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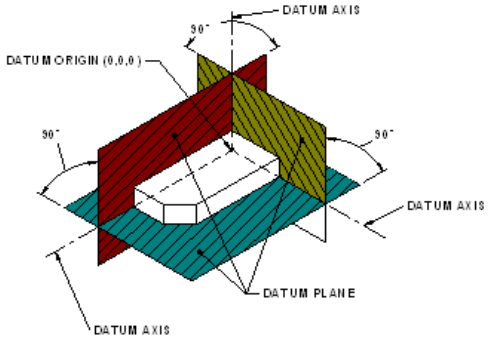

An Introduction to Roofing Systems

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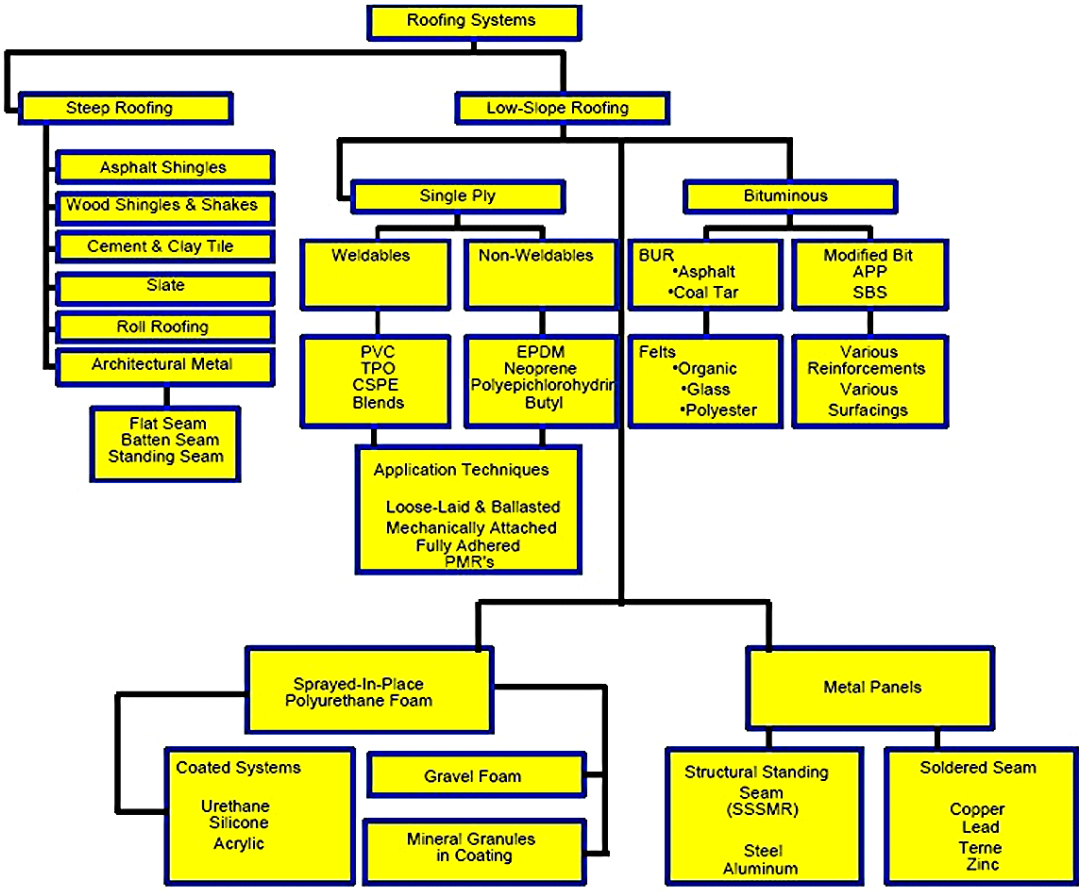
CONTENTS

1. STARTING POINTS FOR ROOF SYSTEM SELECTION. This Chapter is intended to introduce the major considerations in selecting a roofing system. Figure 1 depicts the various alternative roofing systems and how they relate. When commencing the selection process there are two different starting points.



Material and Roofing System Options

Figure 1

1.1 New vs. Reroofing. The roof may be part of a new building design; or, it may involve the reroofing of an existing structure (replacement or re-cover). Today, approximately 75% of roofing activity is reroofing.

1.2 Steep-Slope vs. Low-Slope. In new construction the designer is very likely to have a preconceived notion as to whether a highly visible *sloped-roof* is wanted, or whether a less visible *low-slope* roof design is acceptable. Positive drainage is a very important design criterion. When reroofing, it may be feasible to improve drainage by using tapered insulation or sloped deck fills.

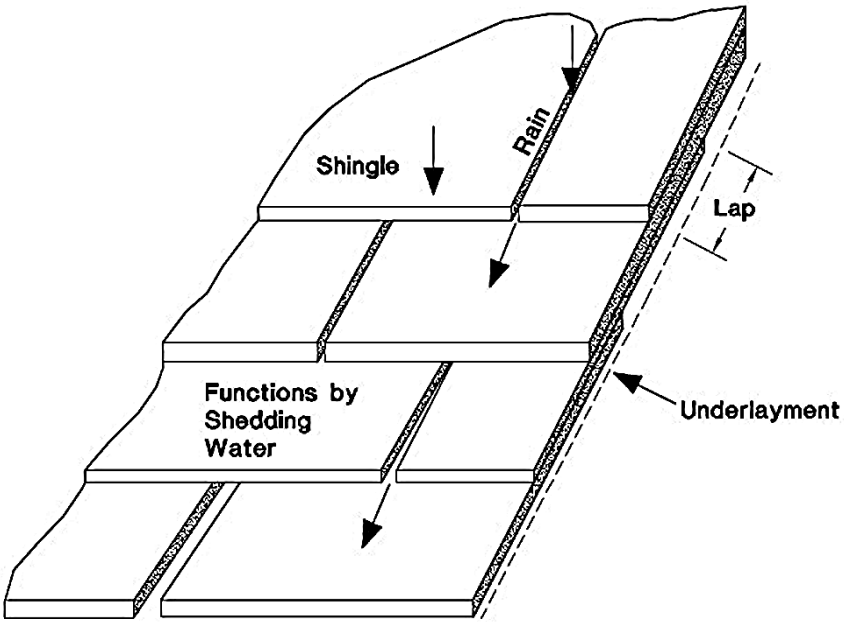
2. SELECTION CONSIDERATIONS FOR STEEP ROOFING SYSTEMS. Table 1 evaluates common steep roofing systems based upon some use criteria.

2.1 Aesthetics. Steep roof systems make a strong visible statement about a building. The texture, shadow-line, and color are major factors in selection.

2.2 Minimum Slope Requirements. Steep roofs function by shedding water rather than by being waterproof (Figure 2). Minimum slopes as shown in Table 13, are required in order to insure proper drainage.

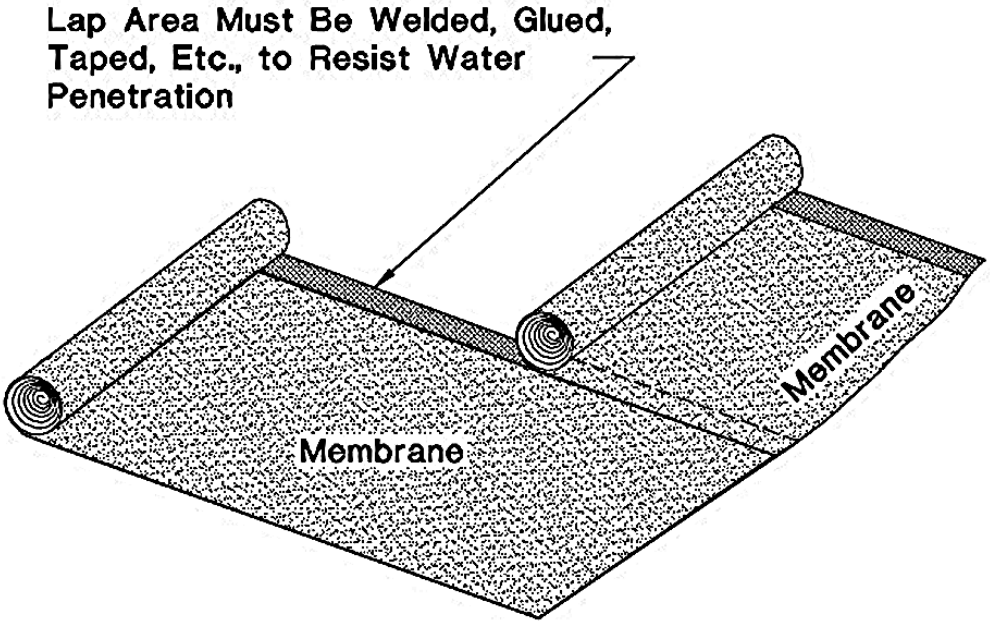
2.3 Categories of Steep Roofing. Major categories of steep roofing include asphalt shingles, wood shingles and shakes, tile, slate, architectural metal, asphalt roll roofing, and fabricated units of metal or plastic intended to look like the others. Only asphalt roll roofing and asphalt or wood shingles may be re-covered.

2.4 Snowshedding and Ventilation. Sloped roofs are effective snowshedders. In addition, the attic space that accompanies steep roofing makes it easy to ventilate the roofing system.



Steep Roofing (hydrokinetic)

Figure 2



Low-Slope (hydrostatic)

Figure 3

2.5 Maintenance Requirements. Sloped roofs in general, require less maintenance than flat roofing systems.

2.6 Steep Roof Conversions. When considering reroofing a flat roof, it may be possible to convert the low-slope roofing system to a steeply sloped roof. This may improve the appearance of the building while resolving drainage problems as well. Steep roof conversions are a viable option for relatively narrow buildings.

	Asphalt Shingles			Asphalt Roll Roofing	Clay Tile	Concrete Tile
	Strip/Seal Down Interlocking	Laminated				
Severe Cold	Fair	Fair	Good	Fair	Poor	Poor
High Temp & Humidity	(e)	(e)	(e)	Fair	Fair/Good	Fair/Good
Severe Hail	Fair	Fair	Fair	Fair	Poor	Fair
Severe Wind	Fair	Fair	Good	Fair	(a)	(a)
Can Be Re-covered	Good	No	Good	Good	No	No
Appearance	Fair	Good	Fair	Fair	Good	Good

	Slate	Arch. Metal	Crafted Metal	Wood Shakes	Wood Shingles	Metal Look-Alike
Severe Cold	Fair	(c)	(d)	Poor	Poor	(c)
High Temp & Humidity	Fair/Good	Fair/Good	Fair/Good	(f)	(f)	Fair/Good
Severe Hail	Fair	Fair	(g)	Thickness	Poor	(g)
Severe Wind	Good	(b)	(b)	Thickness	Fair	(g)
Can Be Re-covered	No	No	No	No	Maybe	No
Appearance	Good	Good	Good	Good	Fair	Good

(a) Requires nose clips, extra fastening
(b) Depends upon gauge, clips design, closures
(c) Requires sealed underlayments
(d) Requires soldered joints, special detailing
(e) Algae resistance is available
(f) Treated wood needed
(g) Heavier gauge better

Steep Slope Selection Based Upon Use Criteria

Table 1

3. SELECTION CONSIDERATIONS FOR LOW-SLOPE (MEMBRANE) ROOFING.
Membrane roofing is typically used on commercial buildings where the minimum slopes required by steep roofing render them impractical for larger buildings. Low-slope membrane systems are completely sealed at laps and flashings (Figure 3) and can temporarily resist standing water conditions. Choices for membrane roofing include multi-ply bituminous built-up (BUR), polymer-modified bituminous (MB), elastomeric

single-ply systems (e.g., EPDM), thermoplastic single-ply systems (e.g., PVC or TPO), sprayed-in-place polyurethane foam (SPF), and some metal (hydrostatic/low-slope/SSSMR) systems. Designers frequently select low-slope roofs when the roof is expected to accommodate rooftop equipment. With the exception of foam and metal, all low-slope systems can be incorporated into Protected Membrane Roof (PMR) designs.

4. REROOFING AND RE-COVERING.

4.1 Reroofing. The term *replacement* is used when the existing roofing system is to be either partially or totally removed and a new system installed. The designer should consider any existing problems and whether drainage and thermal performance needs to be improved. Existing surfaces such as walls and curbs may be contaminated with bitumen, which might affect compatibility with some reroofing options. Additional concerns (as compared to new roofing) include whether the existing structure can handle a significantly heavier roof system and whether construction activities of the reroof system will affect the occupants of the building (i.e., fumes, falling debris, and noise).

4.2 Re-cover. The term *re-cover* is used when a new roofing system is to be superimposed directly over an existing system. In this case, underlying conditions are obscured making assessment of their condition more difficult. Additional concerns include how the re-cover system will be attached to the existing membrane or roof deck, and compatibility with the substrate. The potential for trapped water between the old and new membrane may suggest the use of venting base sheets and/or roof vents.

5. ENVIRONMENTAL ISSUES. A relatively new design criterion is whether the roof system under consideration meets *green* criteria, such as whether the system incorporates postconsumer waste or is itself recyclable at the end of its useful life. Roof system waste is bulky and puts a great strain on waste disposal sites. Energy efficiency is also important in terms of raw materials acquired, production of finished goods, and application of the roof system. Thermal performance in service and retention of thermal

value with age are equally important. A *sustainable* or *robust* roof is highly desirable as extension of the life of the roof contributes to overall conservation. High albedo (reflective) roofs may improve localized climate conditions. The felt used in asphalt organic shingles consists primarily of recycled wastepaper, wood chips, and sawdust. Asphalt itself is a by-product of petroleum refining. Wood fiber and perlite roof insulation contain waste paper. Glass fiber and asphalt organic shingles have been recycled into asphalt curbing and the like. Wood shingles and shakes can be recycled into garden mulch. Steel and aluminum contain recycled scrap and at the end of their life, metal panels can be recycled back into scrap. Tables 2 and 3 compare environmental considerations for steep and low-slope roofing systems.

	Used Recycled Material	Minimize Health Risk	Maint/ Repair (e)	Recyclable Reusable	Typical Durability	Re-cover w/o Removal
Asphalt Shingles						
Strip/Seal-Down	Yes	Yes	Easy	No (b)	15	Yes
Laminated	Yes	Yes	Moderate	No (b)	20	No
Interlocking	Yes	Yes	Easy	No (b)	15	Yes
Asphalt Roll Rfg	Yes	Yes	Easy	No (b)	10	Yes
Clay Tile	No	Yes	Moderate	Reusable	50	No
Concrete Tile	No	Yes	Moderate	Reusable	50	No
Slate	No	Yes	Moderate	Reusable	50	No
Architectural Metal	Yes	Yes	Moderate	Yes	(d)	No
Crafted Metal (Soldered)	Yes	Yes (a)	Moderate	Yes	25	No
Wood Shakes	Renewable	Yes	Easy	(c)	15	No
Wood Shingles	Renewable	Yes	Easy	(c)	15	Yes
Metal Look-Alikes	Yes	Yes	Moderate	Yes	(d)	No

(a) Lead-free solder.
(b) Economics not favorable at this time.
(c) Shred into mulch or incinerate.
(d) Finish may be warranted for 20 yrs.
(e) Ease of replacing damaged units.

Preserving the Environment – Steep Roofing

Table 2

	Use RecycledMaterial	Reuse Production Scrap	Minimize Health Risk	MaintainableSustainable	Recyclable at End of Life
Built-Up Roofing		Dry Felt			
Smooth	Yes		Good	Easy	No (d)
Capsheet	Yes		Good	Fair	No (d)
Aggregate	Yes		Except Tar	Difficult	No (d)
Modified Bitumens					
Unsurfaced	No		Good	Easy	No (d)
Capsheet	No		Good	Fair	No (d)
EPDM		Non-vulcanized			
Adhered	No		Good	Easy	No (e)
Mechanically Fastened	No		Good	Easy	No (c) (e)
Ballast	No		Good	Fair	No (c) (e)
PVC Plasticized		Recycle Trim			
Mechanically Fastened	Maybe		Good	Easy	Maybe
Fully Adhered	Maybe		Good	Easy	Maybe
Weldable Unplasticized		Unreinforced			
Mechanically Fastened	No		Good	Easy	Maybe (c) (e)
Fully Adhered	No		Good	Easy	Maybe
Ballasted	No		Good	Fair	Maybe (c) (f)
SPF	No	No	Once set	Easy	No
Hydrostatic Metal	Yes	Yes	Yes	Fair	Yes

(a) Ballast could be reusable if cleaned and screened. Currently not done.
(b) Polystyrene insulation in unadhered applications could be cleaned and reused.
(c) Lightgard® pavers could be reused.
(d) BUR scrap, asphalt, felt and aggregate could be recycled into curbs or into low grade paving if economics were more favorable.
(e) EPDM could be reprocessed to extract oil, carbon, if economics were more favorable.
(f) Aggregate could be washed and screened to remove fines.

Preserving the Environment – Low-Slope Roofing

Table 3

6. DETAILED INFORMATION. Once a tentative roofing system selection has been made using information provided by this discussion.

7. USING PRINCIPAL DESIGN CONSIDERATIONS TO REDUCE THE NUMBER OF POSSIBLE ROOF SYSTEMS.

7.1 Principal Design Considerations. Tables 4 and 5 list some of the principal design considerations in roof system selection. An explanation of the headings follows the tables. These tables are not all-inclusive but contain many criteria that the designer can consider to reduce the myriad of choices. Systems that fail to meet the principal project

design criteria can be quickly disqualified from further consideration. For example, if an existing structure has reached its design load limit, then heavier roofs (such as ballasted single-ply roofs or concrete tiles) would have to be disqualified (or the structure would have to be strengthened at significant cost).

Steep Sloped Roofing Systems	Initial Cost	LCC Cost	Construction Difficulty	Inspec. & Repair Difficulty	Life Years
Asphalt Shingles	L	L	L	L	15+
Wood Shingles	M	M	L	M	15
Wood Shakes	M	M	L	M	15
Slate	H	M	M	M	50
Concrete Tile	H	M	M	M	50
Clay Tile	H	L	L	M	50
Architectural Metal	H	L	L	M	20
Crafted Metal (Soldered)	H	M	H	M	50

Steep Sloped Roofing Systems	Suitable For Cold	Suitable For Hot	Wind Hail	Traffic Resist.	Resist Chem.
Asphalt Shingles	M	M (d)	M (c)	M	L
Wood Shingles	L	M (e)	L	L	L
Wood Shakes	L	M (e)	M	L	L
Slate	M	H	M	L	H
Concrete Tile	L	H (b)	M	L	M
Clay Tile	M	M (b)	H	L	M
Architectural Metal	M	H (a)	H	M	L
Crafted Metal (Soldered)	M	H	M	M	H (f)

L = Low, M = Medium, H = High
(a) Use heat-resistant underlayments.
(b) Requires nose clips and ties for high winds.
(c) Use extra nails and may require field application of tab cement or use of interlocking shingles.
(d) Use fungus resistant granules.
(e) Use rot-resistant (treated).
(f) Depends upon metal selected.

Principal Design Considerations—Steep Roofing

Table 4

Low-Slope Roofing Systems	Initial Cost	LCC Cost	Constuc-tion Difficulty	Insp. & Repair Difficulty	Life Years
BUR					
Smooth	L	M	L	L	15
Cap Sheet	L	M	L	L	15
Aggregate	M	L	L	M	20
MB	L	M	L	M	15
Single-Ply					
Mechanically	M	M	M	L	15
Adhered	M	M	M	L	15
Ballasted	L	L	L	M	15
PMR/Ballast	H	L	L	H	20+
SSSMR	H	M	M	M	20
SPF	L	M	L	L	20 (a)

Low-Slope Roofing Systems	Suitable For Cold	SuitableF or Hot	Wind Hail	Ponding	Traffic Resist	Resist Chem.
BUR						
Smooth	M	L	L	L	L	L
Capsheet	L	H	L	L	L	L
Aggregate	H	H	H	H	M	L (b)
MB	M	M	M	M	M	L
Single-Ply						
Mechanically	M	H	M	M	L	M
Adhered	M	H	M	M	L	M
Ballasted	M	M	H	M	L	M
PMR/Ballast	H	H	H	L	H	L
SSSMR	M	H	M	L	L	(c)
SPF	M	H	M	M	L	(d)

L = Low, M = Medium, H = High
(a) Requires periodic recoating.
(b) Coal Tar resists petrochemicals.
(c) Zinc/aluminum vulnerable to acids, alkali, salts.
Sealants vulnerable to solvents, oils.
(d) Depends upon coating selected.

Principal Design Considerations—Low-Slope Roofing

Table 5

7.2 Discussion of Headers in Tables 4 and 5.

7.2.1 Initial Cost. This may include materials, labor, and special set-up for construction.

Initial cost may determine if the roof, as designed, is affordable. Perhaps a somewhat less expe ncreased maintena

7.2.2 Life ne maintena r the building is opper or slate roof der the mission o mple, while 45 mil EP uncture resistance with a critical mi

7.2.3 Co commodate applicatio ft. by 200 ft.) may b roof area that is brc ation surfaces, r sprayed-in-place p ding seam metal roo netal panels. T oint where the panel ls must pass thro netrations wider tha ion. Water must flow parallel to the raised seams, never over them.

7.2.4 Periodic Maintenance—(The need for periodic maintenance and difficulty of