SECTION 7.0 PROPOSED CIVIC CENTER - COST MODELS

7.0 INTRODUCTION

It is important to understand that the purpose of this section is to demonstrate a relative analysis between various building systems as they relate to initial cost and life-cycle cost. It is **NOT** meant to establish an actual cost per square foot for construction. The included costs are generic in nature.

7.1.1 COST MODELING & LIFE-CYCLE COMPARISON

During the master planning phase, Vanir conducted a comparative study between the different building systems available for the proposed building type and their associated life cycles. Three cost models were generated to describe the proposed facility in terms of low, medium and high quality/performance. The cost models were developed by Vanir using historical cost data for County-owned facilities.

These models are generic and do not apply to an actual design for this project. However, these cost models can be utilized as a tool to assist the County in selecting building systems that met the needs of the facility. By evaluating the proposed models and selecting building systems, the County is establishing priorities in terms of cost and performance for future design phases of the architectural program. As the design progresses, these selections will be used as the design criteria for the program and help to maintain the design focus and avoid the unpopular practice of Value Engineering.

Value Engineering often occurs during the later stages of a project's design as an attempt to rein in a construction budget that has swelled beyond its original parameters. This often has limited success because as the design progresses, there are progressively fewer opportunities to trim construction costs and any significant changes to the design have significant impacts to the design budget and schedule. The scope of Value Engineering is therefore often limited to systems which have the least impact to the design as a whole. The building's finishes are the most popular target and the resultant reduction in cost is accompanied by a reduction in quality to the most visible portions of the project. By selecting a specific cost model, the project team has a standard that they can always reference as the basis for the project design/cost and measure any deviation against.

The following section depicts the building/site systems used within each cost model. While there are many options available for the various building systems and finishes, the options provided here are the most commonly used within existing buildings of comparable use, type, and function.

Section 7.3 depicts the three different cost models presented to the County, along with the unit costs and typical life-cycle duration associated with each specific system. During the programming phase, the chosen model will be refined to reflect the specific, detailed requirements for the architectural program. The model will again be refined during schematic design to reflect the actual design. The models reflect the costs in **today's dollar only**. Market escalations are not factored into these figures

The referenced total project cost includes two cost elements as follows:

A) **Hard Cost** - The cost of construction (brick, mortar and labor)

B) **Soft Cost** - The remaining costs associated with planning, designing, and inspecting the project as well as costs associated with owner purchased equipment and furnishings.

7.1.2 GREEN BUILDING / ENVIRONMENTAL SUSTAINABILITY

Recent research confirms that it is imperative for local governments to support and implement green building design and practice. It also makes good economic sense. A 2003 report by the California Sustainable Building Task Force predicted that "While the environmental and human health benefits of green buildings have been widely recognized, minimal increases in up-front costs of 0 to 2 per cent to support green design will result in life cycle savings of 20 per cent of total construction costs – more than 10 times the initial investment." It is expected that certified green city and county governments will not only gain recognition and publicity, but also function in a more efficient manner though better internal communication, dollar savings, and effective risk and asset management. As environmental sustainability becomes increasingly important in society, it is up to local governments to implement green building policies within their communities and internal development practices.

The World Commission on Environment and Development (WCED), formed by the United Nations in 1983, defines Environmental Sustainability as, "meeting the needs of the present without compromising the ability of future generations to meet their own needs." Natural resource consumption is one the most pressing topics surrounding environmental sustainability, world wide. In the United States alone, buildings account for 39% of total energy use, 12% of total water consumption, 68% of total electricity consumption, and 38% of the carbon dioxide emissions. Minimizing this impact is accomplished by implementing a planning, design, and construction process known as "Green Building".

Green building is the practice of increasing the efficiency with which buildings and their sites use and harvest energy, water, and materials, and reducing building impacts on human health and the environment, through better siting, design, construction, operation, maintenance, and removal — the complete building life cycle. The practice of green building can lead to benefits including reduced operating costs by increasing productivity and using less energy and water, improved public and occupant health due to improved indoor air quality, and reduced environmental impacts by, for example, lessening storm water runoff and the heat island effect. Implementation of Green Building strategies is typically known as "High Performance Architecture"

By implementing High Performance Architecture in the design and construction of County owned facilities, the County of Tulare can reduce the impact of it's facilities on the environment and also improve worker conditions and productivity, increase energy, water, and material efficiency, and reduce costs and risks. As a representative of the public, the County can also showcase green buildings to educate people about environmental issues, possible solutions, partnerships, creativity, and opportunities to reduce environmental impact.

The greatest barrier to designing green buildings is the perception of increased initial or "first costs". According to the U.S. Green Building Council, "high-performance (architecture) features can increase

first costs from an average of two to seven percent, depending on the design and extent of added features". The U.S. Office of the Federal Environmental Executive (OFEE) further states that, "as many of these features have become more mainstream, there is no longer a difference in cost. Frequently, it is the *perception* that green building costs more that leads many government agencies to insist on more conventional approaches to building."

A secondary obstacle to green building is typical budgetary structures. In many cases, the long-term savings that a green building can generate are not factored into the budgeting basis for building design and construction. Budget decisions are made on a "first cost" basis (what it costs to build or renovate) rather than a "life-cycle cost" (how much initial construction or renovation decisions could cost or save over the life of the building system/component).

Finally, there is usually not a line item in budgets for Operations & Maintenance (O&M) of facilities, and few agencies track the actual O&M costs. Furthermore, different departments/agencies usually manage construction expenditure and O&M costs, further complicating the ability to compare initial costs with life-cycle costs. According to the U.S. Department of Energy (D.O.E.) and Environmental Protection Agency (EPA), facility construction only accounts for 2% of the 30 year life-cycle cost. Operation and Maintenance accounts for the remaining 98%, (6% for maintenance and 92% for operation).

It is in the County's best interest to evaluate these issues as they relate to the current method of funding and supporting facility development and to implement policies by which to require that future facilities be constructed in accordance with the principles of Green Building.

Facility Cost Model Summary -

333,568 SF at buildout (year 2026)
1,334 parking spaces at buildout (year 2026)

		Cost Model A - Low Quality Construction	Cost Model B - Medium Quality Construction	Cost Model C - High Quality Construction
A	Building Cost			
	Hard Cost	$ 96,734,720.00	$ 116,748,800.00	$ 136,305,891.84
B	Site Cost			
	Hard Cost	$ 15,177,344.00	$ 17,512,320.00	$ 22,515,840.00
C	Total Building & Site Hard Cost			
		$ 111,912,064.00	$ 134,261,120.00	$ 158,821,731.84
	Total Building & Site Soft Cost			
		$ 50,035,200.00	$ 50,035,200.00	$ 50,035,200.00
D	**Total Building & Site Project Cost**			
		$ 161,947,264.00	**$ 184,296,320.00**	**$ 208,856,931.84**
E	Parking Structure Cost			
	Hard Cost	$ 22,411,200.00	$ 25,612,800.00	$ 28,814,400.00
	Soft Cost	$ 9,604,800.00	$ 10,976,914.29	$ 12,349,028.57
F	**Total Parking Project Cost**			
		$ 32,016,000.00	**$ 36,589,714.29**	**$ 41,163,428.57**

COST MODELS TOTAL

Cost Model A **Low Quality Construction**	Cost Model B **Medium Quality Construction**	Cost Model C **High Quality Construction**
$ 193,963,264.00	**$ 220,886,034.00**	**$ 258,895,432.00**

BUILDING COST MODELS

County of Tulare - Proposed Civic Center - Facility Cost Models

New facility, accommodating 15 county departments with 333,568 sf area - Building foot print = 83,392 sf per floor - four stories in height

Building Area = 333,568 SF **Parking =** 1,334 Spaces

Building Site = *"As a function of the Building Area"*

		Building Cost Model A - Low Quality Construction			Building Cost Model B - Medium Quality Construction			Building Cost Model C - High Quality Construction		
No.	System	Model A System Selection	Life Cycle	Cost/SF	Model B System Selection	Life Cycle	Cost/SF	Model C System Selection	Life Cycle	Cost/SF
A	**Building Cost**									
	Foundation System	Based on site soils condition	-	$ 17.50	Based on site soils condition	-	$ 17.50	Based on site soils condition	-	$ 17.50
	Vertical Structure	Wood/metal framed	-	$ 28.50	Masonry/structural steel	75	$ 32.50	Poured-in-place concrete	75	$ 40.63
	Horizontal Structure	Wood/metal framed (joist/truss system)	40	$ 40.00	Metal deck with lightweight concrete fill	50	$ 45.00	Poured-in-place concrete	50	$ 54.00
	Roofing Material	Built-up/single ply roofing system	12	$ 4.00	Roofing tile	40	$ 7.50	Standing seam metal roofing	50	$ 8.50
	Roofing Structure	Structure based on desired roof material	-	$ 5.00	Structure based on desired roof material	-	$ 5.00	Structure based on desired roof material	-	$ 4.00
	Exterior Finish	Plaster/EIFS	35	$ 32.00	Architectural masonry/stone veneer	75	$ 37.50	Glass & spandrel curtain wall system	50	$ 37.50
	Exterior Fenestrations	Dual pane aluminum windows	40	$ 12.50	High performance dual pane aluminum windows	40	$ 15.00	Aluminum storefront system with high performance glass	40	$ 15.00
	Interior Partitions	Open plan with moveable partitions	20	$ 12.50	Open plan with moveable partitions, framed office partitions	20	$ 20.00	Raised access floor system with moveable partitions, framed office partitions	25	$ 30.00
	Doors and Windows	Hollow-core interior doors with hollow metal frames	40	$ 6.00	Solid-core interior doors with welded metal frames	40	$ 10.00	Glazed interior doors with welded metal frames	40	$ 17.50
	Interior Finishes									
	Floor Finishes	Carpet and vinyl flooring - low quality	12	$ 5.00	Carpet and vinyl flooring - high quality	20	$ 7.50	High quality carpet with tile/stone/wood accents	35	$ 8.50
	Wall Finishes	Painted drywall	7	$ 3.50	Vinyl & fabric wallcovering	12	$ 5.25	Interior plaster & wood/stone veneer		$ 10.00
	Bathroom Finishes	Vinyl flooring with FRP wall coverings	20	$ 1.00	Ceramic Tile	25	$ 1.75	Stone veneer	30	$ 2.50
	Ceiling Finishes	Faced insulation		$ 4.00	Suspended acoustical tile	12	$ 7.50	Painted drywall	25	$ 10.00
	Other Interior - Case		-	$ 8.00			$ 10.00			$ 10.00
	Vertical Transportation	Standard among all cost models	-	$ 15.00	Standard among all cost models	-	$ 15.00	Standard among all cost models	-	$ 15.00
	Plumbing System	Common facilities for public and staff	-	$ 15.00	Separate public and staff facilities	-	$ 17.50	Separate public and staff facilities with locker room	-	$ 20.00
	Plumbing Fixtures	Vitreous china with plastic laminate partitions and counters	25	Included	Vitreous china with solid surface partitions and counters	35	Included	Vitreous china with stainless steel partitions and stone counters	35	Included
	Fire Protection			$ 6.50			$ 7.50			$ 7.50
	HVAC System	Roof mounted units	20	$ 42.00	Roof mounted chiller plant	20	$ 48.00	Central Plant	30	$ 52.50
	Electrical Power Distribution	Grid power and phone	20	$ 22.00	Grid power with battery backup and surge suppression	20	$ 25.00	Grid power, uninterrupted battery power supply with generator backup	20	$ 28.00

No.	System	Model A System Selection	Life Cycle	Cost/SF	Model B System Selection	Life Cycle	Cost/SF	Model C System Selection	Life Cycle	Cost/SF
		Building Cost Model A - Low Quality Construction			**Building Cost Model B - Medium Quality Construction**			**Building Cost Model C - High Quality Construction**		
	Electrical Lighting and Controls	Fluorescent lighting with occupancy sensors	20	$ 10.00	Fluorescent lighting with occupancy sensors and limited lighting control	20	$ 12.50	High performance lighting with occupancy sensor and full lighting control	20	$ 15.00
	Security System	None	-		Perimeter access control	-	$ 2.50	Perimeter and interior access control with camera surveillance	-	$ 5.00
	Subtotal Building			$ 290.00			$ 350.00			$ 408.63
	Building area	333,568 sf			333,568 sf			333,568 sf		
	Total Building Construction Cost (hard cost only)		**$**	**96,734,720.00**		**$**	**116,748,800.00**		**$**	**136,305,891.84**
B	**Site Cost**									
	Site Utilities	Standard among all cost models based on site selection	-	$ 17.50	Standard among all cost models based on site selection	-	$ 17.50	Standard among all cost models based on site selection	-	$ 17.50
	Site Development			$ 10.00			$ 10.00			$ 10.00
	Flatwork	Minimum walkways between parking and building	-	$ 10.00	Walkways interconnect site buildings and parking with the landscaping	-	$ 15.00	Extensive pathways create destinations and gathering areas within a park-like setting	-	$ 25.00
	Landscaping	Sparse landscaping	-	$ 3.00	Complete landscaping	-	$ 5.00	Ornate landscaping	-	$ 7.50
	Lighting	Minimum code required site illumination	-	$ 5.00	Layered lighting with both site and pedestrian level illumination	-	$ 5.00	Dramatic lighting showcases the landscaping and accents the building's architecture	-	$ 7.50
	Subtotal Site			$ 45.50			$ 52.50			$ 67.50
	Site area	*"As a function of the Building Area"*			*"As a function of the Building Area"*			*"As a function of the Building Area"*		
	Total Site Consruction cost (hard cost only)		**$**	**15,177,344.00**		**$**	**17,512,320.00**		**$**	**22,515,840.00**
C	**Total Building & Site Construction Cost (A+B)**	**$ 111,912,064.00**	**$ 336.00**	**Per Sq. Ft.**	**$ 134,261,120.00**	**$ 403.00**	**Per Sq. Ft.**	**$ 158,821,731.84**	**$ 476.00**	**Per Sq. Ft.**
	Building & Site Soft cost	**$ 50,035,200.00**	@ $150/SF		**$ 50,035,200.00**	@ $150/SF		**$ 50,035,200.00**	@ $150/SF	
D	**Total Building & Site project cost** (Soft & Hard)	**$ 161,947,264.00**			**$ 184,296,320.00**			**$ 208,856,931.84**		

PARKING STRUCTURE COST MODELS

County of Tulare - Proposed Civic Center - Facility Cost Models

New facility, accommodating 15 county departments with 333,568 sf area - Building foot print = 83,392 sf per floor - four stories in height

Building Area = 333,568 SF **Parking =** 1,334 Spaces

Building Site = *"As a function of the Building Area"*

No.	System	Parking Cost Model A - Low Quality Construction			Parking Cost Model B - Medium Quality Construction			Parking Cost Model C - High Quality Construction		
		Model A System Selection	Life Cycle	Cost/SF	Model B System Selection	Life Cycle	Cost/SF	Model C System Selection	Life Cycle	Cost/SF
E	**Parking Structure Cost**									
			-	$ 60		-	$ 69		-	$ 77
	Subtotal Parking (Per Space)			$ 21,000			$ 24,000			$ 27,000
	Total Spaces	1,334 Spaces			1,334 Spaces			1,334 Spaces		
	Total Parking Construction Cost (hard cost only)		**$ 22,411,200.00**			**$ 25,612,800.00**			**$ 28,814,400.00**	
	Parking Soft Cost	**$ 9,604,800.00**	@ 30% of total project cost		**$ 10,976,914.29**	@ 30% of total project cost		**$ 12,349,028.57**	@ 30% of total project cost	
F	**Total Parking project cost** (Soft & Hard)	**$ 32,016,000.00**			**$ 36,589,714.29**			**$ 41,163,428.57**		

COST MODELS SUMMARY
Building & Parking Structures

Cost Model A Low Quality Construction	Cost Model B Medium Quality Construction	Cost Model C High Quality Construction
$ 193,963,264.00	$ 220,886,034.00	$ 258,895,432.00

•The above costs do not include:

- An additional 2%-5% for high performance architecture (environmental sustainability in building design & construction). "A common misperception is that green buildings cost significantly more than conventional buildings. In fact, the increased cost for green buildings is typically 5%, depending on the features, building type, and location. In some projects, where green measures are considered early and fully integrated into the building design, there is no increased cost." (from Global Green, USA - "Developing Green Building Programs").
- An additional $100,000 - $150,000 to commission (L.E.E.D. Certification from the U.S. Green Building Council).
- Escalation factors to cover future market and inflation conditions. The models reflect the costs in today's dollars (2007). Escalation factors will be added once the implementation plan and timelines are developed and adopted (Next Phase).
- No values for design, procurement, or construction contingencies has been included in this analysis.

7.2 Cost Model System Descriptions

7.2.1 Building Systems

Foundation Systems

Spread Footing

A spread footing is a shallow foundation that transfers the weight of the building and all its occupants and furnishings to stable soil or bedrock. The foundation is designed by a structural engineer taking into consideration the building's loads and the capacity of the underlying soil. The primary design concerns are settlement bearing capacity. When considering settlement, total settlement and differential settlement, either from varying soil conditions or changes in moisture content that can cause the soil to shrink or swell due to seasonal climate change, must be considered.

Slab-on-grade

The advantages of the slab technique are that it is relatively inexpensive and quick to construct. The disadvantages are the lack of access from below for utility lines, a tendency to transmit cold upward in areas where ground temperatures fall significantly, and a very low grade elevation that may expose the building to flood damage in even moderate rains. Remodeling or extending such a structure may also be more difficult.

Piles

A pile is one type of a deep building foundation. Piles are used when the soil near the surface is not strong enough and the weight of the building must be carried by deeper, stronger soil layers. Precast concrete or structural steel piles are driven deep into the ground to a point where the end of the pile bears on the stronger soil layer. The tops of these individual piles are then connected to evenly distribute the weight of the building.

Vertical Structure

Cast-In-Place Concrete

Reinforced concrete structures are normally very heavy and have to be designed to carry their own weight as well as the superimposed design loads. The high compressive forces found in concrete columns present few problems, but the tensile stresses found in floor slabs and beams present design challenges. Post-tensioned concrete provides a way to overcome the tensile stresses and can reduce the thickness and depth in beams and slabs.

Steel Moment/Brace Frame

Steel framed structures are built using a skeleton of vertical steel columns and horizontal beams, assembled in a rectangular grid to support the floors, roof, and walls of a building which are all attached to the frame. The beams and columns are assembled and connected using bolts and threaded connections. Shear forces like wind loads and seismic forces are controlled in steel framed structures by using welded moment connections or diagonal bracing members. Diagonal bracing is typically less expensive that moment connections but these members can interfere with the building's flow and fenestration. Steel framed structures typically use concrete filled corrugated metal decking at intermediate floor levels while an alternate is to use precast concrete flooring units. The steel frame needs to be protected from fire because steel loses its strength in high temperatures. Columns and beams must be encased in some sort of fire resistant structure such as masonry, concrete, or sprayed with an insulating coating.

Tilt-Up Concrete

When building with tilt-up, the site is prepared, walls are cast on-site on the floor slab, and then tilted up and secured in place. Engineering plays a key role in the creation of tilt-up buildings: wall panels must be able to withstand lifting loads, and floor slabs must be able to withstand crane and/or bracing loads during construction. Recent evolutions in component and mix design mean that structures can incorporate thinner, taller panels than ever before. And tilt-up panels can be finished in myriad ways, offering aesthetic flexibility.

One of the most evident benefits of tilt-up concrete construction is speed. Wall panels are often placed while the rest of the building systems are designed, and trades can begin work quickly, speeding time to occupancy. Tilt-up structures also offer all the energy efficiency, strength, and durability long associated with concrete.

Masonry Construction

Masonry construction uses concrete masonry units (CMU) as a type of permanent formwork for concrete. The hollow spaces of the CMU block are grout filled which works in conjunction with the steel reinforcing to tie the individual blocks together to provide structural strength. Construction using concrete masonry can be very economical, particularly when the designer uses the modular sizes of the masonry units to full advantage in an effort to minimize wastage. Masonry is available in a wide range of architectural shapes, textures and colors, or it can serve as the substrate upon which veneers of brick, stone, or stucco can be applied.

Wood/Metal Framed

Light-gage steel stud framing or wood stud framing uses lightweight members to form the load-bearing structure. The use of steel studs has quickly eclipsed the use of wooden studs because of their invulnerability to pests and rot and fire resistance. Steel studs are extremely versatile and are available in different gages depending upon loads, are available in almost any length, and can be quickly modified and combined on site to build almost any conceivable structure.

Insulated Concrete Formwork (ICF)

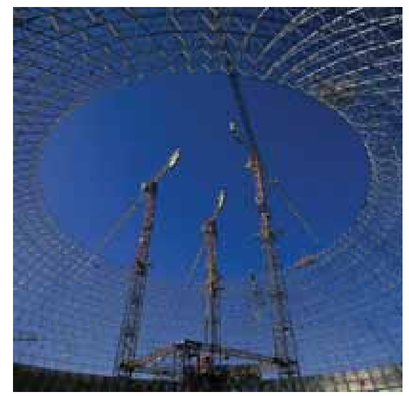
Insulated Concrete Formwork is a series of interlocking lightweight modular blocks which when assembled and filled with concrete gives a monolithic concrete wall with exceptional thermal qualities and no thermal bridges.

Whilst ideal for house building it is now recognized as a modern method of construction for hotels, schools and industrial buildings. ICF blocks are made up of two high-density, fire resistant polystyrene leafs held between apart by a tie system. These tie systems have evolved from the original low density and bulky polystyrene “bridges”, to modern molded plastic spacers or metal struts. Once assembled, the inner cavity is pump filled with a specified concrete mix, this results in a monolithic, high strength, thermally insulated construction with high thermal mass ready for external and internal finishing.

Horizontal Structure

Truss Systems

Trusses are triangulated frameworks used as spanning or bracing elements in buildings, bridges, transmission towers, and other structures. Advantages of truss construction include the following: 1) large trusses can be assembled from small members pinned together, facilitating production, transportation, and erection; 2) the truss is an extremely efficient structural form which translates into a lighter structural weight and material cost savings; 3) because trusses are typically assembled from individual elements bolted, welded, or nailed together, it is relatively easy to customize the overall shape of the truss in relation to external loads and spans.



Space frame

A space frame is a truss-like, lightweight rigid structure constructed from interlocking struts in a geometric pattern. Space frames utilize a multidirectional, three dimensional span, and are often used to accomplish long spans with few supports. Space frames are most commonly seen in large sports arenas and exhibition centers where they enclose large volumes of space without any interior supports.

They derive their strength from the inherent rigidity of the triangular frame; flexing loads (bending moments) are transmitted as tension and compression loads along the length of each strut.

Most often their geometry is based on platonic solids. The simplest form is a horizontal slab of interlocking square pyramids built from aluminum or steel tubular struts. In many ways this looks like the horizontal jib of a tower crane repeated many times to make it wider. A stronger purer form is composed of interlocking tetrahedral pyramids in which all the struts have unit length. More technically this is referred to as an isotropic vector matrix or in a single unit width an octet truss. More complex variations change the lengths of the struts to curve the overall structure or may incorporate other geometrical shapes.

Poured-In-Place Concrete

In this construction method, wood and steel forms are used to create the bottom and sides of the elevated concrete floors. Steel reinforcing bars or wires are placed in grids on the formwork to support the concrete after it is poured and the forms have been removed. The formwork can be reused and jumps from one floor to another making this technique more efficient in structures with a uniform, repetitive layout.

Metal Deck with Lightweight Concrete Fill

Metal decking is most commonly used with lightweight steel framed structures. A corrugated metal decking is welded to the beams and girders supporting the floor, steel reinforcing bars are installed in a grid pattern, and then a lightweight concrete fill is poured into the metal forms. Unlike a poured-in-place concrete deck where the forms are only temporary and removed once the concrete is strong enough to support itself, the metal decking is permanent.

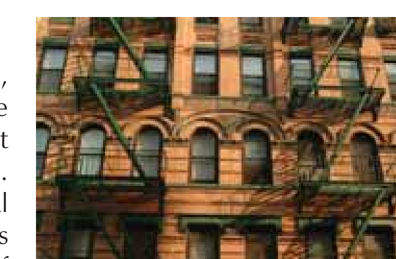
Facade Types

On some buildings the facade provides structural support, but on most modern buildings it exists only to separate the indoors from the outdoors. In any case it acts as a two-way screen, keeping certain things out (bad weather, noise, vermin, etc.) and other things in (personal belongings, good air, private events). The facade system describes the basic ways this surface is formed in a structural sense.

Stucco/EIFS

Exterior Insulation Finishing System (EIFS) is not 'stucco' in the sense of the word stucco. Traditional stucco is often called Portland Cement Plaster, and is a centuries-old non-insulating material. Stucco consists of sand, Portland Cement and water, and is a hard, dense, thick, non-insulating material. EIFS is a modern, lightweight synthetic wall cladding that includes foam plastic insulation and thin synthetic coatings. EIFS can have a similar finish to that of stucco, but they are different types of exterior finishes.

Applied Masonry Facades



These facades cover the structure of a building, but differ from curtain walls because they are assembled from several small pieces and do not hang onto the structure as a single, framed system. Applied masonry does not assist in the structural support of a building, although it sometimes appears to. This type of facade is constructed of individual bricks, blocks, tiles, or pieces of stone laid on top of each other at the construction site in a vertically continuous wall; if the masonry units are installed in prefabricated sheets hung onto the building's structure, or laid in bands on top of structural or curtain wall elements, then this system does not apply to the building.

Curtain Wall Facades

A curtain wall is a continuous sheet of panels hung onto the side of a building over the framework. These sheets may be constructed from prefabricated panels (often as tall as 3 floors each), or assembled at the construction site from their component windows, panels, and vertical and horizontal framing pieces. Virtually any facade material can be employed in a curtain wall, including prefabricated concrete, metal, glass, industrial panels, and sheets of stone or masonry. When masonry is laid over continuous bands of curtain wall elements or window panels, it is considered to form part of the curtain wall because it rests on elements hanging from the structure.

Exposed Structure Facades

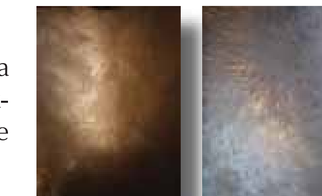
In this facade type the building's structural framework is not covered. It may either be exposed directly to the outdoors or painted; the rest of the enclosure is formed by filling the openings in the framework with windows and/or panels of any suitable material. This is common with concrete structures but not with metal-framed buildings, because structural metal cannot usually be exposed to the air. If a building has a load-bearing masonry structure which is exposed on the surface, it is included in this category. When sections of masonry fill the gaps in a framework instead of covering the frame, then it is listed as an exposed structure facade.

Facade Materials – Metal

Aluminum

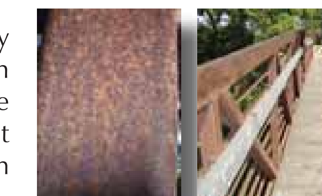
As a building material, aluminum offers several advantages. The metal does not corrode, and therefore requires almost no maintenance. It is extremely light, and its reflective and insulating properties work together to conserve energy.

Bronze



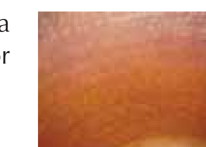
Bronze is a copper alloy which usually contains a percentage of tin, and is considered one of the highest-grade materials used as a building facade. It is more elastic and resistant to corrosion than steel.

Cor-Ten steel



Cor-Ten Steel is a type of steel which oxidizes naturally over time, giving it an orange-brown color and a rough texture. It has a very high tensile strength, and in spite of its rusted appearance it is actually more resistant to damaging corrosion than standard forms of carbon steel.

Copper



The material has a shiny reddish-brown color and weathers to a brilliant pale green. It is considered very attractive as a cladding for ornamental roofs, but is rarely used as a primary facade material.

Stainless Steel

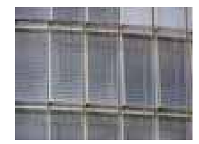
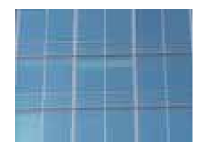
Stainless steel is a special type of steel with a low carbon content, at least 10.5% chromium, and amounts of molybdenum, nickel, and nitrogen. When the metal is exposed to air, the chromium forms an oxide on the surface and will do so again if the original coating is damaged. This protective layer makes the metal resistant to rust and other corrosion, hence its name.

Stainless steel is a high grade of steel, and retains its strength and appearance at high temperatures. It resists scaling in fire and extreme heat, and remains shiny over time and with repeated exposure to water. It is highly valued as a facade material, and because of its aesthetic and hygienic advantages it is a common material for instruments which handle food. Stainless steel is also 100% recyclable.

Steel

Steel is an alloy of iron, usually containing a percentage of carbon. It is stronger than pure iron and has many industrial and structural applications. It forms a very durable building facade, although it must be coated to prevent rust. The surface usually has a dimpled texture and it is much harder than aluminum, which is a less expensive and more common facade material.

Facade Materials – Glass

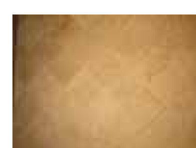
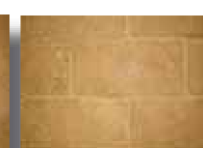
Glass is a transparent or translucent material made by melting sand into a homogeneous, moldable form. Almost all buildings use glass for windows, so a facade is only labeled as "glass" if the opaque parts of the surface (i.e. areas that are NOT windows) are also clad in glass.

Facade Materials – Natural Stone

Granite

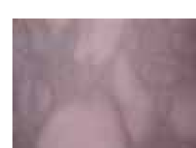

It is extremely hard, and can be recognized by its speckled, grainy composition. The material comes in a wide variety of colors, and can be either rough or polished. This type of stone is extremely durable, and highly resistant to stains, weathering, and corrosion. Granite is not as porous as other cladding stones, and thus is not strongly affected by repeated cycles of freezing and thawing.

Limestone

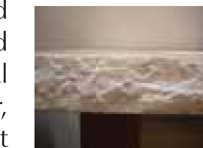
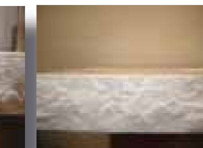
The material has a uniform consistency and texture, and it cannot be polished. Limestone is usually a buff yellow or off-white color, but it can also be gray or very light in tone. Limestone is generally less expensive than other cladding stones, and gives a dignified appearance to a building. It is the most common material used in the art deco and neo-gothic styles.

Marble



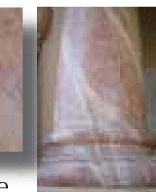

It is softer and more brittle than granite, but as a cladding stone it is considered a luxury material prized for its distinctive mottled look. It is usually polished but can also be used in rough form.

Sandstone

Sandstone is softer than many other rocks, and easily carved. As a building facade it is valued for its textural properties and attractive natural colors. Common impurities such as iron, feldspar, hematite, and mica give it a variety of different colors, including yellowish, brown, and red.

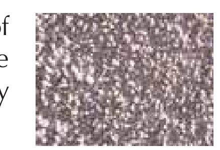
Travertine

Often referred to as "travertine marble", this stone is actually more closely related to limestone but its impurities can give it a marble-like appearance. Formed in water from calcium carbonate deposits, travertine is usually marked by small fossils or hollow fossil imprints. The stone takes a polish and is used for its decorative effect, especially in building lobbies.

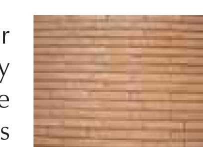
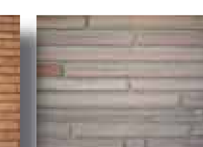
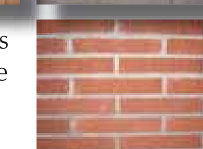
Facade Materials – Industrial Material

Aggregate



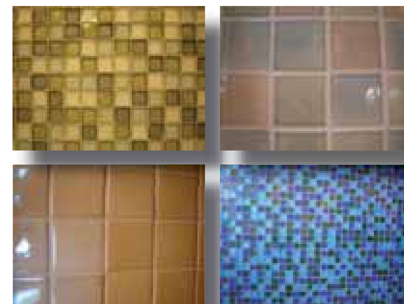

Aggregate stone facades use manufactured sheets of joined rocks or pebbles. The composition of these panels can include any variety of stone types, or may be composed of a single type of stone.

Brick

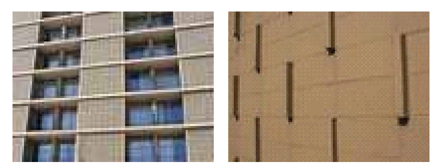
Bricks are small masonry units made of clay or shale, mixed with water and fired in a kiln. They are often coated with sand or lime, and are available in a wide range of colors. Advantages of bricks include low maintenance, energy efficiency, durability, and architectural flexibility. Individual bricks can be shaped according to specification, and arranged in decorative patterns. In many buildings they provide the primary structural means of support, but bricks can also be applied as a curtain wall or supplementary finish to other materials.

Ceramic Tile



Ceramic tiles are usually small, flat, clay-based pieces which are applied with mortar or other adhesive to a backing surface. Most ceramic tile facades are colored and glazed, and in many cases the tiles are arranged in visually interesting patterns. This material allows more flexibility of appearance than almost any other non-painted material, as the tiles have a wider range of color than bricks and their shapes and arrangement are limited only by the imagination of the designer.

Cinder Block



Cinder blocks are masonry units made of concrete, often mixed with coal cinders. They are usually hollow with holes on two sides. Sometimes the holes are configured to form geometric patterns (e.g. pinwheels), and stacked with the holes facing outward. Cinder blocks are very often painted, unless used as a back or side facade material.

Concrete

As a facade material it comes in two forms: poured-in-place, and precast. A poured-in-place concrete facade usually means that the structural concrete (reinforced with steel) is left exposed on the building's surface, either raw or painted. A precast concrete facade is typically made of panels hung over the structural frame as a curtain wall.

Concrete normally has a very light grayish- or yellowish-brown color, but pigments can be added for variety. It often has a very smooth texture, but it is easily molded for a rusticated or patterned surface. Small or large pebbles can be incorporated into the mixture to produce rough textures.

Stucco

Stucco is a thick plaster used for its insulating and textural properties. The material can be made in almost any color, and can be applied as a smooth surface or in geometric or random patterns.

Stucco or plaster can be applied directly to a harder surface like brick, concrete, or cinder blocks, or it can be applied in panels reinforced with wire or plastic mesh.

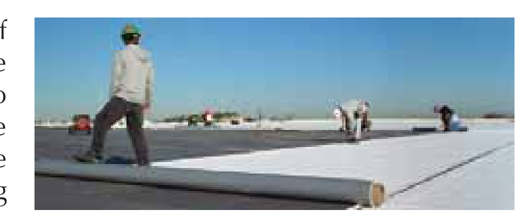
Roof Types

Built-Up Roof

A built-up roof is a roof consisting of multiple plies of roof felts laminated together with bitumen. Built-up roof material can consist of bitumen-saturated felt, coated felt, polyester felt or other fabrics. A surfacing is generally applied and can be asphalt, aggregate (gravel or slag), emulsion or a granule-surfaced cap sheet.

Built-Up Roofing is one of the oldest and most reliable ways of installing a new roof. It was first known as composition roofing and started in the 1840's. B.U.R.'s come in two basic types, asphalt and coal tar, and three basic components – (1) the waterproofing component, (2) the reinforcing component, and (3) the surfacing component which is used to protect the other components from the elements

TPO: Thermoplastic Olefin or Polyolefin



TPO membranes are single-ply roof membranes constructed from ethylene propylene rubber. They are designed to combine the durability of rubber with the proven performance of hot-air weldable seams. They have been tested as having excellent resistance to ozone, are algae-resistant, environmentally friendly and safe to install. The material's manufacturers are so confident in properly welded seams that the material is sometimes advertised as a monolithic (seamless) roof. TPO is highly resistant to tears, impacts, and punctures with good flexibility to allow for building movement.

Standing Seam Metal Roofing

Standing seam metal roofing uses aluminum panels installed over a vapor barrier to provide a watertight roofing system. The panels are formed on site from rolls of factory painted aluminum into the desired profile. They can be cut to almost any length thereby eliminating horizontal seams. The longitudinal seams are mechanically crimped into a watertight seam above the roof line to further prevent leaks.

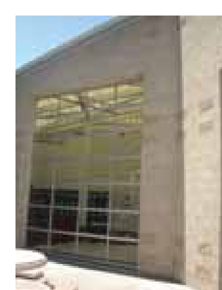
Roofing Tile

Roof tiles are 'hung' from the framework of a roof by fixing them with nails. The tiles are usually hung in parallel rows, with each row overlapping the row below it to exclude rainwater and to cover the nails that hold the row below.

Concrete roof tiles are a durable water-shedding material that most often last the lifetime of a building. Concrete tiles have grown more competitive in price, due in part to the rising costs of roofing products produced from petroleum (such as asphalt shingles).

Exterior Fenestration

Double Glazing Windows



Double glazing is the name given to the modern glazing system where a window is formed by two panes of glass spaced several millimeters apart. This arrangement, when sealed, traps air in between the panes thereby forming an insulating layer.

Aluminium framed double glazing has decreased in popularity with the advent of UPVC frames. Although aluminium frames are very strong, are virtually intruder proof and are not subject to warping or twisting, they have a relatively poor insulation performance when compared to UPVC (unless they are fitted with a thermal break).

Hollow Core Doors w/ Hollow Aluminum Frames

Hollow-core doors are made from two thin veneer plywood or hardboard faces. Between the two are supports, often made of cardboard, to help keep the door rigid. Hollow core doors are much lighter than solid wood doors, cheaper and are easier to install. However, sound travels more freely through them, which can be a problem if the occupants desire a lot of privacy.

Solid-core Interior Doors with welded metal frames

Solid wood doors are slightly more fire resistant because the fire has to burn through more material.

Glazed Interior Doors with Welded Metal Frames

Heating, Ventilation & Air Conditioning (HVAC)

Central heating, ventilation, and air conditioning (HVAC) systems regulate temperature, ventilation, and humidity levels to ensure the physical comfort of occupants in most commercial and industrial buildings. Central HVAC systems come in a variety of different types such as all-air systems, constant volume, variable volume, dual duct, air-water and all-water systems. All-air systems are the most commonly used central HVAC systems because of its simplicity and effective control. Escalating concerns for acceptable indoor air quality may suggest the increasing use of all-air systems. Unfortunately, air is not an efficient heat transfer medium, thus, all-air systems may require extensive building volume for ductwork distribution. In situations where ductwork cannot be reasonably accommodated in the building design, air-water or all-water approaches may be considered.

Roof-top unit (RTU)

An air-handling unit, defined as either "recirculating" or "once-through" design, made specifically for outdoor installation. They most often include, internally, their own heating and cooling devices.

Central Plant

Cooling is generated in a chiller and distributed to air-handling units or fan-coil units with a chilled water system. This category includes systems with air-cooled chillers as well as systems with cooling towers for heat rejection. Heating in these systems is often generated in a boiler and is distributed in hot water or steam piping.

Chiller

A device that removes heat from a liquid via a vapor-compression or absorption refrigeration cycle. This cooled liquid flows through pipes in a building and passes through coils in air handlers, fan-coil units, or other systems, cooling and usually dehumidifying the air in the building. Chillers are of two types; air-cooled or water-cooled. Air-cooled chillers are usually outside and consist of condenser coils cooled by fan-driven air. Water-cooled chillers are usually inside a building, and heat from these chillers is carried by recirculating water to outdoor cooling towers.

Site Systems

Site Utilities

Site utilities is a broad term that encompasses all the infrastructure required to support the building's function. Site utilities include the domestic water service, fire hydrants, gas service, the electric feed, sewer lines, and storm water drainage. These services are dictated by code and are standard among different building cost models.

Flatwork

Flatwork summarizes all the concrete and asphalt paving for circulation, parking, and pedestrian access on site. The flatwork can range from a bare minimum of surface parking and fire department access to an extensive network of artfully designed pathways that draws pedestrians into the site and combines the building to the site to create a unified park-like setting.

Landscaping

Landscaping can range from sparse to lush. Whether your goal is to minimize maintenance or to create a dramatic garden setting