



Metro®

ISDS PROJECT

INTEGRATED STATION DESIGN SOLUTIONS



Station Surfaces and Materials White Paper

November 2021

Gensler

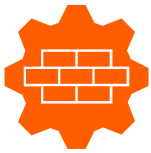
ARUP



STUDIO-MLA

Claris Strategy





Station Surfaces and Materials

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1.0 Element Overview and Problem Statement

1.1 Description of Element

Station Surfaces and Materials include standardized, cohesive and integrated material selections for station floors, walls and ceilings. These materials not only enhance the passenger experience, but also increase accessibility and safety. The multitude of existing finishes, surfaces, materials and colors make stations costly to maintain and impair visually disabled patrons while they attempt to navigate existing Metro stations.

1.2 Problem Statement

Metro requires consistent standards for the design and placement of station materials across the system. Currently, a wide variety of materials exist, creating maintenance challenges. The Facilities Maintenance team has to order and store numerous quantities of spare materials in order to maintain the stations, and in many cases, older materials are no longer available to order when needed. There are also specific challenges with many of the existing materials:

- The extensive variety of existing patterns and colors, particularly on station floors create a challenge for transit riders with visual impairments, who rely on tactile wayfinding paths as well as other visual cues from their surroundings to help them navigate through spaces.
- Differing materials require differing methods and equipment to clean, maintain, remove graffiti, etc. Reducing the types of materials within Metro stations streamlines these tasks, reducing maintenance costs.
- The lack of aesthetic consistency diminishes brand identity, as well as customer navigation and overall experience.

Metro's priorities for station surfaces and materials include:

- Improving the passenger experience by providing a simple, minimal and easily maintainable palette of materials.
- Reducing visual clutter in the station to enhance station safety and security, and create a more streamlined, state-of-the-art aesthetic. Ensuring that all support equipment and conduit is concealed and integrated into the design.

- Simplifying maintenance, operations and project delivery by creating a uniform standard that can be used systemwide and is consistent with the Systemwide Station Design Standards material palette and streamlined aesthetic.



Figure 1-1 Mismatched wall tiles, 7th St/Metro Center station.

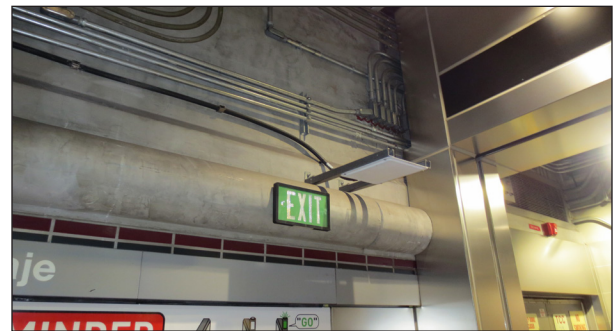


Figure 1-2 Exposed conduit on station walls, 7th St/Metro Center station.

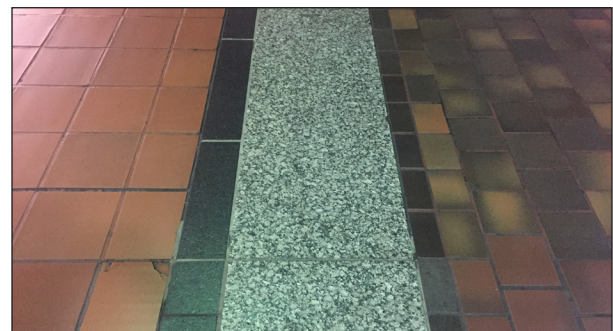
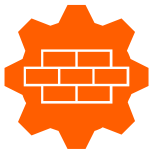


Figure 1-3 Various flooring materials make it difficult for customers to navigate, particularly for those with sight impairments and mobility issues, and for maintenance crews to clean and maintain, 7th St/Metro Center station.



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2.0 Design Process and Principles

2.1 Design Process

The Project Design Team for this element was led by Gensler, and included Arup, RAW, and Claris Strategies. Cost estimates were provided by Leyland Saylor Associates.

Metro departments across the agency provided input throughout the design process. Beginning in May 2018, Working Group Members accompanied the Project Design Team on site visits to existing Metro stations to observe and document the condition of existing station materials. The Project Design Team also conducted a series of interviews with representatives from a wide range of Metro departments, including:

- Arts + Design
- Asset Management
- Environmental Compliance and Sustainability
- Facilities Engineering-Operations
- Facilities Maintenance (including separate interviews with FM field staff and management)
- Fire and Life Safety
- Project Engineering
- Office of Civil Rights
- Operations Liaison and Planning
- System Security & Law Enforcement

Based on the analysis and the information provided during interviews with Metro staff, the Project Design Team developed initial design concepts, which were presented to the Working Group in December 2018

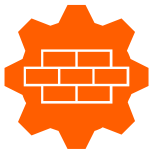
Using the feedback provided by the Working Group members, the Project Design Team refined the initial design concepts into a Draft Concept Design, which was submitted to the members of the Working Group for review in June 2019. Working Group members provided comments on the Draft Concept Design, which were addressed by the Project Design Team. The Project Design team then submitted draft, revised, and final Design Documentation packages in March 2020. For additional information, see “Table 2-1 Timeline of Design Process” on page 4.

2.2 Working Group Feedback

Concept ideas and physical samples of materials (floors, walls, ceiling, etc.) were presented during a Working Group meeting and reviewed by Metro departments. Working Group members provided the following feedback on station surfaces and materials:

Station Floors

- Terrazzo flooring material is preferred because of its slip resistance and ease of cleaning. (Facilities Maintenance)
- There have not been any slip-and-fall claims on existing terrazzo floors in the system in contrast to the large number of claims on other existing floor surfaces such as tile.
- Existing stations with terrazzo flooring, such as Vermont/Sunset station, only requires a third of staff cleaning resources as compared to stations with porcelain tile. (Facilities Maintenance)
- Partial to terrazzo flooring for underground stations, but is concerned that the upfront installation cost may become prohibitive. (Project Engineering)
- Terrazzo divider strips should be close enough together to make it easy to replace sections of damaged flooring.
- Darker colored terrazzo (referring to the darkest of the samples provided, i.e. black/charcoal terrazzo) preferred because white terrazzo shows dirt more clearly and may stain. (Facilities Maintenance)
- Polished concrete samples are too smooth for flooring applications and is perceived to not provide the necessary slip resistance.
- The minimum coefficient of friction requirement for slip resistance is a factor of 0.42 (on a scale of 0 to 1), but higher is preferred, as defined by ANSI A137.1 in the International Building Code
- Rusticated terrazzo is preferred for aerial and at-grade stations because polished concrete or polished terrazzo may not provide the necessary slip resistance for stations that are exposed to the elements.
- Consider lead time and cost for installation and maintenance. Metro has experienced paying high price for matching replacement floor tiles from Italy and new projects require USA-made materials to be purchased and installed. Materials that are not local take ten months to a year for replacement due to the long procurement process. (Facilities Maintenance)

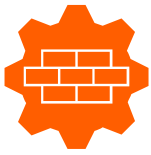


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Table 2-1 Timeline of Design Process

May to June 2018	Project Design Team and Metro Working Group Members conducted site visits of existing stations, including: 7th St/Metro Center, Arcadia, Aviation/LAX, Bundy, Cal State LA, Harbor Freeway, Hollywood/Highland, North Hollywood, Pacific Coast Highway, and Wilshire/Vermont.
June to November 2018	Project Design Team conducted interviews with Metro departments, including: Arts + Design, Asset Management, Environmental Compliance and Sustainability, Facilities Engineering-Operations, Facilities Maintenance (including separate interviews with FM field staff and management), Fire and Life Safety, Office of Civil Rights, Operations Liaison and Planning, Program Management, Project Engineering, and System Security & Law Enforcement.
December to March 2018	Project Design Team developed initial design concepts.
March 2018	Project Design Team presented initial design concepts to the Metro Working Group.
May 2019	Draft Concept Design Package submitted.
June 2019	Revised Concept Design Package submitted.
November 2019	Draft Design Documentation Package and White Paper submitted.
February 2020	Revised Design Documentation Package submitted.
March 2020	Design Documentation Package updates submitted.



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Station Walls

- Wall material should not distract from the artwork and should provide a clean palette to frame the artwork. (Arts + Design)
- Prefer hidden fasteners on wall panels. Exposed fasteners may interfere with cleaning and would leave distinct streak marks after cleaning, which is typically performed by a cleaning vehicle that wipes down the station walls. (Facilities Maintenance)
- Stainless steel metal panels preferred, but upfront installation cost may become prohibitive. (Project Engineering)
- Material selected needs to be scratch and graffiti resistant.
- Integral coved terrazzo base preferred for ease of maintenance.
- Wall material should allow for a gap between the station concrete structure and the wall surface so that conduit and support equipment can be hidden. This would also allow for new equipment to be retrofitted in the future.

Station Ceilings

- Consider suspended ceiling with interstitial space above to install elements, such as lighting and CCTV, flush with ceiling.
- interstitial space above ceiling panel can act as a return air plenum when needed or allow for sound proofing material.
- Choose material that is durable, smooth and easy to clean. (Facilities Maintenance)
- Concealed ceiling grid system for seamless look.

2.3 Design Principles

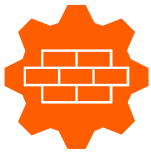
Based on the comments provided by the Working Group and best practice findings, the Project Design Team identified the following Design Principles for station surfaces and materials:

Integrate Materiality by Using Cohesive Finishes

- Use a minimal palette of materials to ease the amount and types of required maintenance.
- Simplify procurement and installation.
- Reduce the visual overload of colors and textures within the station environment to minimize confusion and create a calming presence.
- Evoke the sense of movement by using linear wall panels, ceiling panels and divider strips within the terrazzo, providing a level of distinctiveness from other station areas while being consistent with the overall conceptual framework of reduced colors, materials and textures.
- Station material colors should be subdued to avoid distracting from, and provide a neutral background for artwork.
- The overuse of light materials can provide sterile, harsh hospital-like character to space. Darker colors can be calming when used properly as a contrast to lighter materials.



Figure 2-1 Integrated materiality. 34 St-Hudson Yards station, NYMTA.



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Choose Flexible Materials that Adapt and Integrate

- Use materials that can help conceal infrastructure and de-clutter station spaces, incorporate equipment and minimize vandalism and graffiti.
- Materials should incorporate blind fasteners and be easily removable and replaced by staff, but not by the public.
- Utilizing poured-in-place terrazzo flooring ensures that broken or damaged floor areas can be repaired easily.
- Wall and ceiling system should be panelized to ease the process of refurbishments and repairs, and to allow for future equipment to be easily integrated.

Choose Materials that are Easy to Clean and Maintain

- Materials should be modular for easy maintenance and replacement over time (i.e. wall and ceiling panels).
- Materials should be smooth, hard, durable and easy to clean.
- Minimize gaps that may collect dirt or dust.

Provide a High Level of Slip Resistance

- Floor materials must meet the slip resistance requirements of the California Code of Regulations (CCR) Title 24, but must also satisfy Metro's scrutiny in determining the proper level of slip resistance.
- Use of rusticated terrazzo as a flooring material for at-grade/aerial stations instead of concrete to provide a durable material similar to the underground stations, but that is also slip resistant in outdoor conditions.

Choose Materials that Create Diffuse Reflection

- Materials should generally not have highly polished, mirrored or high sheen or shiny finishes to reduce specular reflection that results in glare, eyestrain and confusion for sight-impaired and general customers.
- Materials should have contrast between the floors and walls to provide sight-impaired riders with wayfinding guidance.
- Using lighter colored materials help bounce light into a space, creating useful passive illumination. Using darker colors can be calming when used properly as a contrast to lighter materials.

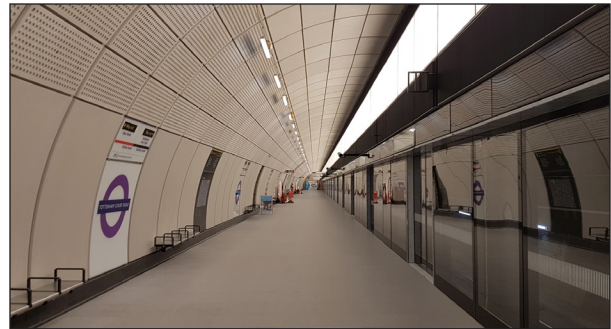


Figure 2-2 Modular wall and ceiling system conceals infrastructure. Tottenham station, TfL.

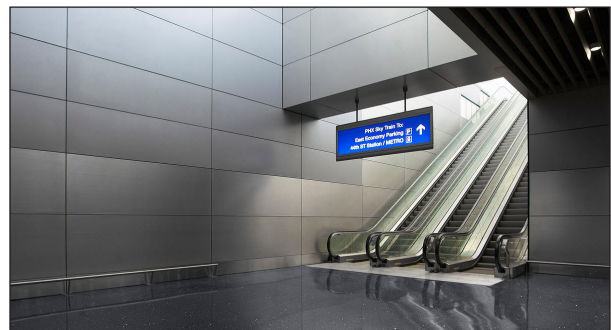


Figure 2-3 Modular steel wall panels for easy maintenance and replacement. Phoenix Sky Train, Phoenix Sky Harbor International Airport.

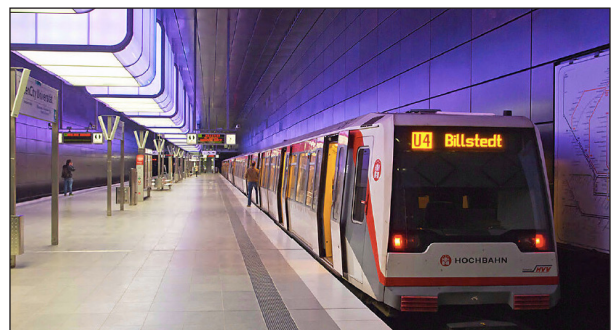
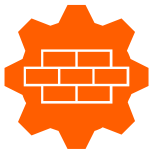


Figure 2-4 Floor light reflectance - diffuse reflection (homogeneous and useful passive illumination) prevents glare, eye strain and confusion. HafenCity station, Hamburg U-Bahn Line U4.



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3.0 Design Solution

The Station Surface designs are divided into three parts: floors, walls and ceilings. Criteria were developed for each surface to ensure proper material selection for underground, at-grade, and aerial stations where feasible. The general design principles outlined also relate to the overall materials selection.

Minimal Palette of Materials

Selecting a minimal palette of materials eases procurement, reduces replacement inventory and streamlines maintenance by minimizing the products and techniques needed for cleaning and repair. In addition, a minimal palette of materials reduces the visual overload of colors and textures, helps wayfinding for the visually impaired and presents an overall calming effect on the senses of customers, leading to a more pleasant passenger experience.

Flexible Materials that Adapt and integrate

Materials selected are hard and durable to be long-lasting and easy to clean, and to minimize vandalism. Wall and ceiling materials have been chosen for their ability to conceal station support infrastructure, ultimately de-cluttering station spaces. Materials have also been chosen for their modularity and ability to be more easily removed and replaced, and its surfaces smooth so they are easier to clean, with the required slip coefficient maintained for floors.

Durability

Materials are selected for their ability to withstand wear and tear in public environments and hide minor chips and soil.

3.1 Floors

The basis of design chosen for the standard flooring is a poured-in-place epoxy terrazzo that is charcoal-colored with white marble mother of pearl and other aggregates (Figure 3-1). Zinc divider strips and a terrazzo coved base at walls and columns are chosen for durability and ease of maintenance.

The terrazzo is considered a long-wearing material. It can be spot-repaired or removed and replaced whole in-between the zinc divider strips. The specification (colors of the binding matrix and amounts and types of aggregates) is standardized so that visual consistency can be maintained for a long period of time unlike many natural stones where quarries may be exhausted and

replacement stones do not match existing installations.

The dark colored terrazzo binding matrix is intended to conceal dirt and create a visual contrast with the lighter colored walls and ceiling. This helps assist visually impaired travelers in managing their movement through the station. At the same time, the mother of pearl and other aggregate types allow the terrazzo to have a visual texture that not only assists in hiding dirt and stains, but raises the light reflectance of the flooring to an acceptable level and create visual interest.

An integral coved base at walls and around columns prevents dirt and grime from building up in the traditionally 90 degree angle between horizontal and vertical surfaces, easing maintenance and maintaining a more clean environment. The terrazzo will prevent cracking and damage to the base of the wall from maintenance equipment or other direct impacts.

Metro has chosen to continue to use granite as the material for stairs and to use rusticated terrazzo at aerial and at-grade station platforms. Rusticated terrazzo ensures that a consistent material is used systemwide, and that additional slip resistance is provided at outdoor stations.

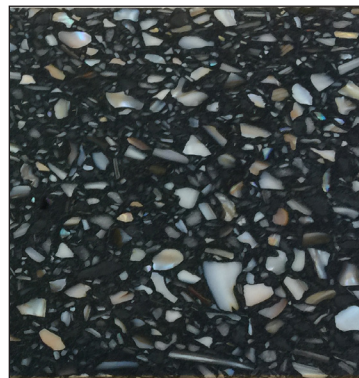


Figure 3-1 Basis of design terrazzo sample

TERRAZZO & MARBLE SUPPLY COMPANIES

Control number: TM1966-583

Epoxy Color: SOOT

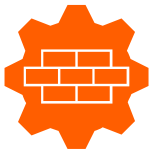
10% BLACK STALLION aggregate sizes 0 and 1

10% BLANCO MEXICANO aggregate sizes 0 and 1

80% MOTHER OF PEARL aggregate sizes 0, 1 and 2

WATER BASED ACRYLIC Sealer

100 GRIT



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3.2 Walls

The basis-of-design chosen for the standard wall material is a preformed metal panel system (Figure 3-2). The panels are steel with a fused coating of porcelain enamel and are integral with an overall system of structural members, stiffeners, fasteners and other elements needed to complete the wall system assembly. The panels are attached to an integral sub-structure framing system with regularly spaced openings in vertical and horizontal members, which together with a continuous interstitial space between the structural wall and the wall panel system allow for plumbing and electrical conduit runs to be installed and concealed from public access and view.

Porcelain enamel is an inorganic, glassy coating fused at high temperatures to form a mechanical and chemical bond with a metal substrate. The glass is permanently fused with the steel at high temperature and is inseparably bonded to form a hard surface finish. The finish does not peel, crack or fade as may be the case with enameled or other painted surface treatments. Porcelain enameled steel is also mold-resistant and is fireproof and non-toxic during fires. The surface of the panel is hard, durable, scratch resistant, and chemically resistant and can accept anti-graffiti solvents such as acetone. Colors do not fade under ultraviolet light because the enamel is glass and not a pigmented paint product.



Figure 3-2 Wall panel sample (see construction documentation details for correct panels sizes, joint spacing, etc.)

The panels chosen for Metro are light-colored/white with a semi-gloss finish to aid in creating passive illumination within stations and contrast with the darker colored terrazzo flooring. High shine, reflective and mirror-like surfaces have been avoided to minimize specular reflection that can lead to glare, eye strain and confusion for travelers within a station. The wall panels also provide a clean backdrop for artwork.

The 3' H x 10' L panels are to be horizontal, small enough to be installed by only two persons with a minimal amount of additional mechanical aid, and large enough to minimize the joints/gaps between panels. Horizontal and vertical joints will be 1/16" to 1/8" max. Fasteners will be vandal resistant, blind-type connectors that are easily accessible to maintenance staff. The panels are aligned in a running bond pattern at the platform level for the train wall and in a grid pattern elsewhere for ease of equipment integration.

3.3 Ceilings

The basis of design chosen for the standard ceilings is a perforated suspended aluminum ceiling panel with a concealed ceiling grid system (Figure 3-3). Typical panels are to be 2' x 10'. A suspended ceiling provides the opportunity to hide many infrastructure elements, allowing for light fixtures to be installed flush with the ceiling surface and for security cameras and speakers to be fully integrated into the ceiling panel. Concealed pop-down sprinkler heads and fire annunciator equipment can also be mounted onto the ceiling panels. The ceiling panels are perforated to allow for the interstitial space above the ceiling to include acoustical material, and/or act as a return air plenum and accommodate sound attenuation material.

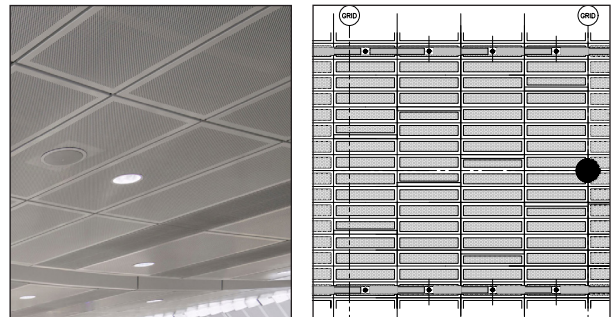
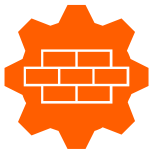


Figure 3-3 Basis of design ceiling panel



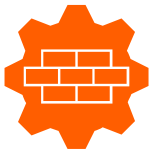
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Table 3-1 Key Design Features: Floors

Design Feature	Rationale
1. Hard, durable, monolithic flooring surface.	An epoxy terrazzo floor provides a hard, durable and monolithic flooring surface. The terrazzo specification is standardized and visual consistency can be maintained for a long period of time, unlike many softer man-made materials or natural stones where quarries may be exhausted, leading to costly replacement stones that do not match existing installations. Zinc divider strips between pours at the same elevation as the terrazzo provide a seamless surface devoid of any changes in elevation, and can be spot-repaired or removed and replaced whole in-between the divider strips. This smooth surface makes cleaning easier, and easier for those using mobility devices to navigate. An integral coved terrazzo base at walls and around columns prevents dirt and grime from building up, easing maintenance. To ensure a consistent material is used systemwide, rusticated terrazzo should be used on at-grade and aerial station platforms to provide the additional slip resistance needed for outdoor stations.
2. Darker colored, mottled flooring surface.	A dark color and mottled appearance was chosen for the flooring to better hide dirt, scuff marks and other blemishes. Lighter colors tend to show dirt and grime buildup. The original basis of design (National Terrazzo and Mosaic Association NTMA EP4-80) was a black colored epoxy matrix with mother-of-pearl and other aggregates. This standard was tested for its luminance via its Light Reflectance Value (LRV) and determined to only have a LRV of around 2% (the current standard for LRV for Metro projects is 10%). A new sample (figure 3.1) was created that slightly lightened the epoxy matrix and increased the amount of lighter colored aggregates. This new sample was determined to have a LRV of 11%.
3. Non-specular flooring surface.	Shiny, highly reflective surfaces were eschewed in lieu of honed or satin surface characteristics that reduce specular reflection ("hot spot" reflections on the surface from surrounding light sources). Specular reflection produces glare, eyestrain and confusion while diffuse reflection produces homogeneous passive illumination and more uniform surface appearance. The sealer used on the epoxy terrazzo test sample is a water based sealer that produces a less reflective shine than the TRX polished sealer, but more satin shine than the matte sealer.
4. Non-slippery flooring surface.	The Metro standard requirement for slip resistance is based on the International Building Code dynamic coefficient of friction of 0.42 as defined in ANSI A137.1. The surface of the epoxy terrazzo test sample has been sanded to a 100 grit level. This produces a less slippery surface than the standard 200 grit surface texture. (For reference, the terrazzo flooring installed within the recently remodeled LAX airport terminals is sanded to a 200 grit level.)

Note: This table provides a summary of key features only and is not an exhaustive list of all design features. Project design documentation provides complete details and requirements, and is available upon request.



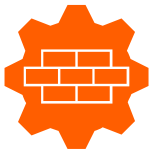
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Table 3-2 Key Design Features: Walls

Design Feature	Rationale
1. Hard, durable, smooth wall surface.	Porcelainized steel panels are high-heat fired panels that fuse the glass material to the steel panel. This material is a more durable, scrubbable, graffiti- and scratch-resistant surface than other surface finishes considered.
2. Systematized wall material that maintains an interstitial space behind it.	Wall panels are installed to allow the routing of conduit, piping and other infrastructure elements behind the panel, reducing clutter and providing a clean and simple wall surface. Vertical and horizontal support members have regularly spaced voids to accommodate piping and conduit runs.
3. Blind, tamper resistant mechanical fasteners with no glue or other adhesives.	Panel attachment points are hidden and fasteners are easy to remove with the proper maintenance tool. Adhesive fasteners are avoided to ease maintenance.
4. Minimized panel joints.	Panel sizes are 3' H x 10' L, installed horizontally. This is about the largest size that allows for two people to remove or replace the panels. Vertical and horizontal panel joints are 1/16" to 1/8" max wide to minimize dirt and grime build-up within the joints.
5. Non-specular wall surface.	Panels are low-polished with a semi-gloss finish to avoid high levels of specular reflection. Panels are semi-gloss in lieu of matte finish to provide visual "life," and minimize dirt and stain adhesion for easier cleanability.

Note: This table provides a summary of key features only and is not an exhaustive list of all design features. Project design documentation provides complete details and requirements, and is available upon request.



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Table 3-3 Key Design Features: **Ceilings**

Design Feature	Rationale
1. Suspended ceiling.	A suspended ceiling system was chosen as the ceiling standard to allow for the routing of conduit, piping and other infrastructure above the ceiling for a de-cluttered and clean ceiling plane. The material is aluminum, which is relatively lightweight and considered an industry standard material. Lighting is integrated into the ceiling system and the light fixture surface is flush with the ceiling plane. Concealed sprinkler heads are flush with and the same color as the ceiling plane. Some infrastructure elements must be visible and mounted to the ceiling such as CCTV cameras, fire alarm horn and strobe warnings.
2. Perforated ceiling.	The ceiling panels are perforated to allow airflow to pass through the panels. The interstitial space above the ceiling acts as a return air plenum when needed and allows for sound proofing material.
3. Texture.	Surface finish to be smooth, semi-gloss finish for visual quality and ease of cleaning.

Note: This table provides a summary of key features only and is not an exhaustive list of all design features. Project design documentation provides complete details and requirements, and is available upon request.

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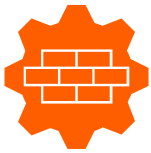
metro.net/projects/station-design-projects/

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Figure 3-4 Rendering of concourse on 7th St/Figueroa St station entrance side at 7th St/Metro Center station, incorporating design solutions for surfaces and materials.

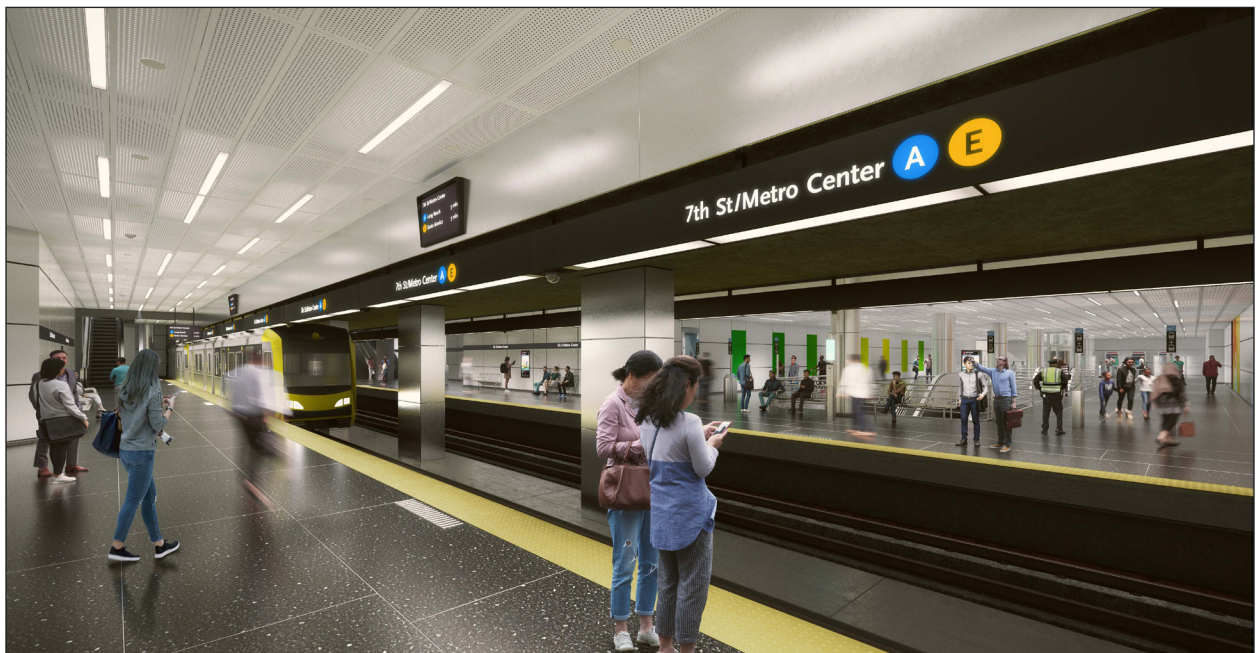
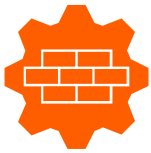


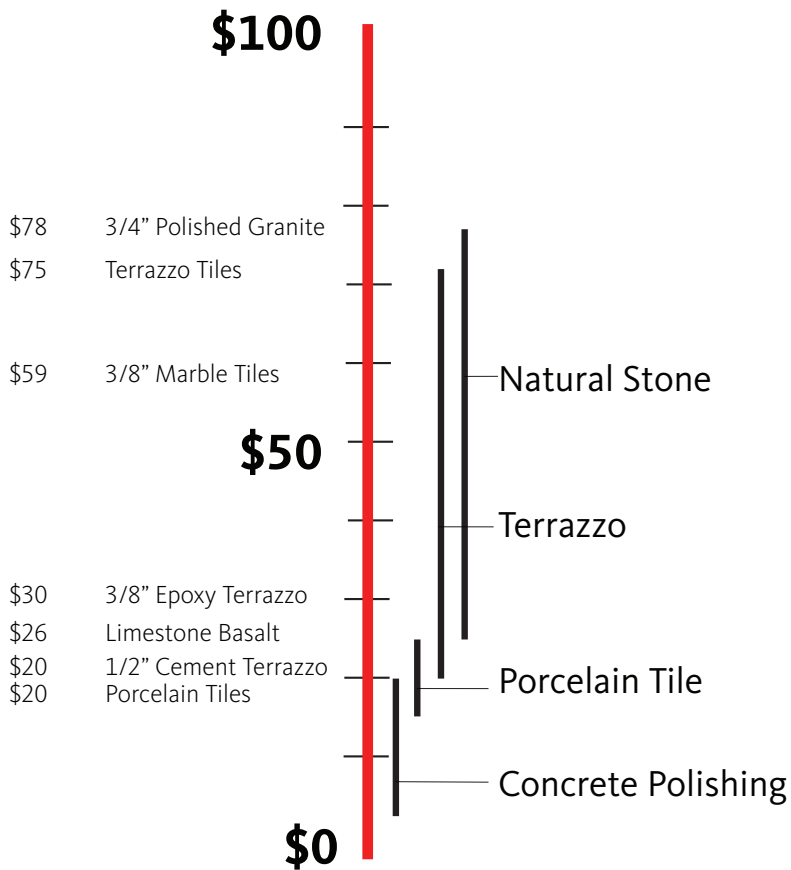
Figure 3-5 Rendering of current A (Blue) Line platform at 7th St/Metro Center station, incorporating design solutions for surfaces and materials.



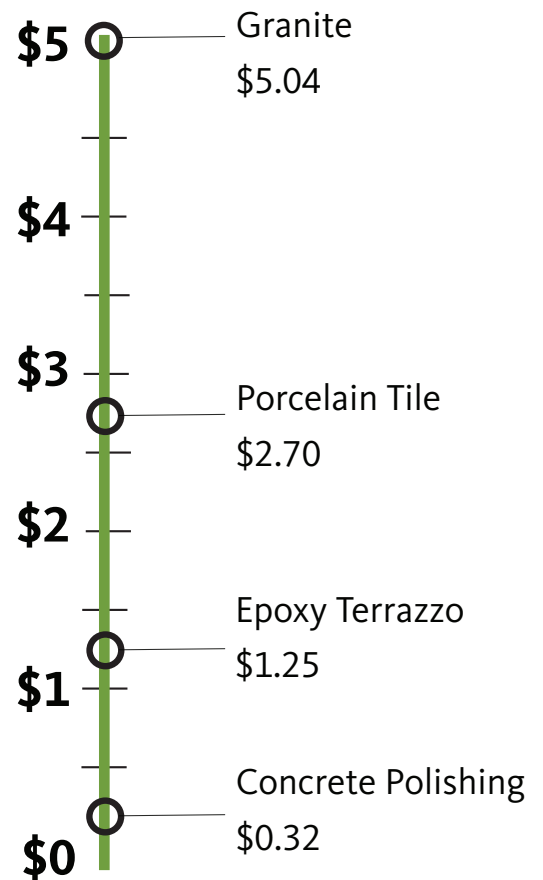
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Rough Cost Estimate: Floors

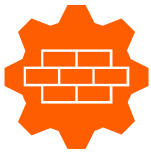


Per square foot installed cost



**Annual Cost per Square Foot
40 year span life cycle analysis**

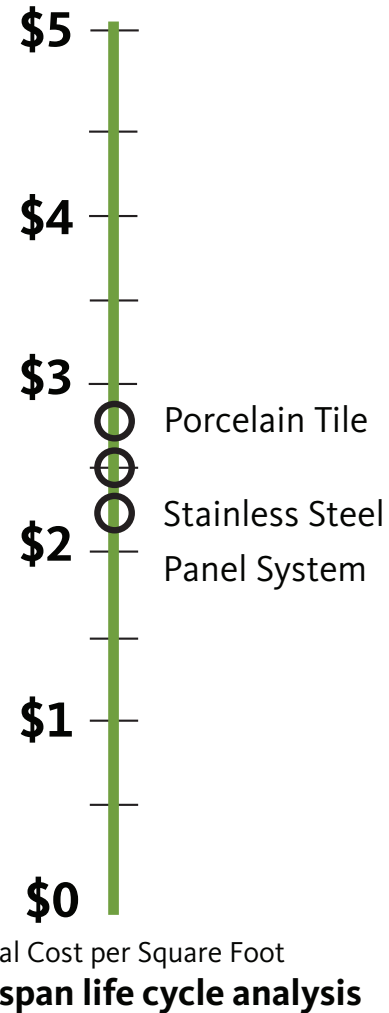
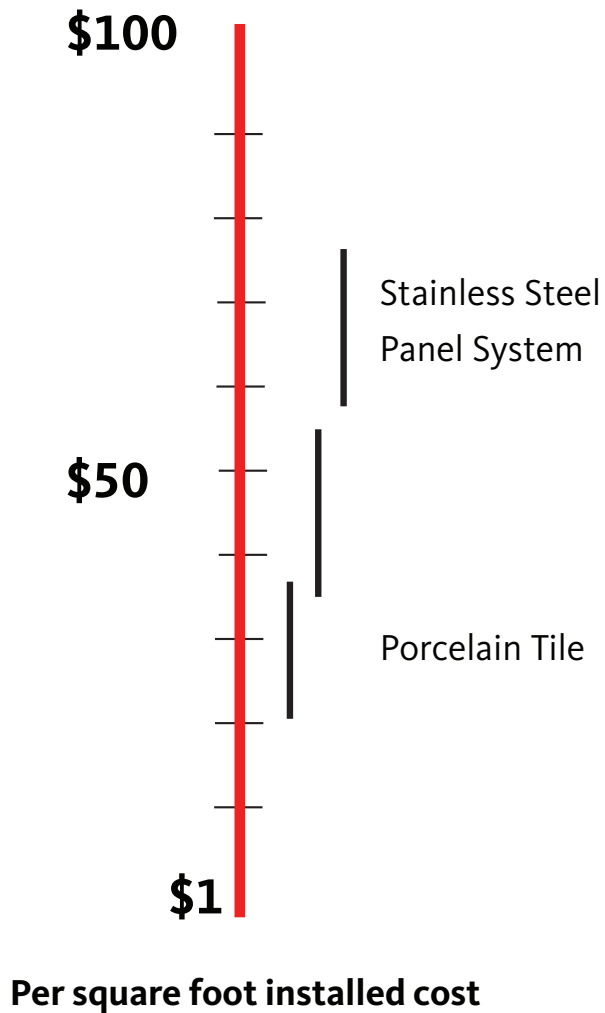
Note: Costs vary on a number of factors, including exact material, location, size of job and availability. Rough estimates for comparison purposes only.



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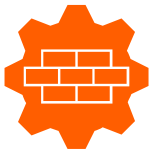
Rough Cost Estimate: Walls



Notes:

Walls - Costs vary on a number of factors, including exact material, location, size of job and availability. Rough estimates for comparison purposes only.

Ceiling - Cost associated with recommended ceiling panel is similar to existing panels currently used on the Metro system.



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Acknowledgments

Several internal and external stakeholders shared their feedback and expertise to help develop world-class station design solutions as part of the ISDS project. Thank you for your time and participation.

Adam Light, Systemwide Design	Greg Wasz, TAP
Al Martinez, Transit Operations Systems	Holly Harper, City of LA Urban Design Studio
Alvin Kusumoto, Environmental Compliance and Sustainability	Israel Marin, Service Planning & Scheduling
Amador Nafrada, Systems Engineering	Jacob Lieb, First/Last Mile Planning
Andres Di Zitti, Rail Transportation	Jenny Wong, Systemwide Design
Andrew Kao, Bike Share Planning and Implementation	Jila Mendoza, Systemwide Design
Andrina Dominguez, Environmental Compliance and Sustainability	Joseph Russell, Marketing
Androush Danielians, Engineering Management	Karen Parks, System Security & Law Enforcement
Angelka Grandov, Project Engineering	Katherine Lemmon, First/Last Mile Planning
Anthony Jusay, Bike Share Planning and Implementation	Kay Koopman-Glass, Safety
Anthony Loui, Operations Liaison and Planning	Kristie Crawford, Marketing
Arkady Bernshteyn, Rail MOW Engineering	Lan-Chi Lam, Marketing
Aspet Davidian, Project Engineering	Lance Glover, Arts + Design
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Bonn Dumaliang, Systems Engineering	Mario Del Rosario, Systems Engineering
Brad Owen, Construction Management	Marshall Epler, Rail MOW Engineering
Brady Branstetter, Facilities/Property Maintenance	Mauro Arteaga, TAP
Brandon Farley, Operations Liaison and Planning	Maya Emsden, Arts + Design
Carlos Martinez, Facilities Maintenance Contracts	Mayen Alcantara, Arts + Design
Christopher Limon, Facilities/Property Maintenance	Medford Auguste, Operations Performance Analysis
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Craig Reiter, Environmental Compliance and Sustainability	Peter Jung, Project Engineering
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Eladio Salas, Wayside Systems Facilities Maintenance	Susan Gray, Arts + Design
Emmanuel Liban, Environmental Compliance and Sustainability	Susan Walker, System Security & Law Enforcement
Erica Lee, TAP	Thomas Eng, Safety
Fred Feng, Systems Engineering	Timothy Lindholm, Facilities Engineering-Operations
	Zipporah Yamamoto, Arts + Design