

## Designing with Form Liners

An almost unlimited variety of attractive patterns, shapes, and surface textures can be achieved by casting against elastomeric, plastic and polystyrene-foam form liners. (Figure 1)



**Figure 1 – Multiple Concrete Textures**

These form liners may be incorporated in or attached to the surface of a mold. Concrete's plasticity offers the opportunity for innovation and individual character in the surface textures, patterns, and shapes, which can be achieved by casting against various types of form liners. A large pattern offers ever-changing details due to the play of light and shadow; a fine texture offers a muted appearance that is subtle but not drab and smooth surfaces bring out the elegance and richness of simplicity. Form liner textured surfaces also mask minor imperfections that would otherwise be obvious in a smooth as-cast surface, yielding a more uniform appearance.

Light and shade created by modeling or sculpturing with liners may be used for visual effect to enliven large concrete surfaces with patterns at a reasonable cost or can economically simulate another material in concrete.

Form liners can be used to replicate stone textures matching natural rock formations; fractured fins or flutes; wood boards; trapezoidal, wave and rib textures; sandblasted or bushhammered looks; stucco or masonry textures, including bricks; custom graphics, including true 3-D. The options with combination finishes, involving one or more basic finishing methods together with form liners, are almost infinite.

An important consideration is selecting the texture and/or type of form liner best suited to the project. Concrete can be produced with vertical ribs or striations in a range of sizes to suit a particular structure and the distance from which it will most often be seen. Overall, the cost of liners depends on the ease of use and number of reuses actually obtained. Regardless of form liner used, draft must be incorporated to prevent chipping or spalling (chipping or splintering) during stripping of the unit from the mold.

Liner size and characteristics may require that an architectural feature in the form of a demarcation groove, recess, rib, or plain area (Figure 2) be detailed to hide joints between liners, or limit usage to within less than the available width of the liner, or the liner joints should be designed at form edges.

## Types of Form Liners

Form liners are available in multiple materials ranging from single-use materials, such as expanded polystyrene or high impact polystyrene, to multiple-use materials, such as urethane rubber. One must consider the type of project the form liners will be used for, as well as associated costs, such as labor, shipping and transporting of the liners on the jobsite.



**Figure 2 - Smooth Transition Strip between Textures**

### **Single-Use Form Liners**

Single-use form liners offer many advantages, including reduced costs. A single-use product may be only a fraction of a multiple-use product. These liners provide a lightweight option and make this product easier to work with on the jobsite; applied to formwork without the use of a machine.

#### *EPS – Expanded Polystyrene*

EPS is a very lightweight material that offers low cost custom forming options. These

form liners require no master molds and can be produced with a fast turnaround time. Because of their lightweight attributes, EPS form liners, as well as other single-use form liners, are easier and less expensive to ship, generally easier to cut in the field, if needed, and easier to mount to the formwork. Figure below shows custom graphics using EPS molds. (Figure 3)

EPS form liners would not be the best choice for patterns that require a large relief over 1". The pattern produced using these liners would be less crisp than other types of single-use products. When choosing EPS, one

must also consider the size limitations created by the available sheet sizes and thermal-forming equipment.

#### *HIPS – High Impact Polystyrene*

HIPS form liners are rigid sheets of thermal-formed plastic and are recyclable. With many similarities to other single-use form liners in regards to lower production costs, shipping and ease of use, HIPS form liners are available in a large variety of textures, including custom textures. HIPS form liners can be used for reliefs up to 2". However, larger reliefs and



**Figure 3 – Nebraska National Guard Atlas and Titan Readiness Centers, Meade NE**

flat areas may require the form liner to be backed up with wood before pouring the concrete.

Because HIPS is a thermal-formed product, it is also limited to the available sheet size and vacuum-forming machine size. This material also tends to offer less sharpness to details in the concrete and requires slower concrete pour rates.

### **Low Re-Use Form Liners**

Low re-use form liners offer many advantages over other types of form liners. As with single-use form liners, the type of use will determine if a low re-use liner will work for the particular project. One must consider if a small number of re-uses can be accomplished, considering window and door openings, among other variables in the panel design. The low re-use form liners typically can offer larger reliefs than single-use as they tend to be constructed of more rigid/thicker materials.

#### *ABS – Acrylonitrile butadiene styrene*

ABS plastic is another thermal-formed sheet that offers some reusability – up to 5 times, especially for patterns with lower reliefs, such as 1” and under. ABS is more flexible than

HIPS and can be stripped with more ease than the rigid HIPS material. As with HIPS, ABS plastic is recyclable and provides some cost benefits, but not as much as HIPS. Sizes up to 4’x12’ sheets are easier and less expensive to ship than traditional, reusable elastomeric form liners. ABS form liners are available in a large variety of textures and can be created for custom patterns, as well.

Of course, as with other low re-use options, there are some disadvantages to ABS, including the fact that ABS has greater shrinking and expanding characteristics than HIPS, offers less crisp patterns than elastomeric, can support only a slow concrete pour rate and is limited to the size of the available sheets and thermal-forming machine.

#### *Fiberglass*

Fiberglass form liners are a low re-use product that can offer large variety of textures, custom designs and provide an option for deep relief patterns. They are more durable than ABS, are lightweight and are more flexible, offering easier stripping.

The process used to make the fiberglass form liners is more difficult than the other types of form liners and is becoming obsolete. They



**Figure 4 – Lightweight Elastomeric Medium Re-Use Custom Form Liners Create Graphic Bridge Piers (Wisconsin DOT - Oneida County)**



are not recyclable and disposal of the used form liners would have a negative environmental impact. Some other drawbacks of the fiberglass form liners are that they are limited in size, can be difficult and expensive to ship and can be more expensive to produce.

### **Multi-Use Form Liners**

Certain projects would require a form liner that can be reused many times. These projects may be large runs of identical sound wall panels, warehouses or large buildings with many identical panels. The reusability properties of these types of form liners will offer cost savings to the project, provided that there is a need for repetitive panels.

#### *Elastomeric – Urethane Rubber*

Rubber form liners have outstanding replication abilities and are used to create fine details for textures and graphics, including 3-D and photo-engraved concrete. They are highly durable and can allow for seamless finishes in sizes that are only limited by shipping regulations and manufacturing facility

dimensions and capabilities. Rubber liners are easier to install and can withstand higher temperatures than other types of form liners. Plus, they can be manufactured in 3 different styles to best meet the needs of the production team: rolled rubber sheets, flat rubber sheets or rubber cast onto a plywood backing. Each style has its own merits for the particular type of production.

However, rubber form liners do have some drawbacks, as well. These include higher production and shipping costs, and an environmental impact due to demand for a non-renewable resource and disposal of used form liners. These types of form liners are also very heavy per SF and can make transportation both to and on the jobsite more difficult.

### **Form Liner Textures**

Form liners are available in many textures ranging from traditional building patterns, such as brick or stone, to custom, highly detailed 3-D graphics. Form liners have been used for many years to create what ACI



**Figure 5 – Wells Federal Bank, Wells, MN**

calls architectural concrete—defined as "concrete that will be permanently exposed to view and therefore requires special care in selection of the concrete materials, forming, placing, and finishing required to obtain the desired architectural appearance." Sounds like a definition for decorative concrete, doesn't it? New materials and techniques, though, are allowing us to create form liners that impart more intricate patterns on the concrete surface—realistic rock patterns, detailed graphics, even photographs that appear photo-engraved.

#### *Brick Textures*

Concrete form liners that emulate brick textures can provide a cost effective means to providing a brick façade on a structure. With less onsite labor, "perfect " mortar joints and brick coursing can be achieved using form liners to emulate all brick sizes, joint types and textures.

However, this appearance may be too perfect and takes away the natural, hand-laid element of traditional brick buildings and requires staining to achieve any sense of realism. Also with most decorative, form-lined

concrete, seams in the concrete panels are visible and may appear unnatural.

#### *Wood Textures*

Many types of wood textures, such as weathered wood boards, split cedar stakes, hand hewn woods (Figure 6), and many others, can be emulated on a structure with the use of concrete form liners. Form liner molds can be machined to provide for perfect board coursing and less onsite labor, thus reducing costs. Lower-cost options of form liners, such as HIPS/ABS plastic types, allow the user to cut window/door openings rather than bulk heading on top of the elastomeric form liners.

As with most form-lined, concrete panels, seams between panels and repeating patterns can be visible and distracting to the overall feel of the building. Plus, staining will need these panels will need to be stained to achieve a look of realism.

#### *Masonry/Stone Textures*

Realistic stone and block textures can be achieved with the use of form liners. They can provide cost-effective methods to acquiring



Figure 6 - Hand Hewn Hemlock Texture - Flight 93 Memorial



Figure 7 – Capital Health, New Hope, NJ

a look of hand-laid stone and blocks and allow for the easy mixing of various textures on the structure (Figure 7). Plus, the varying textures, sizes and shapes of the stones and mortar joints provide a place to “hide” panel seams and make a more natural appearance. Many different types of stones, rocks and blocks, such as quarried rocks, ashlar, dry-stacked stones, concrete masonry units and many more types can be replicated with form liners. The use of these form liners provide for less onsite labor and can provide perfect coursing dimensions that may not be attainable with normal building products.

Once again, the designer must consider that masonry/stone textured form liners will provide repeating patterns and need to be minimized with innovative design techniques that incorporate the use of multiple textures and varying panel layouts.

### *Flat Textures*

Flat texture form liners can be used to provide uniform texture, such as matte finishes, sand blast textures and stuccos, to concrete which is generally difficult to achieve with typical hand tooling techniques on a large scale. Large areas of smooth, flat surfaces are attainable with these form liners, generally the most affordable of all elastomeric form liners.

The drawbacks with flat-textured form liners include the fact that seams between panels and minor imperfections can be very visible. These limitations can be limited by the use of chamfer or reveal strips to transition between panels.

### *Geometric Textures*

Geometric textures, such as pyramids, diamonds, sine waves, and many others, are patterns that can be repeated over large areas through the use of a concrete form liner (Figures 8&9). Because of the use of machined molds, manufacturers of form liners can offer



form liners that will provide for perfect matches between panels. Innovative designers can also utilize varying and multiple textures within the geometric patterns to provide one-of-a-kind designs for the structure, possibly adding a stone-like or sandblast-finished texture to a normally smooth pyramid face.



Figure 8 – University of Scranton, Scranton, PA

The designer who chooses to use these types of designs must keep in mind that geometric-patterned form liners tend to be some of the most expensive form liners to manufacture. These costs can be minimized through a design that will allow the construction techniques to reuse the elastomeric form liner, thus reducing the initial outlay for the form liners.



Figure 9 – First Baptist, Dallas, TX

### *Fractured Textures*

Fractured fins and fluted textures are 2 examples of fractured patterns that can easily be utilized over large areas on buildings. The seams on these types of textures can be matched easily and allow for perfect repeating patterns. Because of these advantages and the reusability of elastomeric form liners, fractured textures are some of the most affordable types of textures to use and are more economical than fracturing concrete by hand. Plus, any imperfections in the form-lined concrete are generally hidden within the randomness of the fractured patterns.

These types of fractured textures, with reliefs greater than 2 inches will be best achieved using elastomeric form liners and may be more difficult to strip the form liner from the concrete.



Figure 10 – Federal Courthouse, Billings, MT

pattern that may be more acceptable than other types of textures.

### *Rhythmic Textures*

Rhythmic-textured form liners (Figures 11&12), like the geometric textures, are manufactured with the use of machined molds and offer the construction industry form liners which can provide very uniform coursing and patterns. An example of this may be dividing a 12' space with a perfect  $\frac{3}{4}$ " deep, 2" center-to-center sine wave. With the use of this type of form liner, the designer can incorporate this rhythmic pattern into any design that would match this center-to-center dimension. That is, the designer could properly place window/door openings to fit within this design parameter. The seams between panels can be matched perfectly because of the exactness of the pattern and rhythmic patterns offer a repeating



Figure 11 – East Baltimore Community School, Baltimore, MD



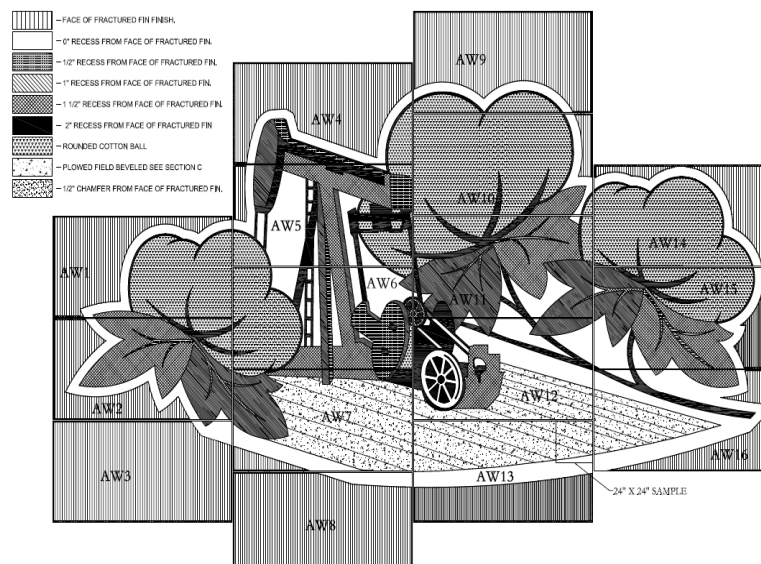


**Figure 12 – Rhythmic Textures – Cleveland Medical Mart, Cleveland, OH**

### *Custom/Graphics*

Custom form liners allow designers to “think beyond the box.” Large murals can be created from multiple panels through the use of concrete form liners. It is in these panels that multiple textures can be combined to produce the desired effect and to create the images

building. There are typically three different types of graphics that can be achieved with the use of form liners. A two-dimensional pattern can be machined into the mold and replicated onto the form liner. These types of graphics could be letters, dates, and simple flat-planar designs. The next level of custom designs may include the design of multiple planes to produce a graphic. These planes may also be textured with different types of textures, such as bush hammer, sand blast, fractures, etc. The final type of custom graphic one could consider is the true, three-dimensional graphic. A photo-realistic graphic can be achieved through advanced machining of the molds and transferred to concrete through the use of the elastomeric form liner. Large, photo-engraved walls are possible, as well as sweeping three-dimensional murals that encompass multiple, realistic graphics. Designers need to realize that



**Figure 13 – Large Mural Design Work**

desired. Figure 13 shows the design work in the drawing stage. The use of form liners greatly reduces the onsite labor costs associated with carving patterns onto the building. Plus, the form liner will allow the designer to easily duplicate the exact design many times on the

two-dimensional pictures can now be expanded onto the wall to produce three-dimensional works of art. Figure 14 shows the combination of fractured fin texture with smooth 3D graphics.



Figure 14 – Completed Oil Well/Cotton Mural, Texas DOT

### *Surface Modeling*

Custom form liners can be created from accurately machining 3D images. Figure 15 shows a 3-D rendering of a rosette for a cast pillar. As you can see, the computer

rendering on the left side of the picture accurately portrays the look of the concrete before any concrete is ever poured. Sophisticated computer software and milling machines can produce elaborate 3-D graphics to be utilized in the master moldwork, which is incorporated in the production of form liners.



Figure 15 – Computer Rendering (Left) – Finished Concrete Pillar



### *Photo-Engraved*

Photo-engraved concrete is also possible using form liners. Figure 16 shows actual concrete wall panels that have been engraved using an elastomeric formliner. Photo-engraving is a technique that creates a series of grooves with varying widths and depths. These grooves cast shadows onto the wall, thus producing an image on the concrete.



Figure 16 - Sugar Hill, Harlem NYC, NY