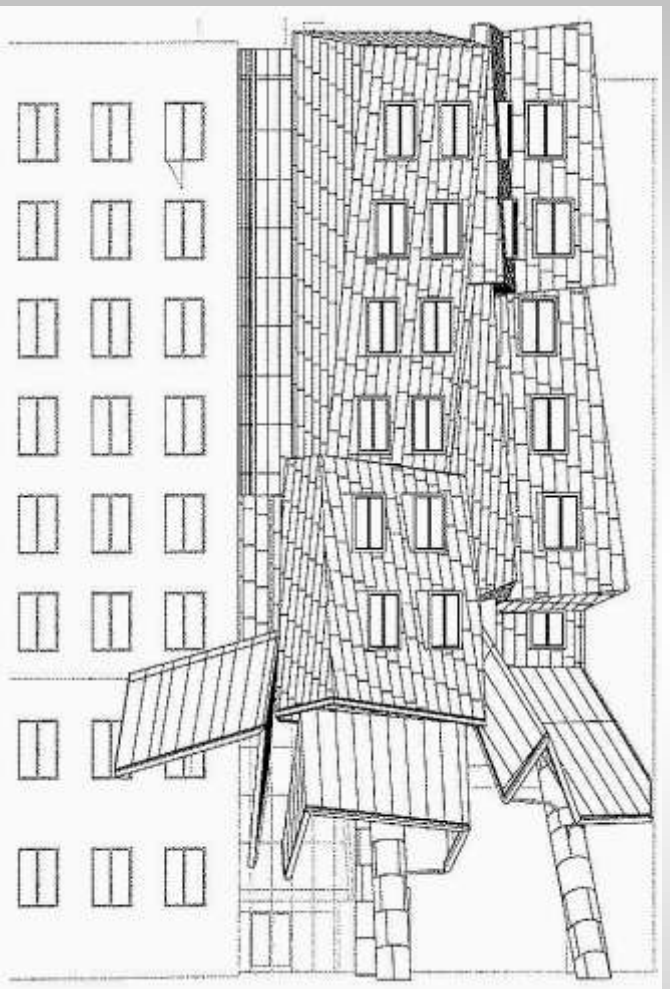
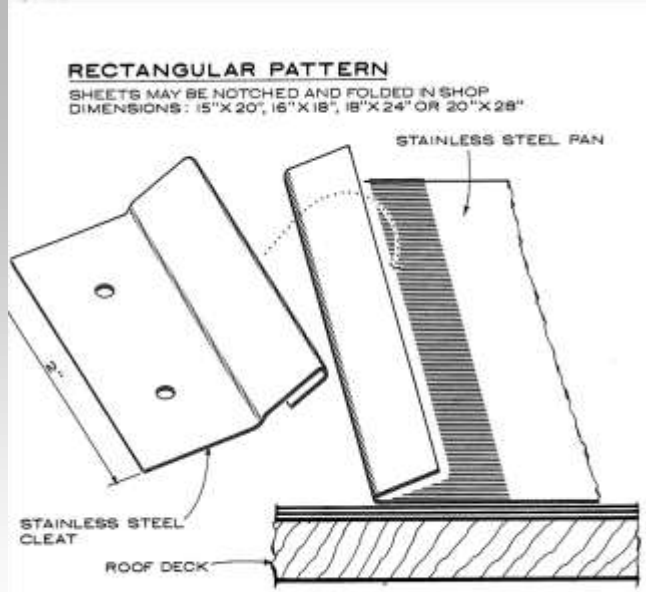
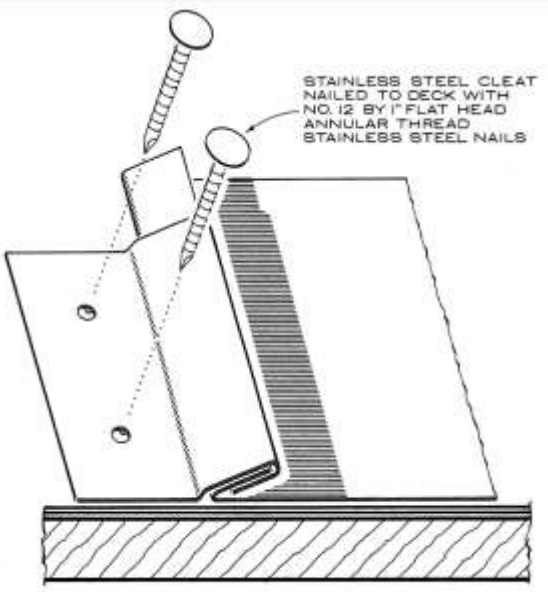


RECTANGULAR PATTERN

SHEETS MAY BE NOTCHED AND FOLDED IN SHOP
DIMENSIONS: 15"X20", 16"X18", 18"X24" OR 20"X28"

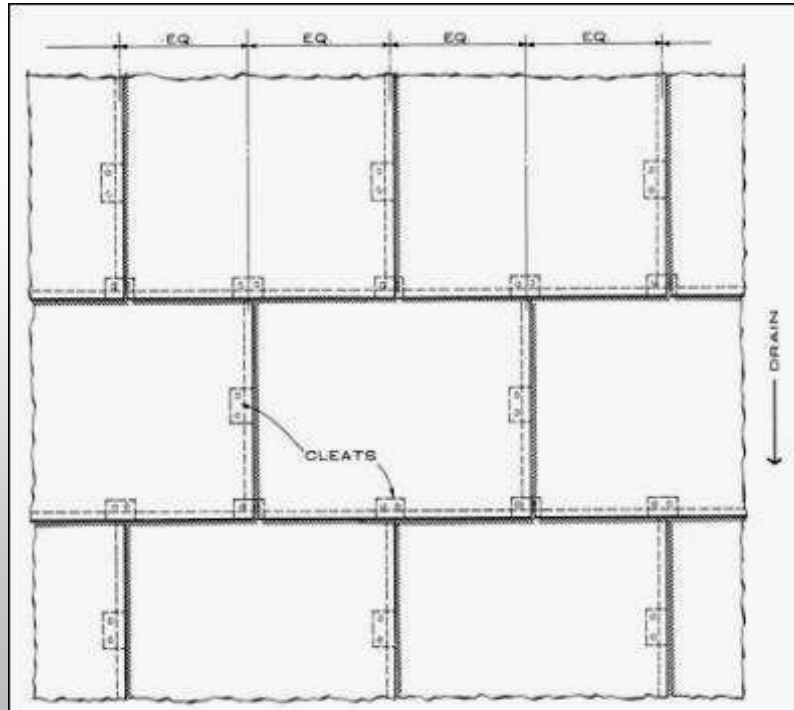


METHOD OF CLEATING

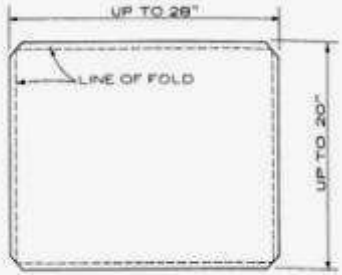


STEP 1

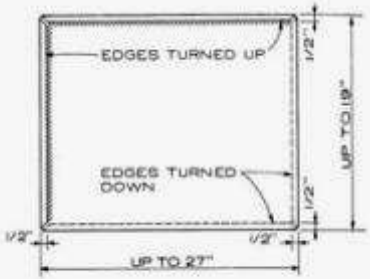
STEP 2



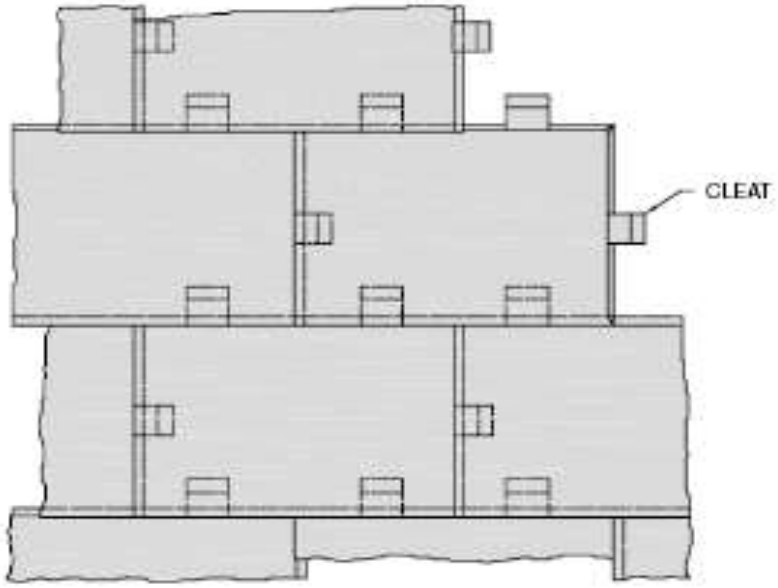
PARTIAL PLAN OF LAYOUT



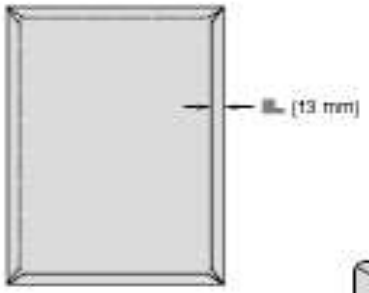
STEP 1 NOTCHED & TINNED



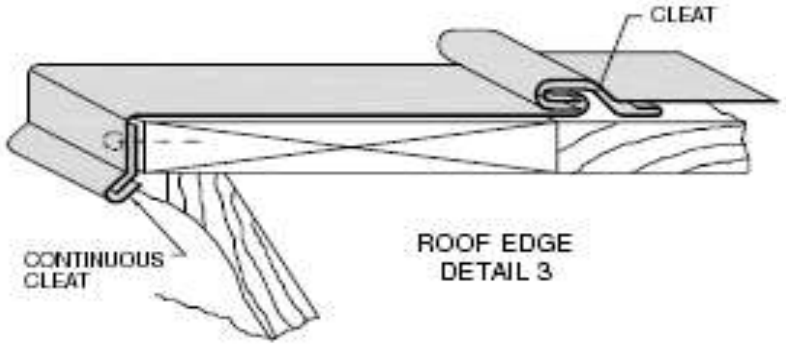
STEP 2 FOLDED INTO PAN



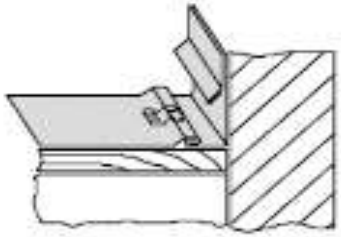
FLAT SEAM ROOF



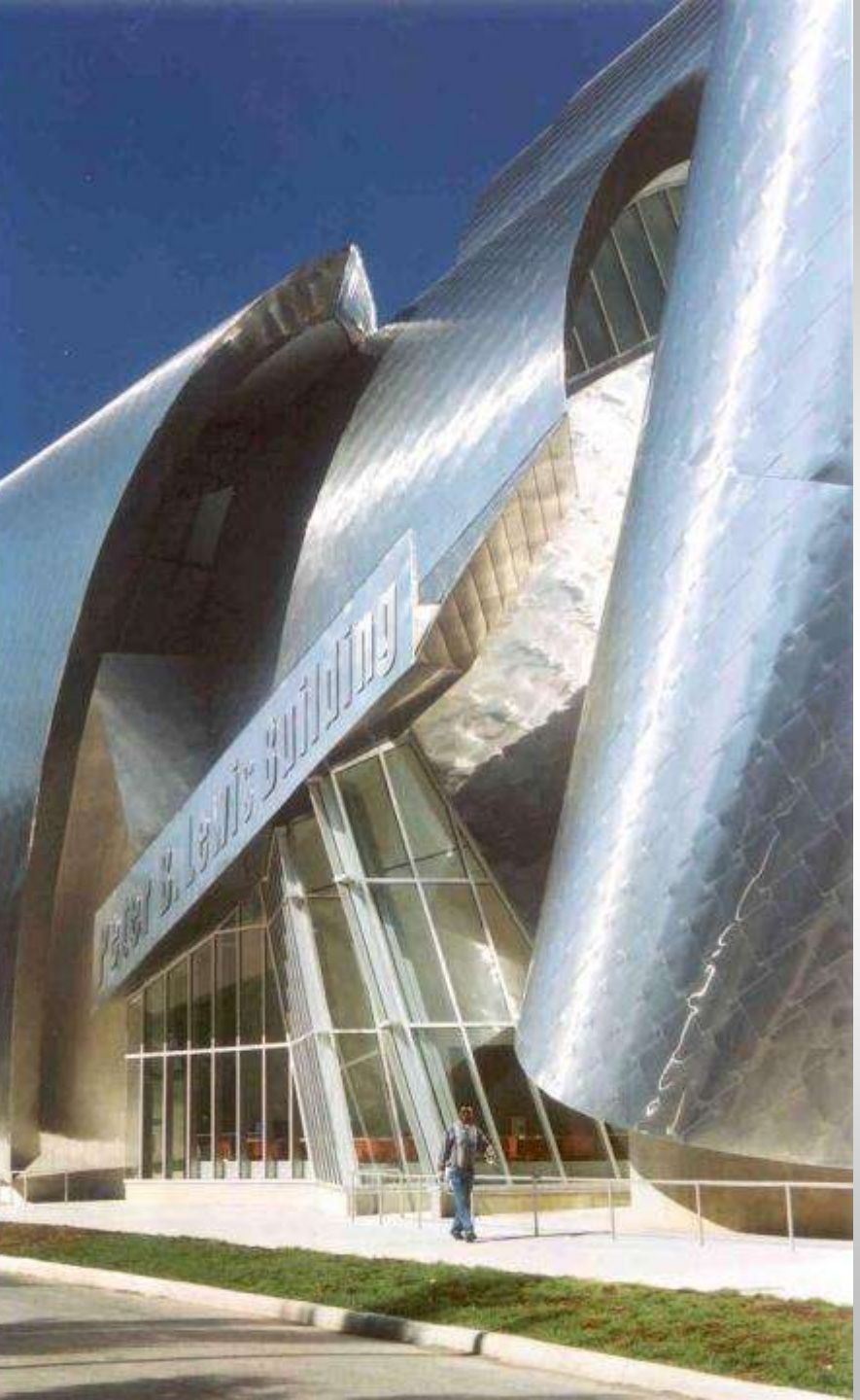
ROOFING SHEET
DETAIL 1



ROOF EDGE
DETAIL 3



JUNCTION PARAPET WALL
DETAIL 2



Peter B Lewis Building

Case Western Reserve University, Cleveland

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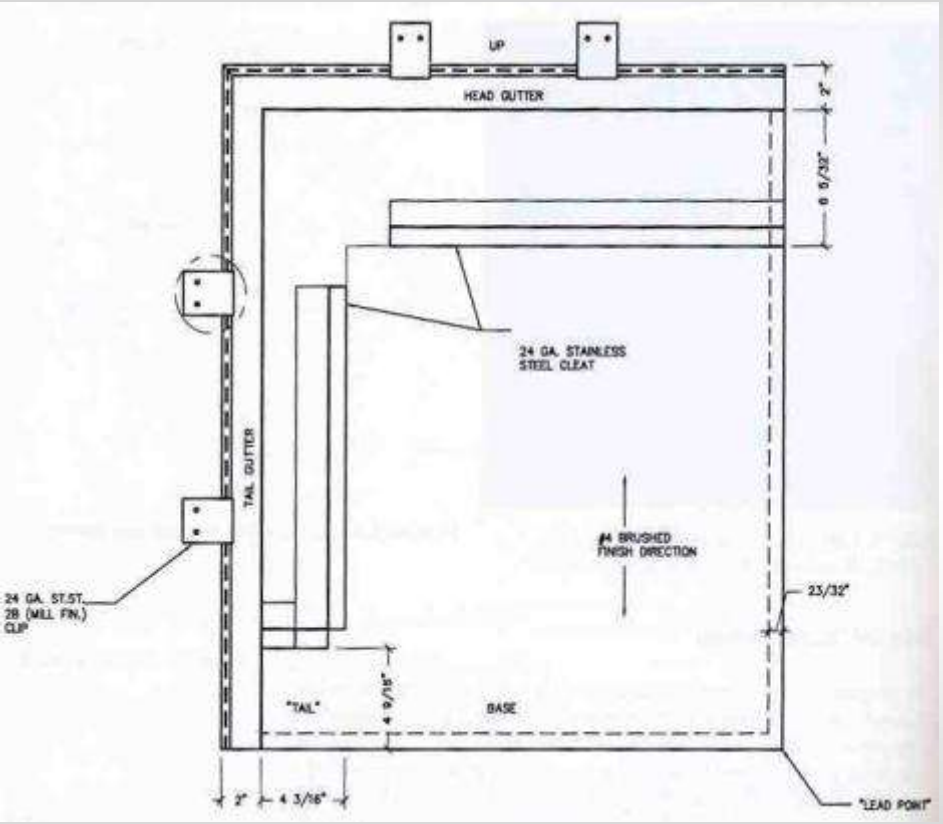
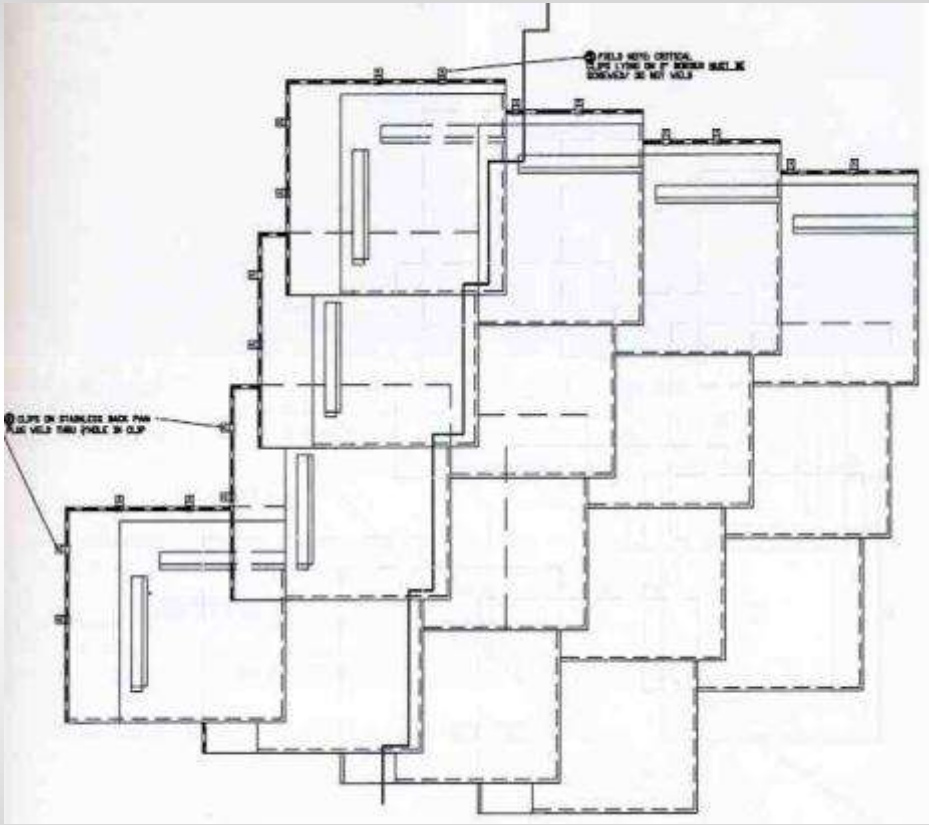
Peter B Lewis Building Details

Overlapping, interlocking shingles in a predetermined design

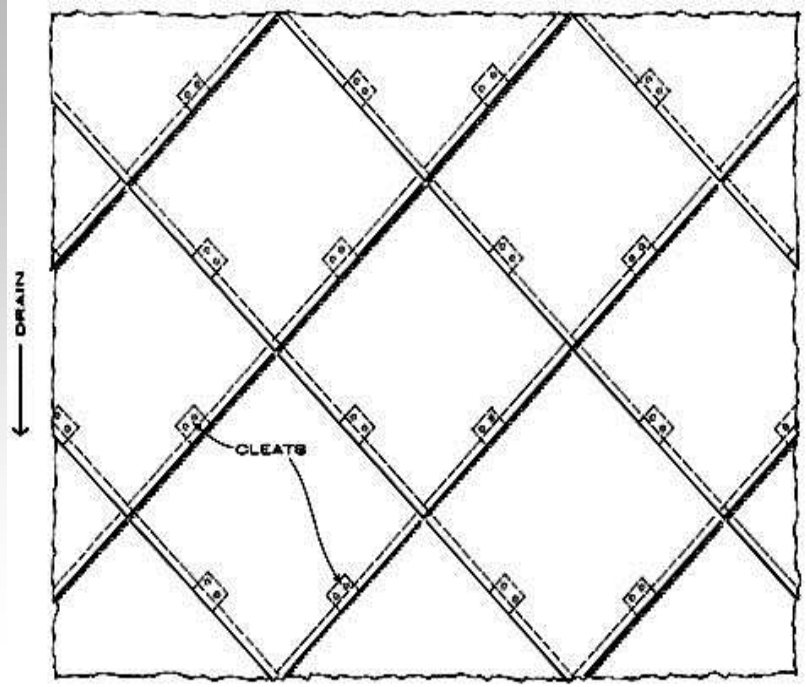




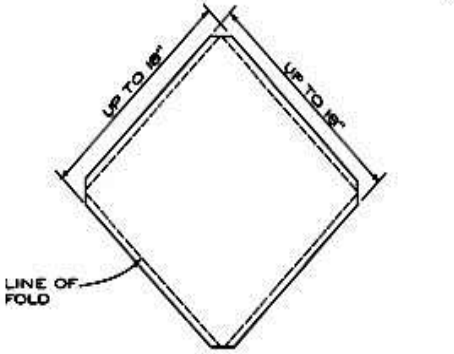
University of Texas, Natural Science & Engineering Research Building

Type 304, electrochemically colored stainless shingles

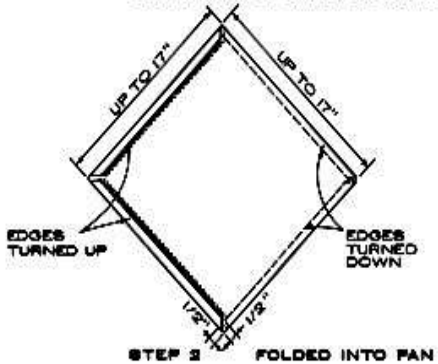
Design for 50+ year life to sustainable design standards



PARTIAL PLAN OF LAYOUT



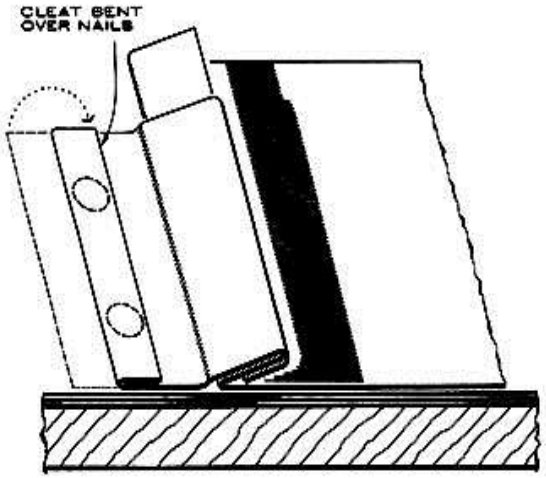
STEP 1 NOTCHED & TINNED



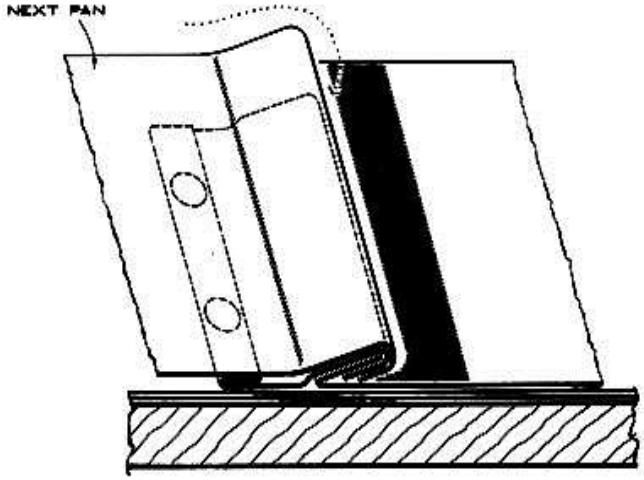
STEP 2 FOLDED INTO PAN

DIAMOND PATTERN

SHEETS MAY BE NOTCHED AND FOLDED IN SHOP
DIMENSIONS : 15"X 15" OR 16"X 16"



STEP 3

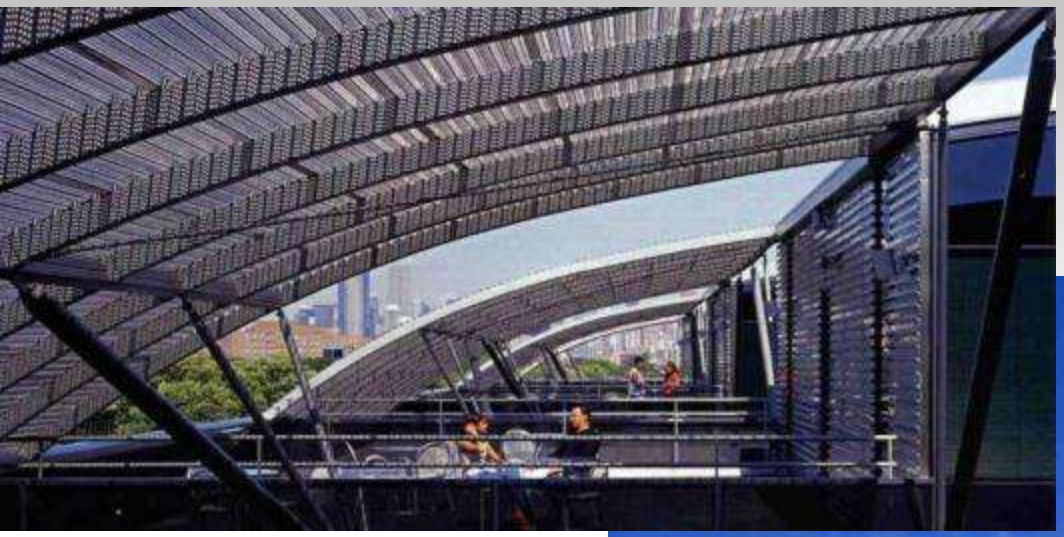


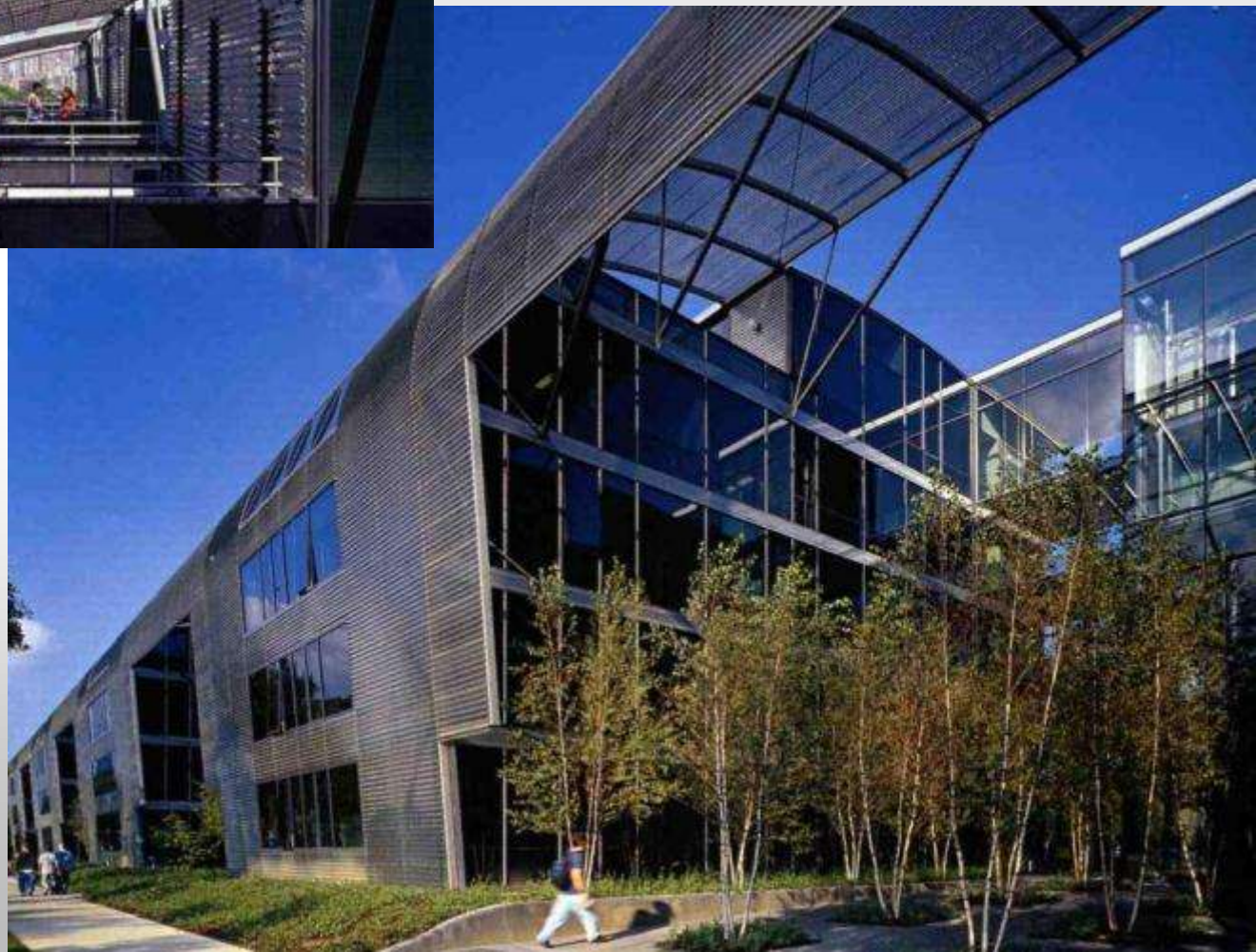
STEP 4

Maggie's Cancer Center Dundee, Scotland

Gehry Partners
Flat lock seam roof
A small entrance that makes a big design statement

Illinois Institute of Technology, Chicago





Architect:
Rem Koolhaas

Corrugated wall panels and perforated patio screens

Nippon Sheet Glass Building

Osaka City, Japan
Type 304 with black electrochemical color
Scratching damage is visible at ground level

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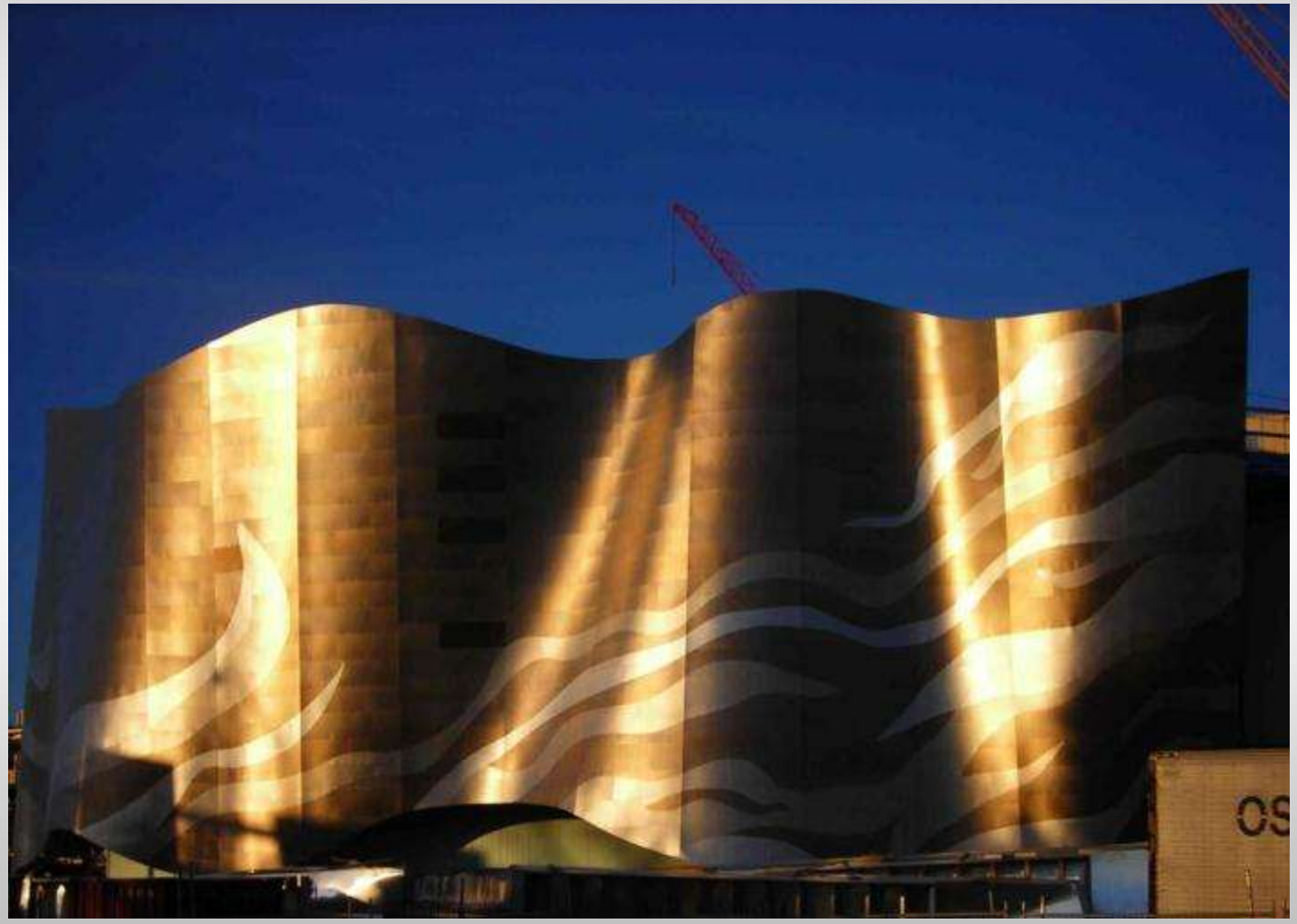
Neiman Marcus Store

Electrochemically Colored Stainless Steel

Custom color variation creates wave pattern



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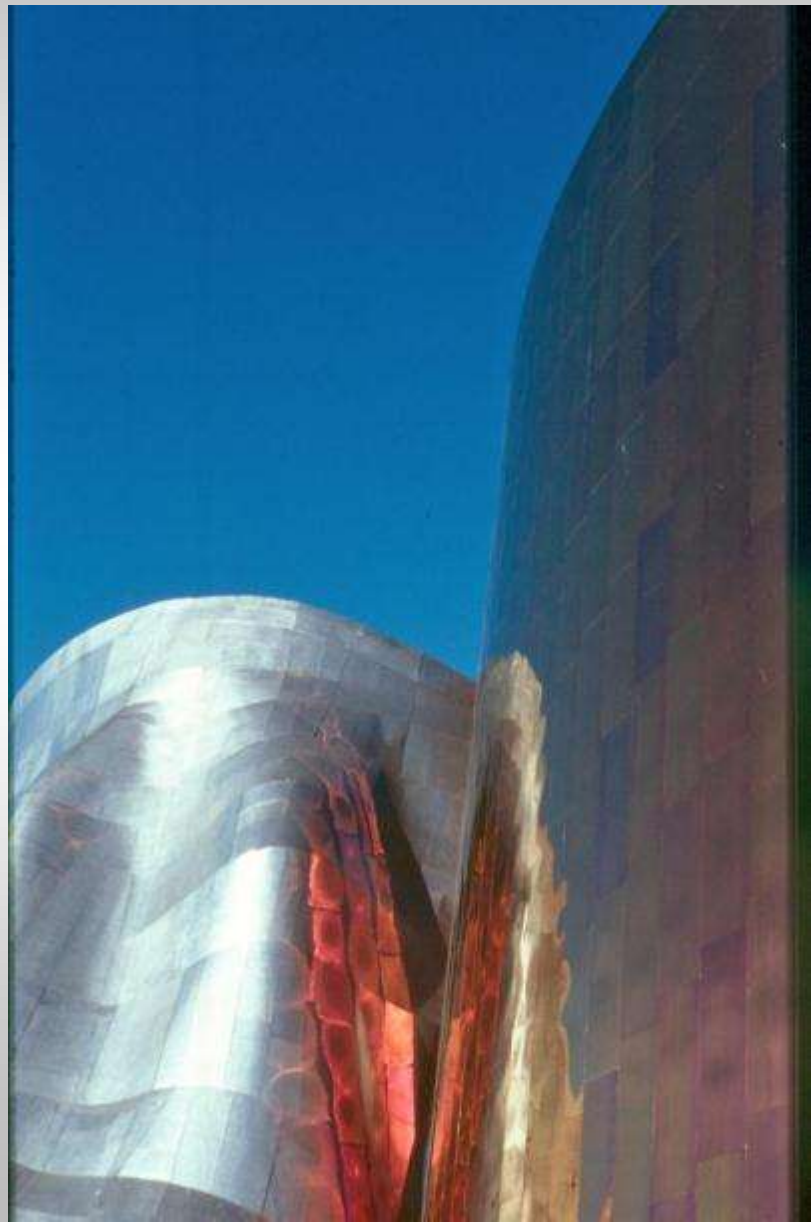
Experience Music Project

Seattle, Gehry Partners



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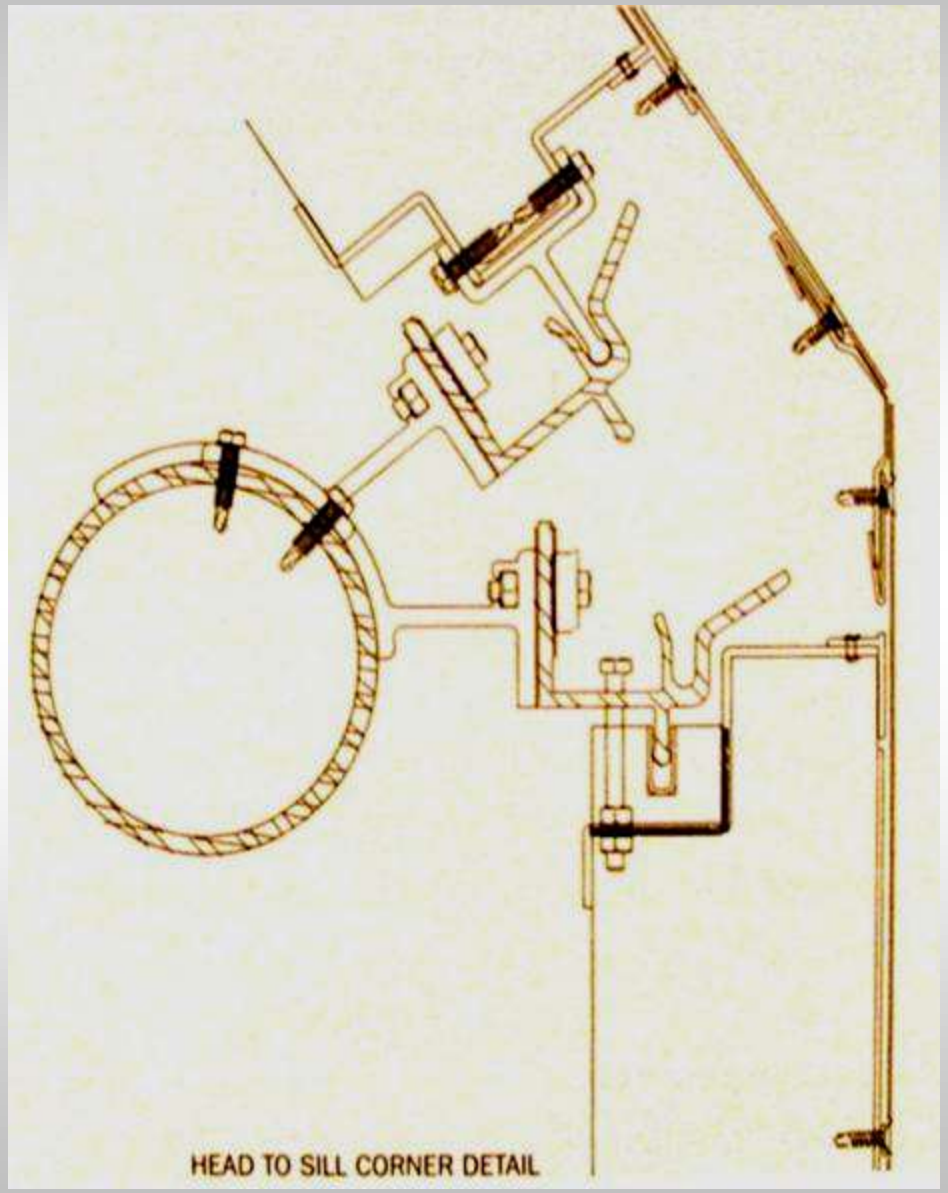

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41 Union Square

Perforated stainless steel sunscreen panels
Installed over poured concrete building and windows
Screens reduces building energy consumption

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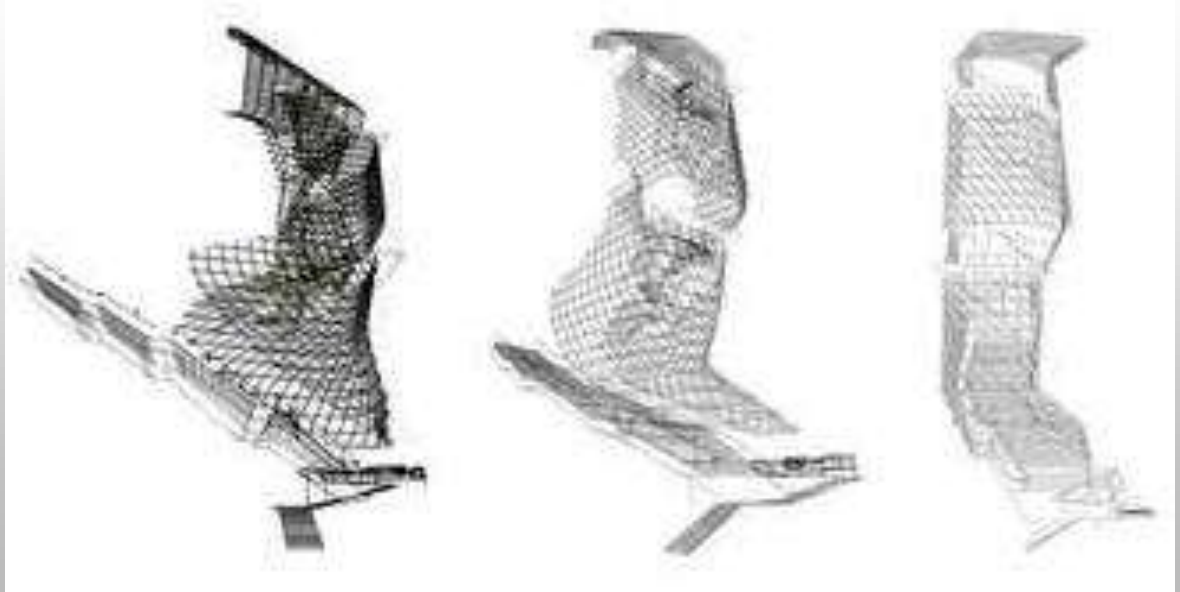
41 Union Square



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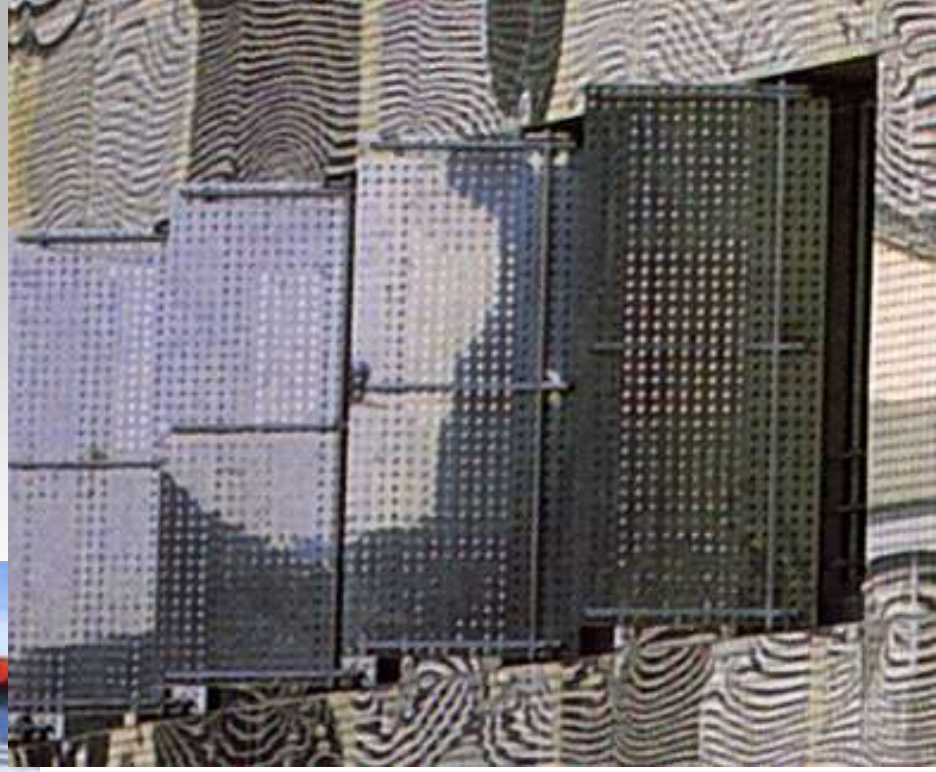
Sun Screens

University of Chemistry, Physics, and Electrical Engineering (CPE), Lyon



Installation of perforated sunscreens over an existing glass wall dramatically reduced heat gain

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Kuala Lumpur International Airport
Stainless Steel Plant Support Sun Screens

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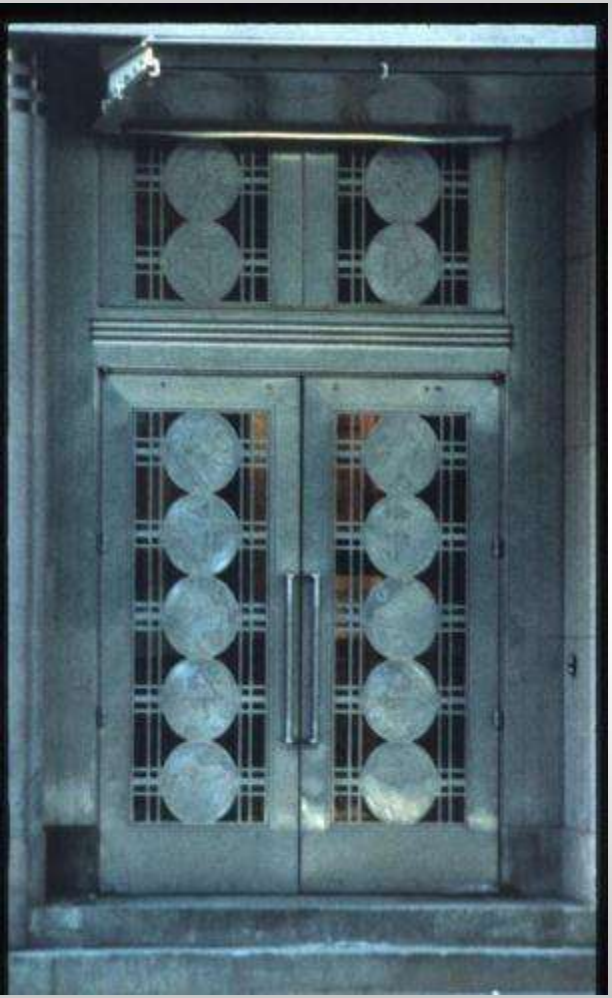
Residential Photo Studio

Salzburg, Austria
Electrochemically colored stainless
Deliberate color variation
Shaped like camera lens

Stainless Doors Provide Long-Term Durability & Security



Toronto Stock Exchange 1932

Cast disks

Tiffany & Co. Solid vault-like doors

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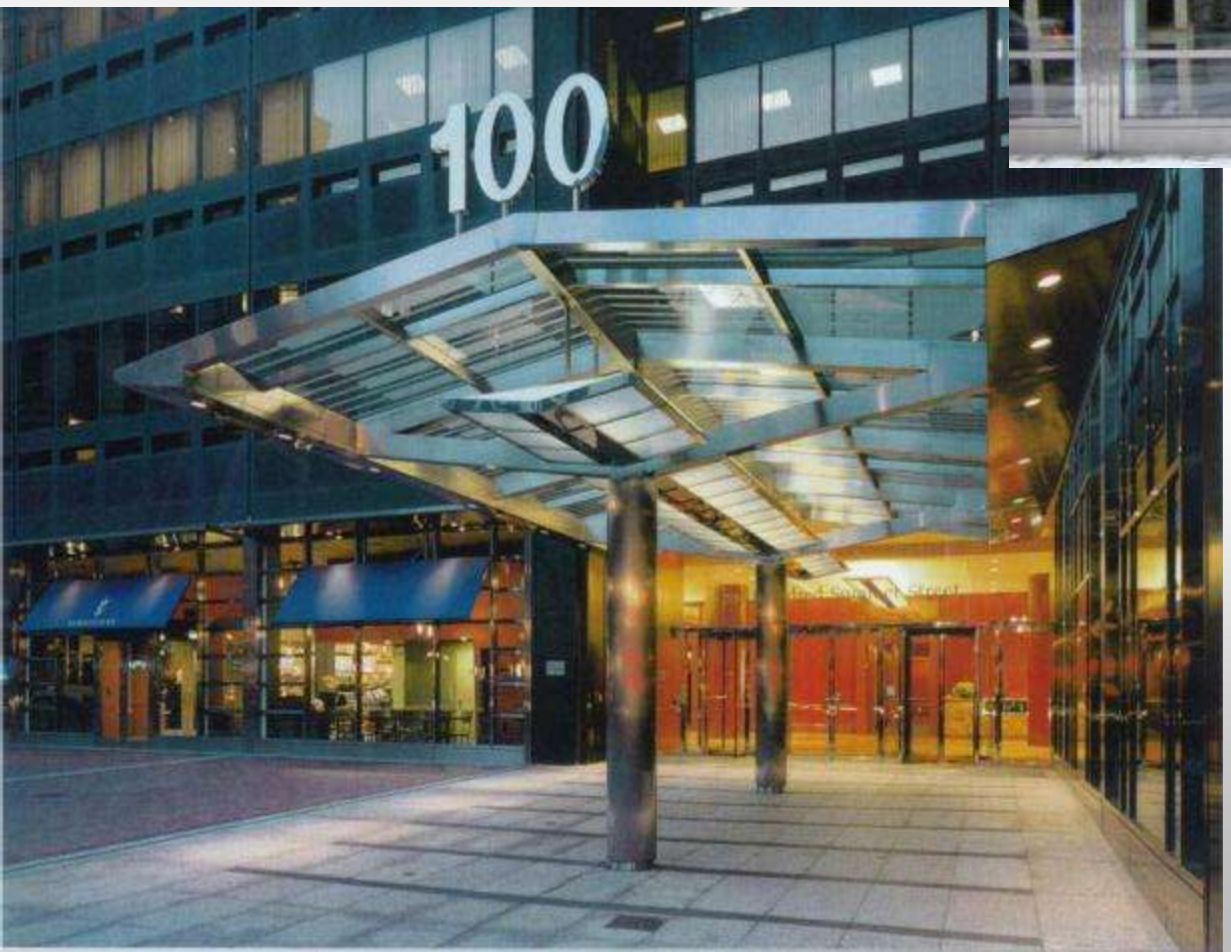
100 Summer Street,

Boston

Type 316, No. 4 Finish



Renovation

First floor of a weathering steel building

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Design

- All standard metal designs are possible in stainless steel
- There are differences in
  - Thermal expansion
  - Strength
  - Appropriate thickness
  - Weight/square foot

Chrysler Building

Completed 1930

Type 302, 2B finish

Stainless replacement masonry angles and wall ties

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Wind Uplift Resistance

- Design
- Material strength
- Strength retention over time
  - Minimal corrosion

New York University website

Hurricane Katrina
New Orleans Mint

Stainless roof, private residence, Florida

Both roofs exposed to 257 km/hr gusts

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Impact Resistance

Increased strength = Increased impact resistance

- UL 2218 Class 4 impact resistance
- Resistant to:
  - Hail damage
  - Damage from walking on roofs
  - Perforation by falling tree limbs and wind blown debris
- Best performance - stainless steel or carbon steel

Copper hail damage

Roofing Finishes

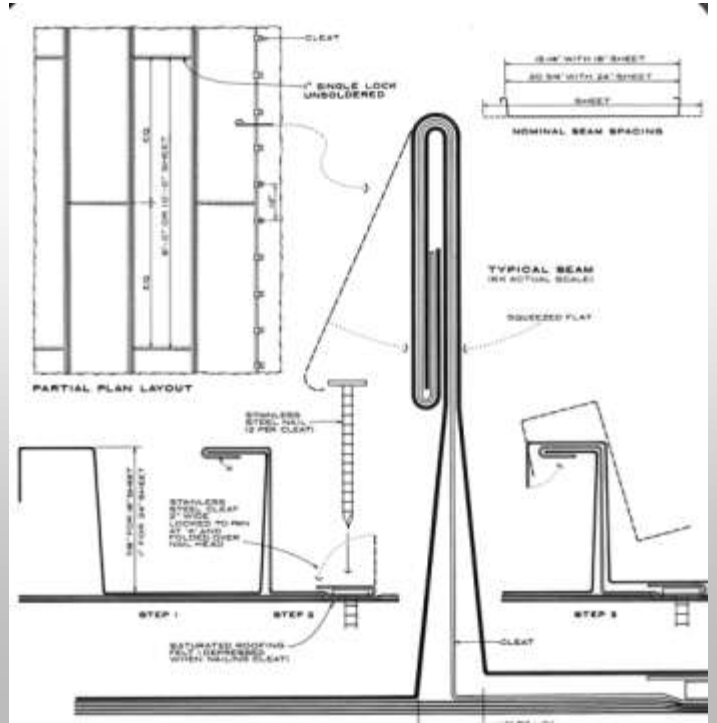
- Low reflectivity
- Most common finishes
  - 2D
  - 2B
  - Terne-coated (tin, zinc/tin)
  - Rolled-on abrasive blasted look finishes
- Other finishes
  - Electrochemical color
  - Nickel oxide coated
  - Zinc coated “spangled”
  - Paint (plastic resin) coating
  - Embossed and colored

Bending Characteristics Annealed Stainless Steel

R = bend radius, T= metal thickness

Type	Free Bend	V-Block
Austenitics	180°R = 1/2 T	135°R = 1/2 T
Ferritics	180°R = T	135°R = T

Standing seam roof detail with very tight bends



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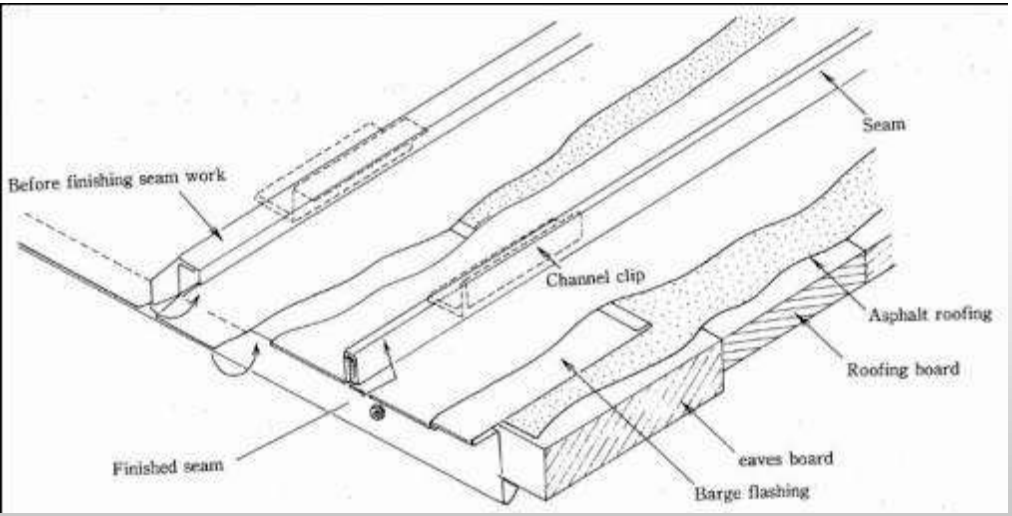
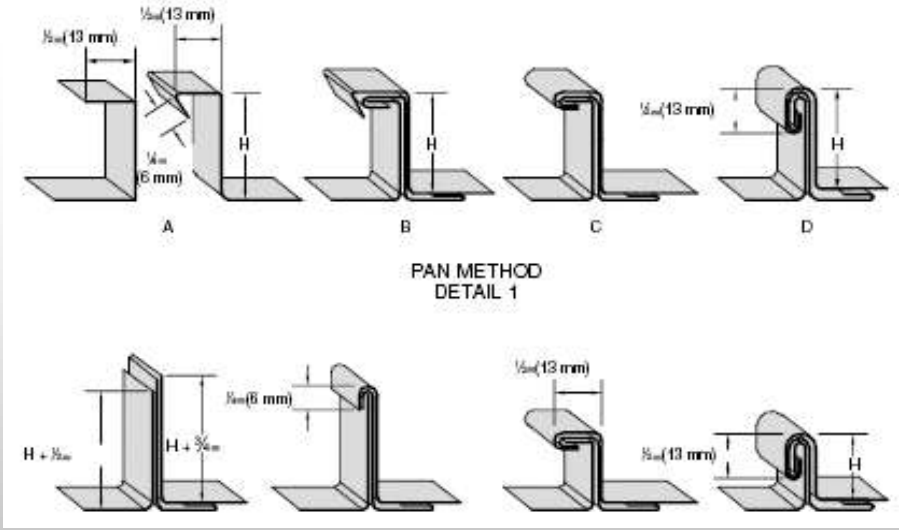
Standing Seam Roofs

Thickness and pan width comparison (mm) and profiles

Pan Width	Stainless Steel	Galvanized Steel	Copper	Aluminum
430	0.38	0.61	0.55	0.81
580	0.46	0.61	0.69	1.02

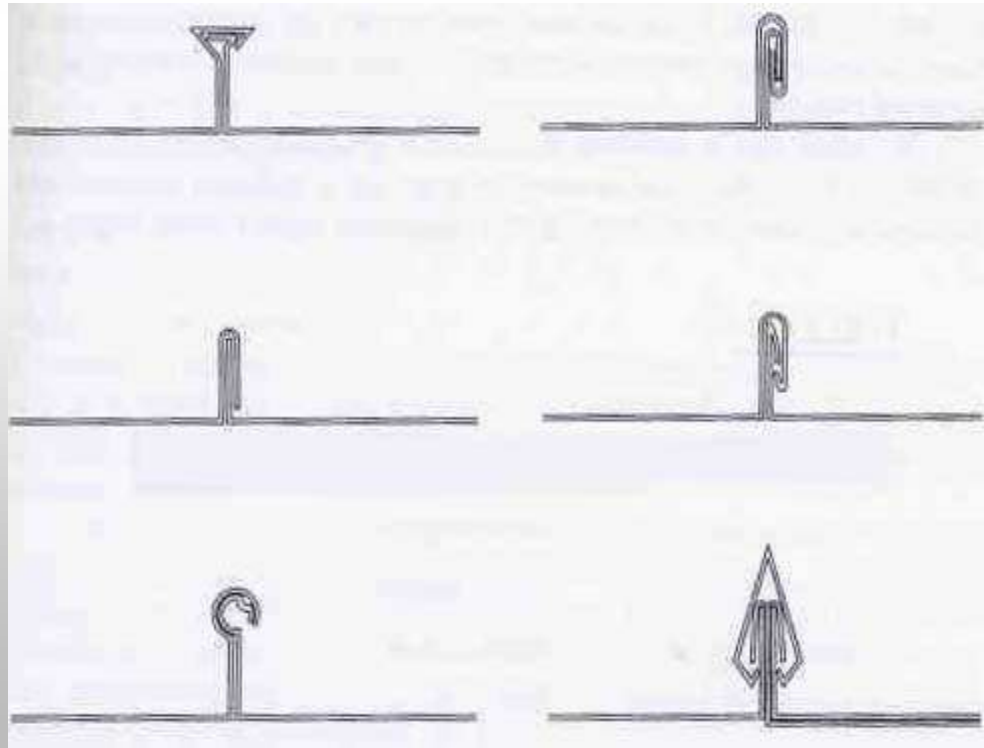




Reform Later Day Saints Temple Complex

Hellmuth Obata Kassabaum Architects

Standing seam roof, 4,500 roof panels, Type 304, 2D finish



‘s-Hertogenbosch Apartment Block, Netherlands

1 mm thick, 2B finish, Type 304

Adjoining fresh water artificial water course

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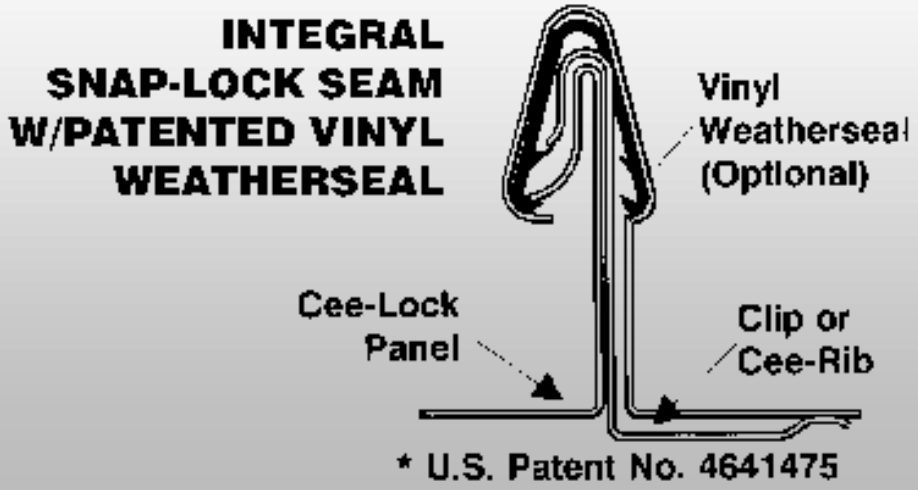
Doha International Airport

Under construction – estimated completion 2012



Roof: Duplex AL2003 and 2205
Interior: Type 304

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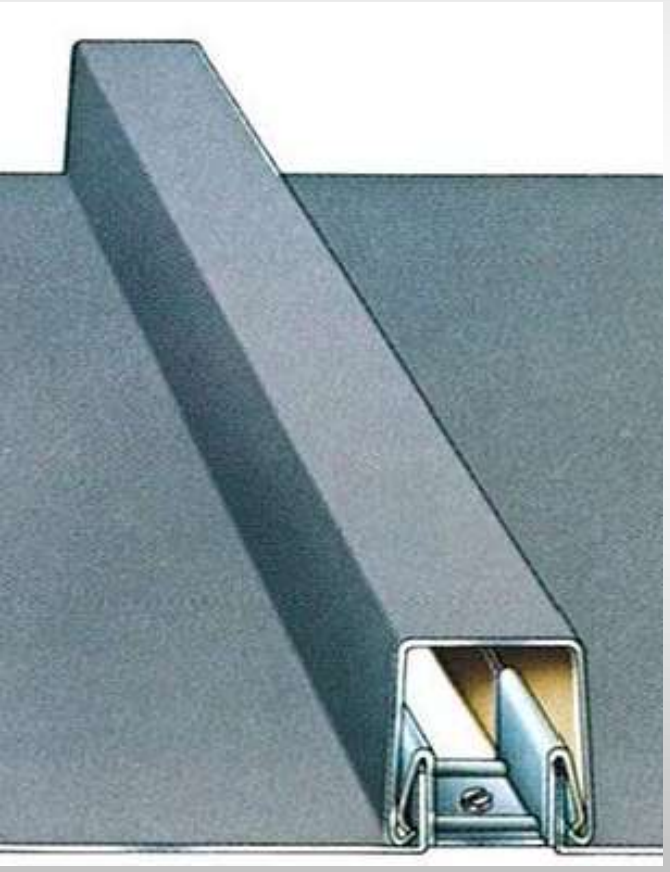
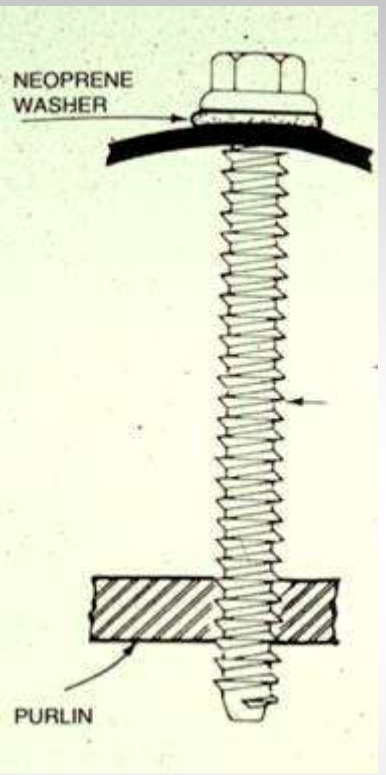
Kowloon Station, Hong Kong

Batten cap design, Type 316, proprietary dull rolled finish resembling abrasive blasting



Stainless Steel Roofing Fasteners



- All metal roof types
  - Stainless steel
  - Aluminum
  - Painted galvanized steel
- Wood shingles, tile, slate

San Francisco Type 316 bay-side sine-wave roof design represents rolling hills, ocean waves, movement…..

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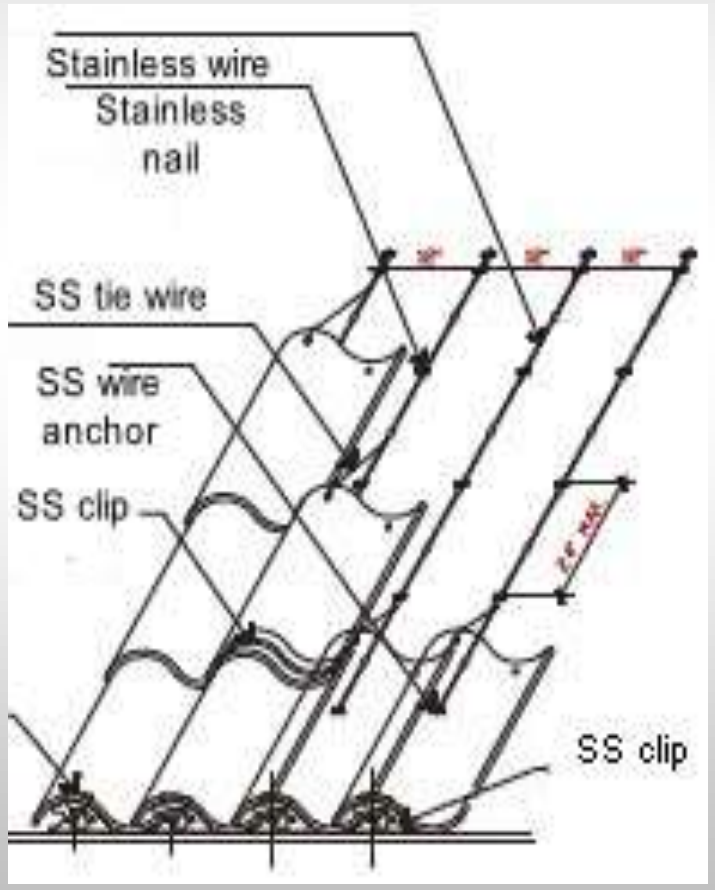
Stainless Steel Wire Ties for Tile or Slate

Recommended by FEMA in coastal areas

Should be considered for any corrosive high wind area



Hurricane damage

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Gateway Arch

First large stainless steel structural application

Architect: Eero Saarinen

Completed: 1965

192 m (630 ft.) high

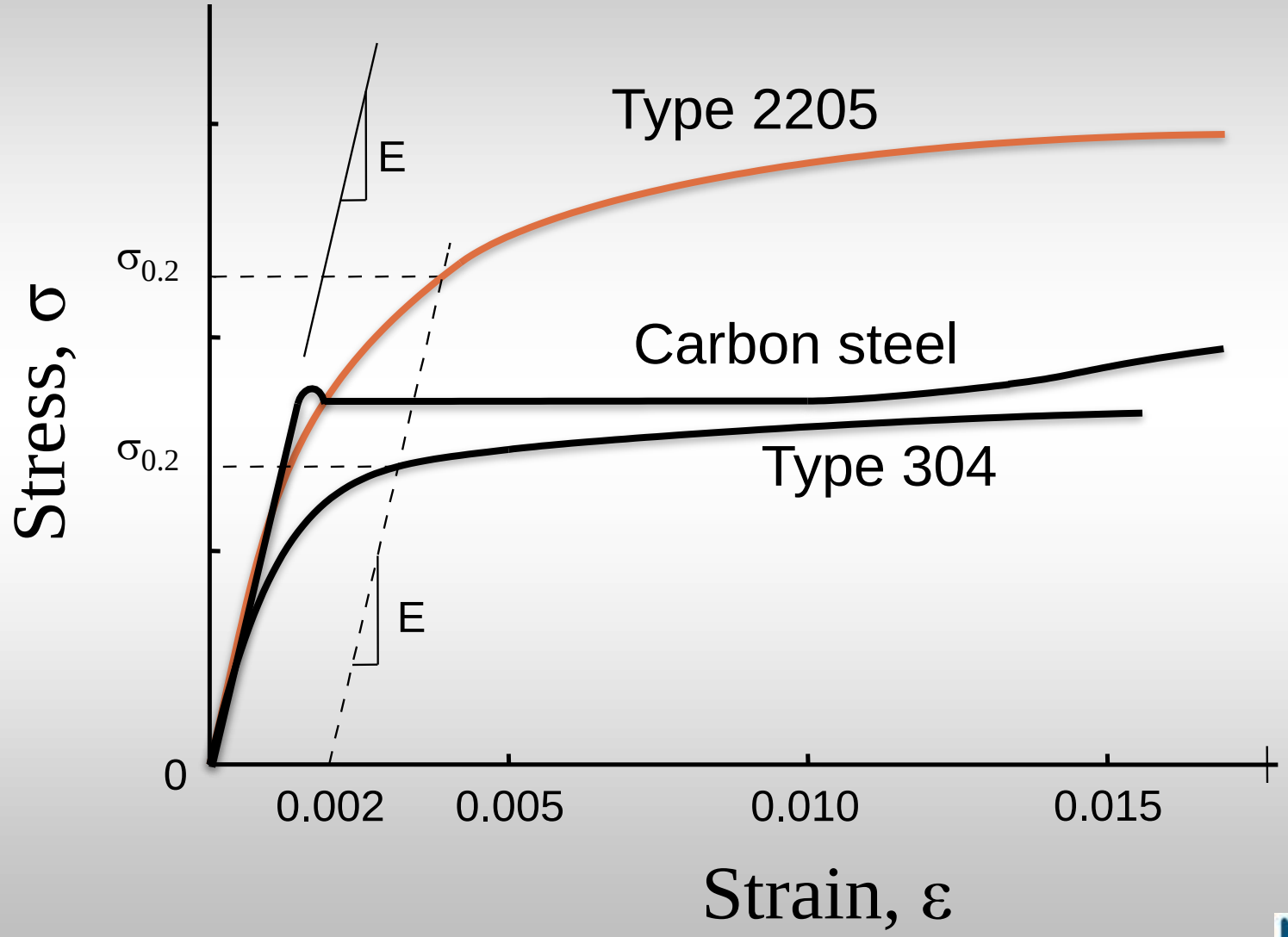
Exterior: Type 304, 6.3 mm (0.25 inch) plate, No. 3 polish

Interior: Carbon steel, 9.5 mm (0.375 inch) plate

Stainless Steel's Advantages

- Corrosion resistance
  - Sustainability/long term performance
  - Avoid coatings and see structural detail
  - Reduce maintenance
  - Long term security
- Seismic performance
- Impact resistance
- High temperature strength & stiffness retention
- High strength stainless steels
  - Reduce section sizes & minimize visibility

Stress-Strain Behavior



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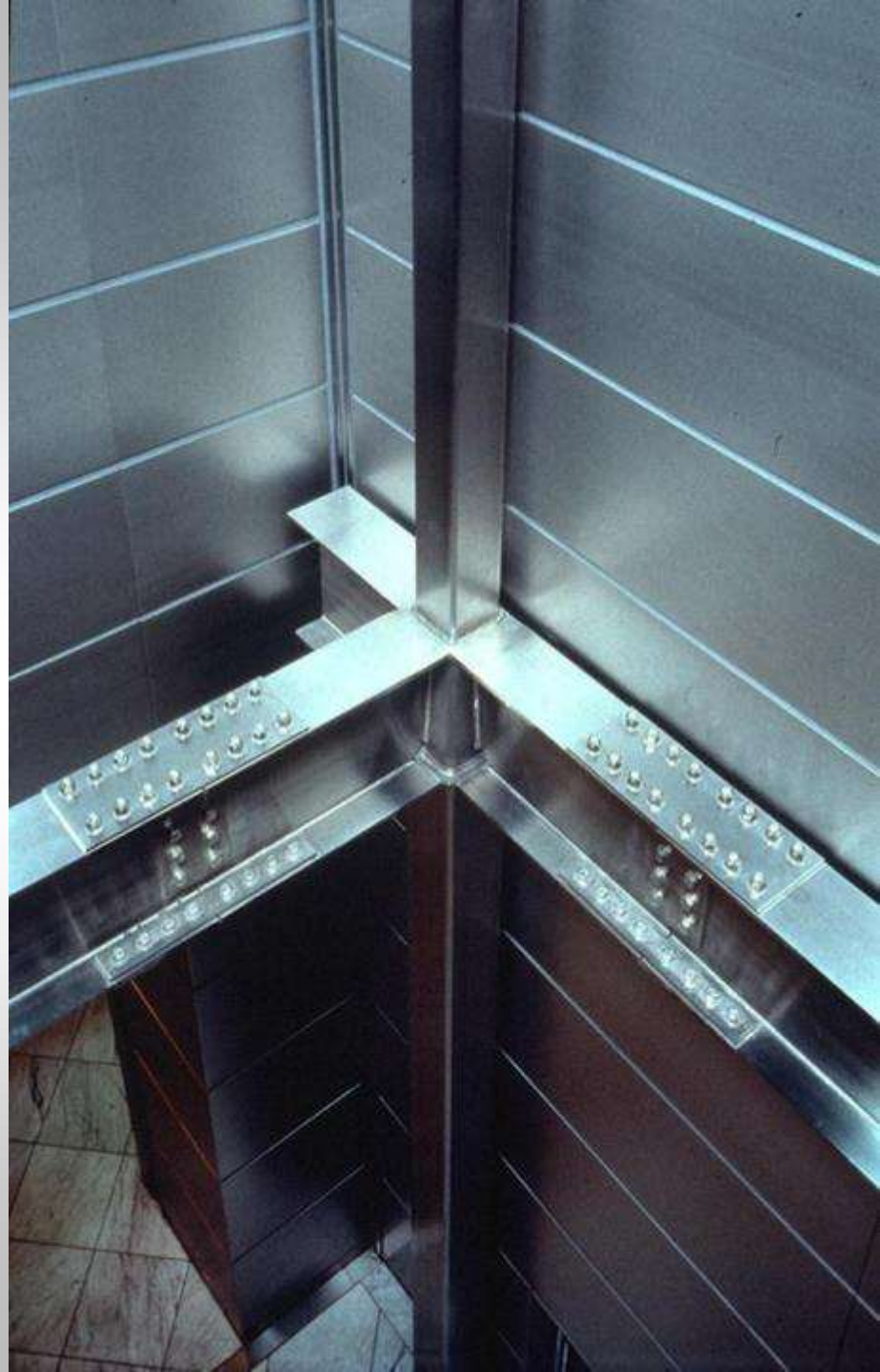
Japanese Structural Demonstration Building

Osaka, Japan

Photo taken after major 1995 earthquake - No damage



Pio of Pietrelcina Church, Italy

Type 316
used in seismic design

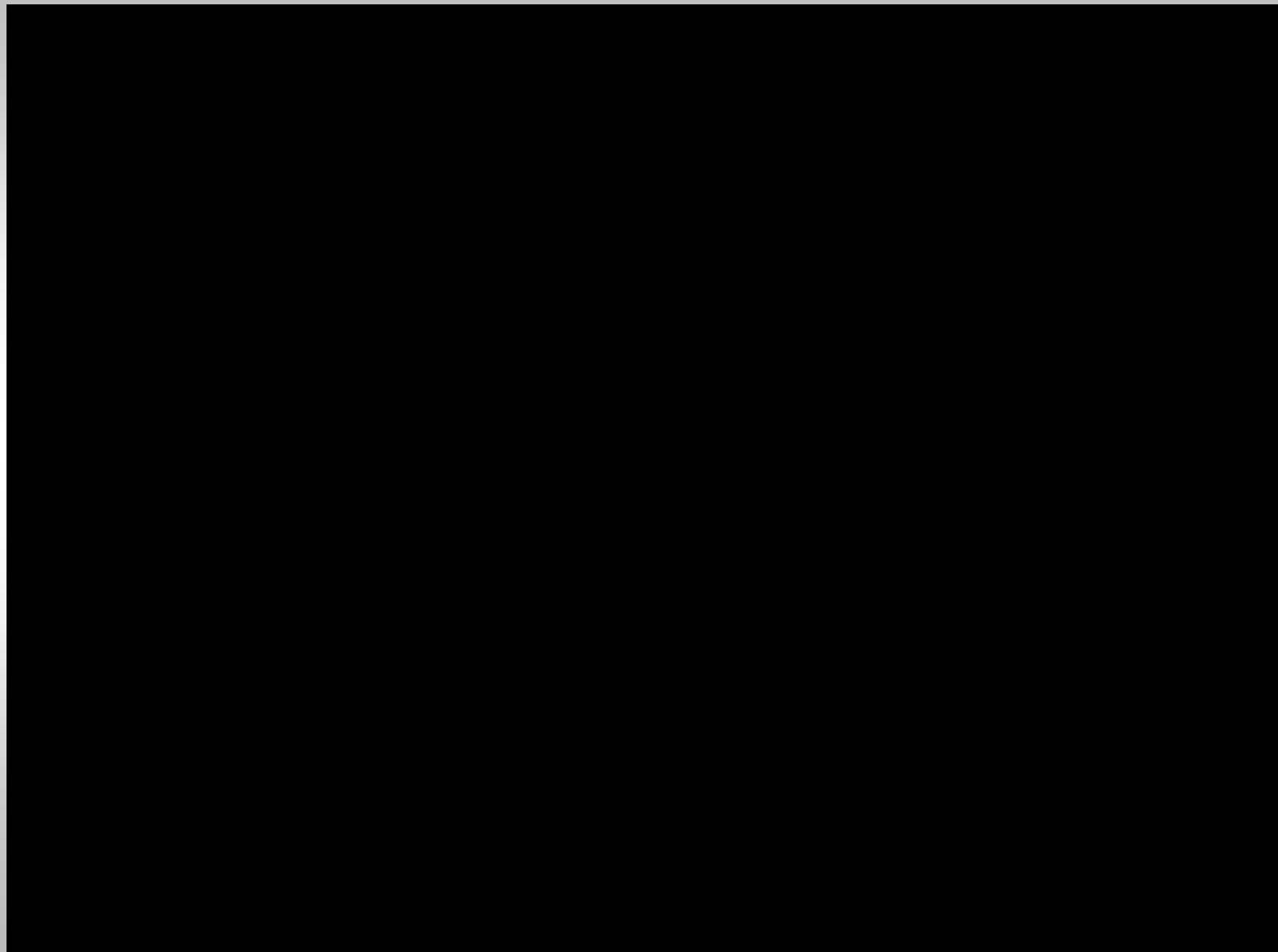
Stainless mesh ties stones in arches together to allow movement during earthquakes

Roof supports above arches are stainless steel

Fire and Thermal Radiation Resistance

- Aluminum is least resistant
  - Aluminum's strength decreases above 100ºC
  - 6061-T6 tensile strength decreases 60% at 200ºC
- Carbon & weathering steel are normally fire proofed
  - Carbon steel limited to 370ºC under continuous loading
  - Carbon steel tensile strength drops 30% at 500ºC
  - Weathering steel tensile strength drops 50% >540ºC
- Stainless steel has better strength and stiffness retention
  - Stainless steel used for heat treating furnaces for other metals

Fire Testing Video



Darchem Engineering
Fire Resistance Testing Summary

Test: Loaded structural cable supports exposed to 1,000 – 1,050 C (1832-1922ºF) flames

Requirement: Retain structural integrity for 5 minutes

Metal	Result	Comments
Stainless Steel	Passed	Test extended to 45 minutes when gas ran out. No failure occurred. Deflection was 80.5 mm (3.2 inches) after 45 minutes.
Galvanized Steel	Passed	Deflection was 166.5 mm (6.6 inches) after 5 minute test, some molten zinc observed
Aluminum	Failed 26 seconds	Collapsed
Fiberglass	Failed 30 seconds	Collapsed and started to burn, releasing fumes

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Darchem Engineering
2-Hour Radiant Heat Testing

Loaded structural supports exposed to radiant heat from cabinet

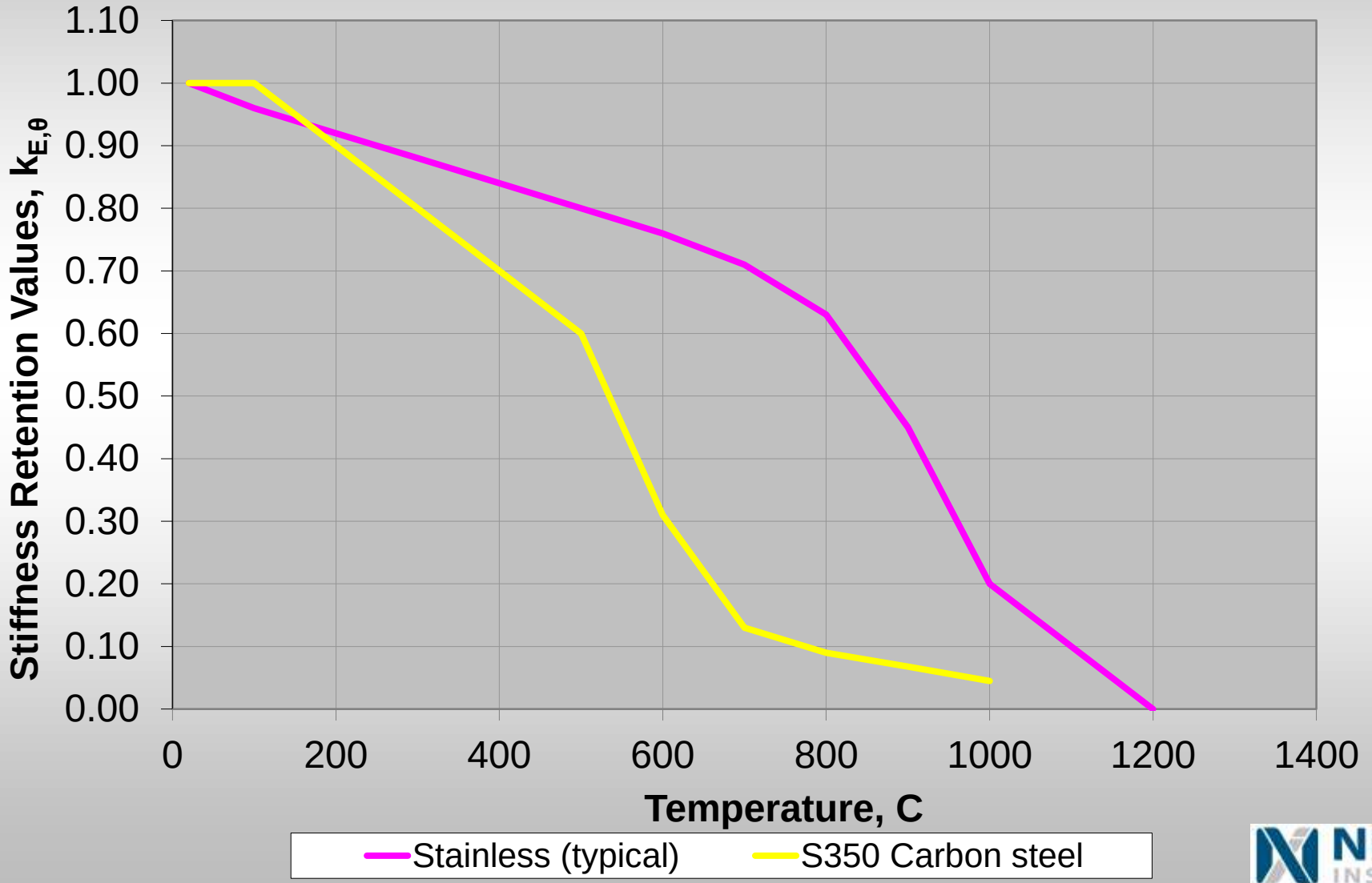
Requirement: Retain structural integrity until temperature stabilizes

Summary: Carbon & stainless steel maintained structural integrity. Carbon steel stabilized faster and had 3 times the deflection

Metal	Result	Comments
Stainless Steel	Stabilized in 3 hours	Average temperature at end of test = 556 C Stainless had 1/3 the deflection of carbon steel
Galvanized Steel	Stabilized in 2 hours	Average temperature at end of test = 552 C 3 times the deflection of stainless steel
Aluminum	Failed 12 minutes	Average ladder temperature at failure = 238 C
Fiberglass	Failed 6 minutes	Average ladder temperature at failure = 185 C

Stiffness Retention at Elevated Temperature

7 times the stiffness retention of carbon steel at 800 C (1472 F)



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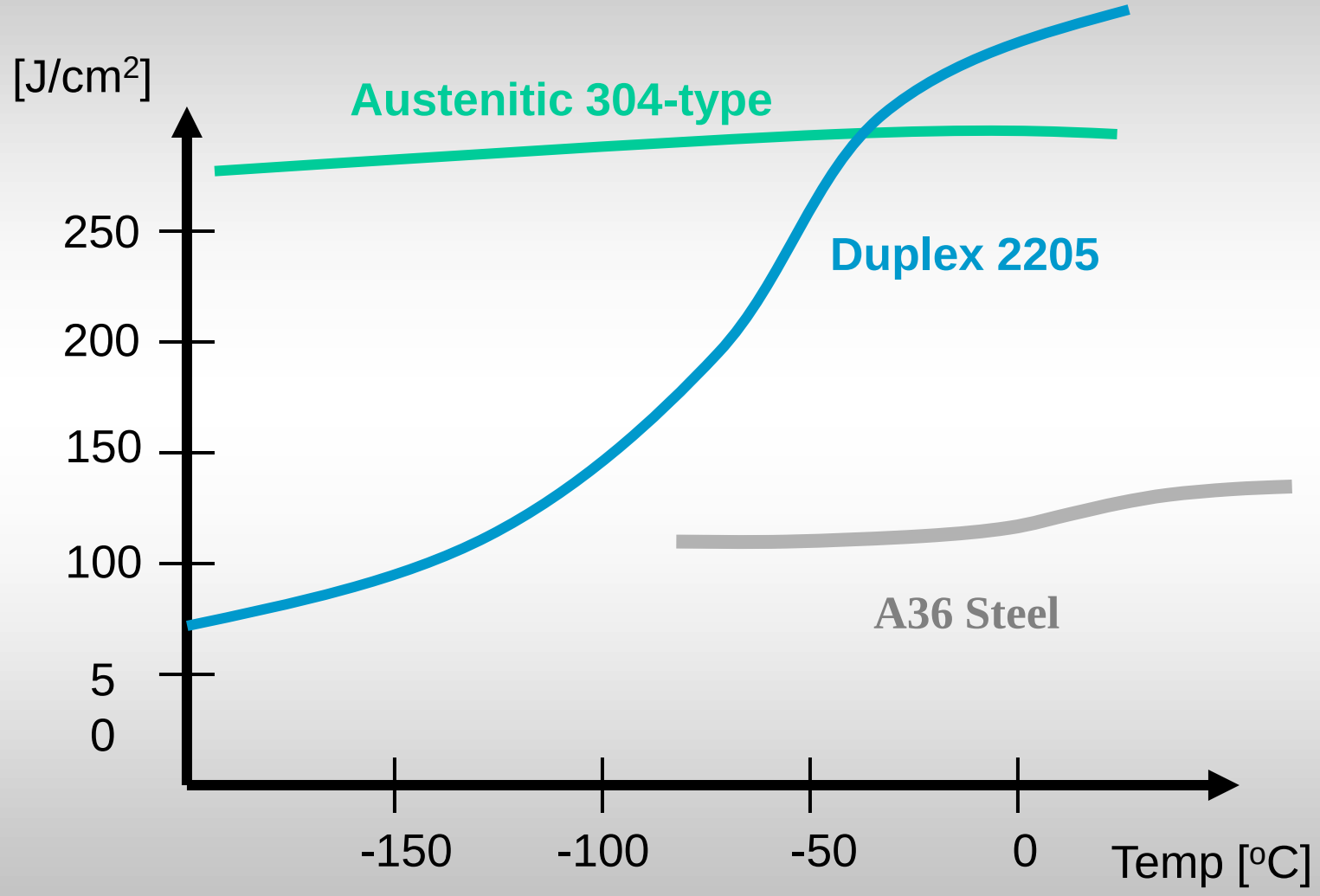
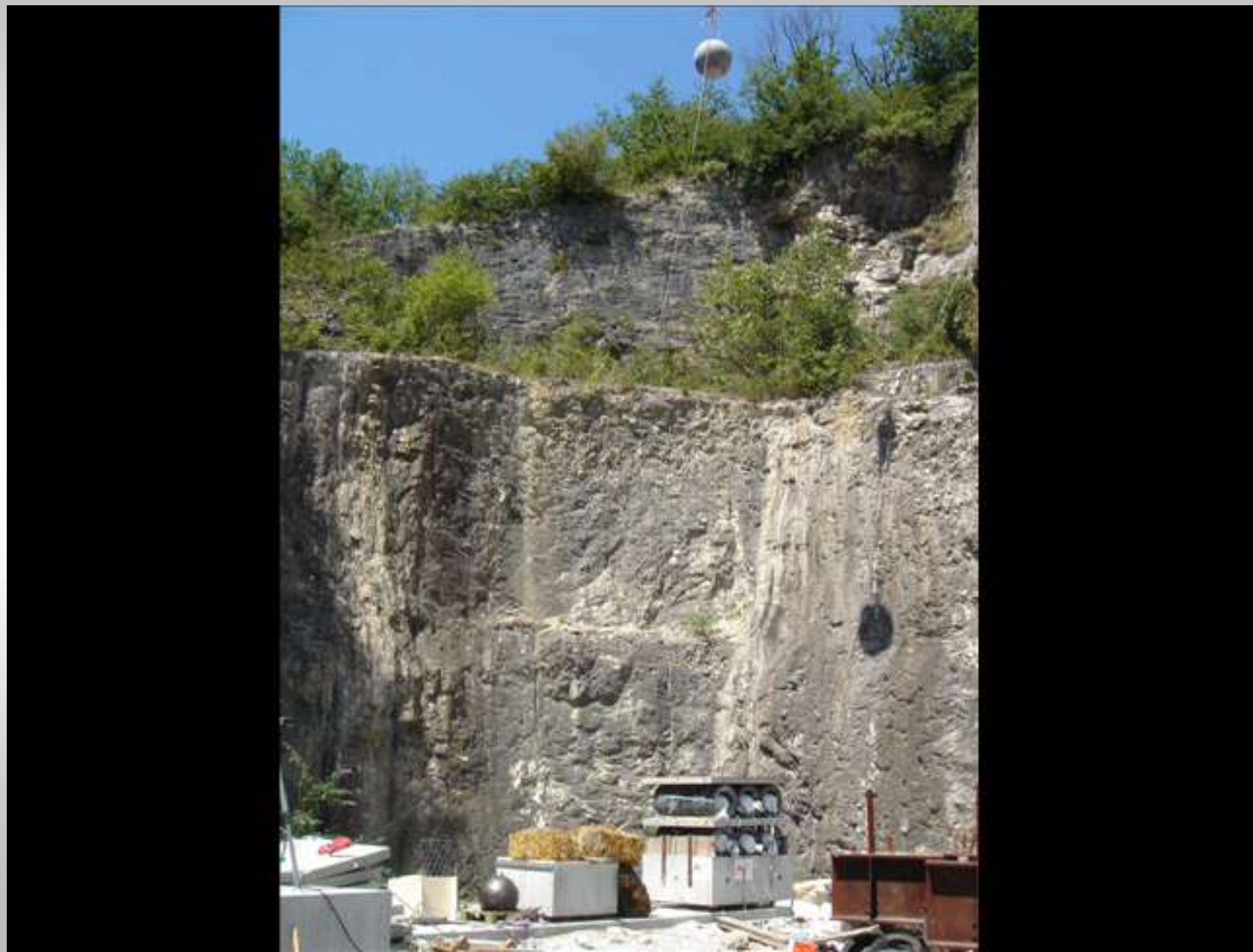
Toughness vs temperature



700 KG Ball Impact
Carbon Steel Reinforced Concrete



700 KG Ball Impact
Type 304 Stainless Reinforced

Stainless Steel Reinforced Concrete

- Concrete slab connections in seismic zones
- Impact and blast security
  - Building walls, security barriers
- Buildings with sensitive electronic equipment
  - MRI facilities, government buildings

Coastal Ground Anchors & Retaining Walls

San Francisco ground anchors

Salt = corrosive soil

After >50 years, unprotected stainless ground anchors had no significant corrosion

Triple protected carbon steel deterioration after 15 years

Stainless initial cost is lower

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New Bangkok International Airport

- Type 316 sun screens over skylights
- One the world's largest low profile stainless steel and glass curtain walls - 37 m high, 441 m long

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New Poly Plaza, Beijing

Skidmore Owings & Merrill

Type 316 cable
2205 tension
bars and spiders

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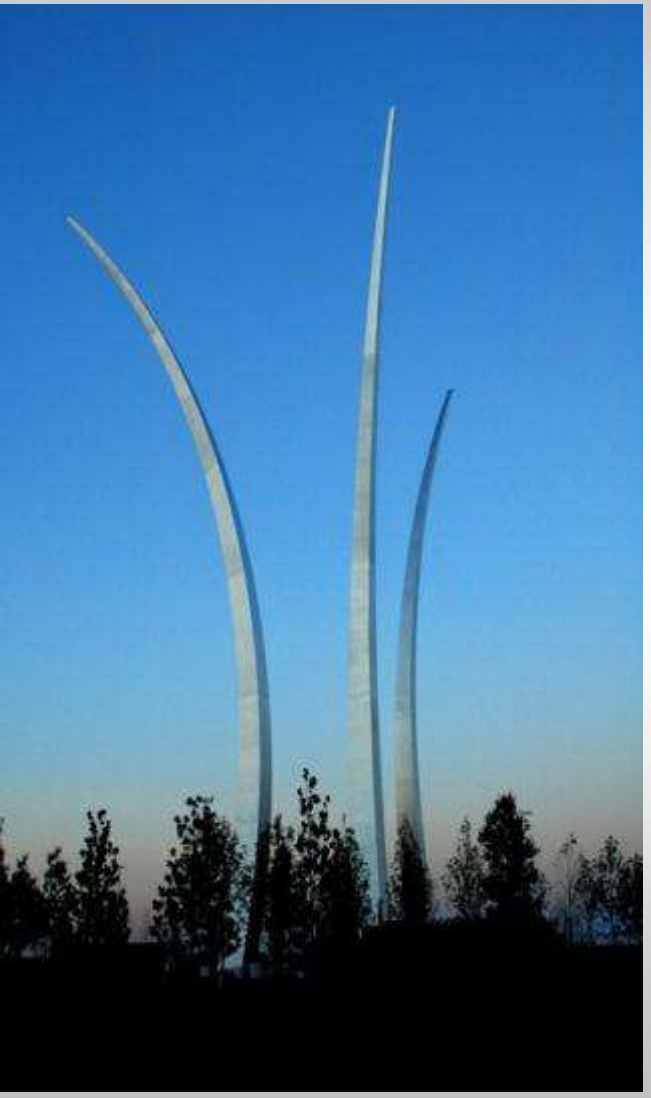
Apple Cube, Manhattan

Glass supported by high strength 2205 duplex,
Points of light created with highly polished Type 316

US Air Force Memorial



Pei Cobb Freed

Structural: Arup

Type 316 plate
0.75 in (19 mm)

3- step dull finish

66 - 87 meters
(218 to 284 feet)

South Bank Arbour, Brisbane, Australia

Type 316 plate and wire support plants over a curving walkway

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New York City
New 2nd and 7th Avenue Subway Lines

Both lines will extend up the sides of Manhattan Island
Extensive use of Type 316 in 23 stations and tunnels

The new 2nd Avenue subway along the east side of Manhattan

Some section open including Fulton Street station

2020 completion

2nd Ave Entrance design

Hanover Square/Ferry Station

Type 316 structural components and glass

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Conclusions – Stainless Steel

- Very sustainable construction material, particularly for
  - Long building service lives
  - Corrosive locations
  - High traffic/low maintenance
- High level of design and finish flexibility
- Contact ISSDA or the Nickel Institute for free literature and technical assistance
- Questions?

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