Appendix J
Material Durability in Coastal Environments

J.1 Wood

J.1.1 Wood Foundations

Wood piles are probably the most widely used foundation material for elevated coastal residential structures. The piles are placed in the ground by impact driving, water jetting, augering, or some combination of these methods. The piles must be durable in a ground-contact environment at least and a saltwater immersion environment at most. Southern Pine and Douglas-Fir are the principal wood species used for piling.

Because no wood of natural resistance to decay is considered to have sufficient decay and infestation resistance for these exposures, piles are almost always preservative pressure-treated to at least the required ground-contact level of resistance. Wood piles must have sufficient strength and straightness to carry the weight of the structure, withstand pile-driving forces at installation, and resist the wind and wave forces acting on the building. Both round tapered timber piles and square cross-section timber piles are commonly used.

J.1.1.1 Round Tapered Timber Piles

Tapered timber piles with a circular cross section are frequently used in coastal areas. Generally, these piles are available in longer lengths than square piles, and for lengths greater than about 25 feet, it may be necessary to use round tapered piles. The larger round piles can provide a greater cross section area, strength, and stiffness than the commonly used 8-inch-square and 10-inch-square section piles. The pile size is specified by the tip or butt circumference and length. The wood species can be specified, and the *International Building Code* (IBC) and *International Residential Code* (IRC) provide allowable design stresses for each species. The IBC and IRC refer to the American Society for Testing and Materials (ASTM) D25 – *Standard Specification for Round Timber Piles* for physical specifications.

The natural form of a round pile is advantageous for pressure treatment. The sapwood, which is easier to treat than the heartwood, naturally occurs around the tree exterior. The sapwood is exposed to the treatment chemicals and absorbs the chemical to some depth, protecting the largely untreated heartwood. There will usually be sufficient sapwood thickness to allow minimum pressure preservative treatment penetration requirements to be met.

A round-section pile should bear both the wood species stamp and the preservative treatment certification in the form of a stamp, brand, or an attached certificate. The preservative treatment certification should include the American Wood Preservers Association (AWPA) name, the ground contact or better level of treatment, and the type of treatment, as discussed in more detail below.

The straightness of a round tapered pile will affect the accuracy to which the top of the pile is located after the pile has been driven. The straightness is determined by the physical warp properties of sweep and crook. ASTM D25 limits the amount of sweep and crook allowed in a pile.

Poles normally have most of their length above grade. They are normally placed with the least dimension end up, so that their tapered section is most effective in resisting axial and bending loads. That is, the axial load increases from the top down in the exposed part, and the thicker section is located near grade where the bending is maximum. Because of this configuration of the taper, poles cannot be driven, but must be placed in a drilled hole and backfilled. It is unlikely that pole construction would be found in V zones; pole construction would be possible in A zones.

J.1.1.2 Square-Section Timber Piles

In some locations, square section piles are preferred over round piles because of cost, availability, and ease of framing and connecting the structural beams to the piles. The most widely used square piles are the full-sized undressed (rough) 10-inch and 8-inch-square members. The latter size is the minimum size generally approved for use in coastal high hazard areas. The 10-inch-square piles provide a greater axial and bending capacity than 8-inch-square piles, and some local jurisdictions require the larger 10-inch-square piles.

Square section piles are produced and structurally graded under the “post and timber” lumber grading classification. Like all sawn lumber, square section piles are cut from the log section. Knots in the log will either become edge knots or center knots in the pile, depending on their location. With an edge knot, the wood that had wrapped around the knot has been cut away, so the knot presence weakens the member, especially in bending. This will be reflected in the structural grading of the member. Figure 12-79, in Chapter 12 of this manual, illustrates a failure of a square wood pile at a edge knot.

A square-section pile should bear both the structural grade stamp and the preservative treatment stamp. The structural grade will be Select Structural, No.1 or No.2, in order of decreasing allowable design stresses and stiffness.

The lower structural grades allow more and larger knots and more grain slope and warp. The preservative treatment stamp should include the AWPA name, the ground-contact or better level of treatment, and the type of treatment, as discussed in more detail below.

In a sawn square-section member, both sapwood and heartwood can be exposed at the surface. The pressure treatment is taken better by the exposed sapwood than by the exposed heartwood. The resulting preservative treatment for a square pile can thus be less effective than for a round pile. Ordering Marine Framing of Seawall Grade is one sure method of obtaining a sawn member with no exposed heartwood.

J.1.1.3 Exposed Wood Beam and Girder Construction

Typically, wood horizontal beams and girders are connected to the top of the wood piles to support the floor framing of the building. These members are often fully or partially exposed to salt spray and precipitation if not saltwater immersion. The selection of materials for these members for strength and durability considerations is critical. These members can be solid sawn timbers, glue-laminated timbers, or built-up sections.

The IBC and IRC require that wood of natural resistance to decay or treated wood be used for those portions of structural wood members that are exposed to the weather to prevent moisture or water accumulation on the member surface or at the joints between members. This requirement is excepted when climatic conditions preclude the need for durability, a condition unlikely at coastal sites. Thus, lumber of natural resistance to decay or lumber that has been pressure-treated for above ground exposure, but not necessarily for ground contact, should be used for exposed wood beam and girder construction.

J.1.1.4 Solid Sawn Timbers

Solid sawn timbers, in 4-, 6-, or 8-inch nominal widths and 6- to 18-inch depths, can be used for exposed wood beam and girder construction. It is unlikely that structurally graded lumber of natural resistance to decay will be available in these larger sizes, so lumber that has been pressure-treated for aboveground or better exposure is the most available choice. Like piles, each timber should bear both the structural grade stamp and the preservative treatment stamp, brand, or certificate. The structural grade will have a designation such as Select Structural, No.1 or No.2, in order of decreasing strength. The pressure preservative treatment stamp should include the AWPA name, the aboveground or better level of treatment, and the type of preservative.

The type of pressure preservative treatments available for solid sawn timbers are the waterborne arsenicals, such as Chromated Copper Arsenate (CCA), and the oil-borne treatments, such as creosote or pentachlorophenol. The choice of treatment will depend on availability and the enclosure within the residential envelope. Wood pressure-treated with waterborne arsenical preservatives may be used within residential interiors. Creosote and pentachlorophenol-treated sawn wood timbers should not be used where any part will be within the residential interior, or where frequent or prolonged contact with bare skin is anticipated.

Both treated and untreated solid sawn timbers usually have a high water content when they are sold. As the timber dries, it will shrink to about 92 percent of its wet dimension. This shrinkage must be anticipated in the construction. The shrinkage will usually be accompanied by the formation of checks and splits in the wood. The checks and splits have been anticipated in the strength characteristics of the timber, but their presence may be visually objectionable to some. They are less likely to form in the glue-laminated and parallel-strand lumber discussed below.

J.1.1.5 Glue-Laminated/PSL/LVL Products

Glue-laminated timbers are usually manufactured by gluing together horizontal layers of dried nominal 2x lumber to form a deeper beam section. They have the advantage of being available in many widths, depths, lengths, and strength ratings. Their shrinkage is minimal compared to sawn wood members.

Parallel-strand lumber (PSL) is made from long, thin strands of wood bonded together in a microwave process. This product can be produced in long, large cross-sections to reduce splices or columns in large layouts. Laminated-veneer lumber (LVL) is constructed of sheets of thin veneer in order to create long spans and stronger cross-sections.

The IBC and IRC state that the portions of structural glue-laminated timbers that are exposed to weather are to be preservative pressure-treated or be manufactured of naturally durable or pressure-treated wood. Glue-laminated timbers can be fabricated so that only the part intended for exposure is of a durable wood such as heart cedar or redwood.

The only type of pressure preservative treatments usually available for glue-laminated timbers is pentachlorophenol in a light solvent. Pentachlorophenol-treated glue-laminated timbers can be placed within residential interiors if two coats of appropriate sealer are applied. Unsealed pentachlorophenol treated glue-laminated timbers should not be used where frequent or prolonged contact with bare skin is anticipated.

An important consideration of treated sawn and glue-laminated timbers is that the treatment does not penetrate the full cross-section of the wood. Cuts, bores, and deep checks formed after treatment must be field treated so as not to expose untreated wood within the section. In contrast, PSL provides an advantage in the depth of treatment obtainable. PSL is made of wood strands (about the size of an ice cream bar stick) glued together parallel and under pressure to form the timber. Preservative-treated PSL has treatment through about 90 percent of its cross section. This makes it less susceptible to decay caused by the penetration of water at cuts and bores.

J.1.1.6 Built-Up Members

Beams can be built up using 2x nominal treated lumber pieces of appropriate depth placed vertically and bolted or nailed together. All members of the built-up beam should be continuous between supports, because splices materially reduce strength. Each piece of lumber should have little or matching crook (strong-axis warp) so that the assembled pieces are aligned. The treated lumber pieces should be dried to below 19-percent moisture content before the built-up member is assembled. Unless it is certain that the building construction will not allow water to enter and be retained between the pieces of these built-up members, the wood pieces should preferably be treated to the ground-contact retention level rather than the above ground level.

J.1.1.7 Decking

Decking wood is usually 2x4, 2x6, or 5/4x6 material. Because this wood will be in frequent contact with bare skin, wood pressure-treated with creosote or pentachlorophenol should not be used. Wood treated with the waterborne arsenicals is often used, although it may be objectionable to some.

Woods of natural resistance to decay may be used. These include redwood, cedars, and some oaks. This material is ideal in that it has decay resistance through full heartwood thickness of the member. In all of these woods, only the heartwood is resistant; this consideration is often not made evident in promotional literature. For example, redwood grades with “heart” in the designation will be predominantly heartwood with natural resistance to decay. “Construction Common” redwood will be predominantly sapwood without natural resistance to decay.

Wood pressure preservative treated with waterborne copper-based products without arsenic compounds, such as Ammoniacal Copper Quat (ACQ), and oil-borne copper-based products such as copper napthenate and copper–8 quinolinolate, may be used, with some reduction in durability. These treatments are often considered more evironmentally friendly than the arsenicals.

Composite wood members, usually manufactured of recycled plastic and sawdust, is another decking choice. These materials have decay resistance through their full thickness. They are available commercially (e.g., Trex, Re-Source) in a 2x4 size for various joist spacing span ratings.

J.1.2 Preservative Pressure Treatment of Wood

Wood piles that will not be completely submerged in water are pressure-treated with preservative chemicals that make them more resistant to decay, insect infestation, and marine borer degradation. The piles are often incised with parallel-to-grain cuts for better preservative penetration. The AWPA sets standards for preservation treatment of all wood products, including piles. Treatments are prescribed for various levels of durability such as above ground exposure, ground contact, and marine (saltwater). Treated wood piles not bearing the AWPA certification may not be as durable.

Pressure preservative treatment of round piles subject to ground contact should conform to the recommendations of AWPA Standards C1, C2, and C3. For round piles subject to marine (saltwater) exposure, pressure treatment should conform to the recommendations of AWPA Standards C1, C2, C3, and C18. Where marine borers are present and where the piles are close enough to the seawater to be wetted, AWPA Standards C3 and C18 will recommend treatment with a waterborne preservative, a creosote preservative, or a dual waterborne preservative-creosote treatment, depending on the local marine borer hazard. Usually, round timber piles driven into sand under houses well up from the shore need only be treated to the ground contact standard and not to the much higher marine standard.

For square-section sawn piles subject to ground contact, pressure preservative treatment of piles should conform to the recommendations of AWPA Standards C1 and C2 or the higher level of protection in accordance with AWPA Standards C1 and C24. Square-section piles subject to saltwater wetting can be treated in accordance with AWPA Standards C1 and C18.

Pressure treatment preservatives used for both round and square piles fall into two general classes: waterborne arsenicals, such as CCA; and oil-borne treatments, such as creosote. Both are considered in the AWPA Standards discussed above.

Wood that has been pressure-treated with chemicals will make it more resistant to decay and infestation. The degree of resistance depends on the treatment chemical and the amount of retention in lb/ft^3 of wood. Aboveground exposure requires the least treatment; ground contact requires more, permanent wood foundations still more, and saltwater contact requires the greatest retention and chemical effectiveness.

The waterborne arsenical treatments sometimes are objected to because of their arsenic content, but studies have not conclusively found them to be harmful. In non-marine applications, once the waterborne arsenicals have been forced into the wood and the wood has dried, they are considered “fixed” chemically to the wood and not able to leach out.

An important consideration of treated wood is that the treatment does not penetrate the full cross-section of the wood. Cuts, bores, and deep checks formed after treatment all expose untreated wood within the section to moisture and infestation. Even when using preservative-treated wood, it is still important to design for minimum water retention.

The American Wood Preservers Association sets standards for preservation treatment. Wood not bearing the AWPA stamp or other AWPA certification may not be as durable as wood with the stamp. As an example of standards, the AWPA CCA retention for Southern Pine lumber in #/cu. ft. is as follows:

- 0.25 above ground
- 0.40 ground contact and fresh water
- 0.60 wood foundation and sawn timber building posts
- 2.50 salt water

The preservatives commonly used in pressure treating wood are:

- waterborne arsenicals, such as CCA and Ammoniacal Copper Zinc Arsenate (ACZA)
- waterborne products without arsenic compounds, such as ACQ
- oil-borne products such as copper napthenate and copper–8 quinolinolate
- oil-borne pentachlorophenol
- creosote

J.1.2.1 Waterborne Arsenicals

The waterborne arsenicals, such as CCA and ACZA, are the most commonly used. CCA-treated Southern Pine is widely used on the East Coast. The CCA penetrates fairly deeply into the Southern Pine and Hem-Fir species sapwood and less well into the heartwood. CCA does not work well in Douglas-Fir; ACZA is used instead of CCA on Douglas-Fir to obtain better depth of treatment and retention. ACZA is proprietary with the J.H. Baxter Co.

Wood treated with the waterborne arsenicals is usually not redried. Its shrinkage must be considered when building with it.

As of the date of this manual, there have been alleged problems with the corrosion of galvanized framing hardware and nails in contact with wood members treated with ACQ and ACZA. Designers and builders considering the use of ACQ- or ACZA-treated wood should consider using stainless steel hardware and fasteners or obtain the latest information on this condition. Wood treated with CCA has not been observed to have this alleged problem.

Wood pressure-treated with waterborne arsenical preservatives may be used inside residences as long as all sawdust and construction debris are cleaned up and disposed of after construction.

J.1.2.2 Waterborne and Oil-Borne Products Without Arsenic Compounds

Waterborne copper-based products without arsenic compounds, such as ACQ, and oil-borne copper-based products such as copper napthenate and copper–8, are often considered more environmentally friendly than the arsenicals. They have not been considered acceptably strong for the treatment of piles. Also, the aversion to arsenicals is more of a lay public reaction than a scientific fact; copper-based products may, in fact, be more harmful to aquatic life than the arsenicals. ACQ is acceptable for uses such as tabletops. Lumber pressure-treated with copper napthenate may be available for above ground applications. As discussed below, copper napthenate should be used as a field treatment of cuts and bores in pressure-treated wood.

J.1.2.3 Oil-Borne Pentachlorophenol and Creosote

Wood treated with oil-borne pentachlorophenol or creosote cannot be used within the enclosed part of a building. Pentachlorophenol is not used for salt water immersion because of leaching concerns. Pentachlorophenol and creosote may be used for above-grade glue-laminated beams under the enclosed portion of the structure. Pentachlorophenol-and creosote-treated timbers cannot be painted. Fasteners used in the oil-borne-treated products are not corroded by the wood contact as in the waterborne products. In the presence of certain marine borers, there is a dual CCA-creosote treatment.

Wood treated with creosote should not be used where it will be in frequent contact with bare skin (e.g., chairs and other outdoor furniture) unless an effective sealer has been applied. Creosote-treated wood should not be used in residential interiors.

As possible, design for “preframing,” where members are cut and bored prior to pressure treatment, in order to reduce or eliminate the need for field treatment. This is likely not feasible on small jobs, where pressure-treated lumber used is “off-the-shelf” in standard lengths, and quantities are too small to justify pressure treatment of finished members. Preframing is also impractical for piles driven to uncertain depths. Preframing is worth considering for larger jobs, because pressure treatment is much more effective than field treatment. Contact local treating plants for information.

J.1.3 Wood With Natural Resistance to Decay

Species of wood with natural resistance to decay include redwood, cedars, some oaks, and bald cypress. Old growth trees have more natural resistance than do second growth trees. This material is ideal in that it has decay resistance through full heartwood thickness of the member. In all of these woods, only the heartwood is resistant; this consideration is often not made evident in promotional literature. For example, redwood grades with “heart” in the designation will be predominantly heartwood with natural resistance to decay. “Construction Common” redwood will be predominantly sapwood without natural resistance to decay. No wood with natural resistance to decay is considered by the model codes to have sufficient decay resistance for ground contact or partial water immersion. Building codes require that heartwood of “Foundation Grade” be used for sill plates on concrete.

Woods with natural resistance to decay are increasingly hard to obtain. It is also difficult to find these woods in the structural grades. For example, redwood heartwood is only available in 2x6s and 2x8s in the open grain No. 2 structural grade. These woods can be used in aboveground applications in coastal construction.

J.1.4 Wood – Plastic Composite

Composite wood of plastic and sawdust has decay resistance through full thickness. It is available commercially in 2x4s for decking.

J.1.5 Selection of Materials for Construction Within the Building Envelope

The choice of materials for the framing within the building envelope is important. This framing must serve both aesthetic and structural functions. It must remain straight and true to provide acceptable plane surfaces for interior and exterior sheathing. The framing and its connectors must provide a strong load path from the sheathing through the building to the foundation for large wind and seismic forces; if properly elevated, the building should not be subject to flood forces. Within the building envelope, the lumber need not be resistant to decay or infestation unless a high probability of termite infestation is feared. In a building with a non-elevated foundation, wood defined by the IBC and IRC to be in close proximity to the ground must be resistant to decay.

The framing within the building envelope will be mostly 2x members, with some 4x or 6x members. The framing is usually of sawn wood lumber, although manufactured lumber is increasingly available. The strength and stiffness of sawn wood members depends on the clear wood strength for the wood species, the wood density, the knot placement and size, and the grain slope. These characteristics are observed at the sawmill and the wood piece is stamped with an appropriate structural grade. Higher grade sawn lumber also has less allowable warp, an important aesthetic consideration. The strength and trueness of manufactured wood members, further described below, are more uniform.

In the eastern United States, most 2x lumber is sold dried to less than 19 percent moisture content. On the west coast, Douglas-Fir 2x lumber is usually sold "green," with a high moisture content. In all regions, 4x and larger lumber and lumber treated with waterborne preservatives is sold with a high moisture content. Lumber with a high moisture content will shrink about 8 percent across the grain, and this should be anticipated.

Wood pressure-treated with a waterborne preservative may be chosen, especially for first floor framing, in areas with high termite infestation incidence. The IBC and IRC require that wood pressure-treated with a waterborne preservative and used in enclosed locations be at a moisture content of 19 percent or less before being covered. Compliance with this provision may be difficult with 4x members or with tight construction schedules. Pressure-treated wood that is kiln dried after treatment (KDAT) is difficult to find. One solution is to stack the "wet" treated wood with spacers (stickering) in a protected and ventilated location to dry it for several weeks before its use.

Joists and rafters within the building envelope are usually of 2x sawn wood lumber. Joists must be sized for both strength and live load deflection. Many builders choose to exceed the code requirements for deflection to avoid complaints of springy floors. There is usually a choice to be made between higher structural grades with shallower depths or lower structural grades with greater depth. Rafters supporting plaster or gypsum board ceilings must also be sized for both strength and roof live load deflection. Rafters must also be sized for considerable wind uplift loads.

A type of joist coming into increasing use is the wooden I-beam, manufactured with sawn or manufactured wood flanges and a plywood or oriented strand board (OSB) web. I-beam joists are lighter and can be produced in longer lengths than standard lumber; the thin webs simplify the installation of wiring and plumbing through the webs. Depths of these members typically range from 8 to 30 inches with flange widths up to about 3-1/2 inches. Typically available lengths range up to 36 feet.

Metal-plate-connected wood roof trusses are commonly used for coastal residential construction. Their use in coastal construction must consider the increased wind speeds. All inward, outward, and uplift wind forces acting on the main spans and the eave projections of trusses must be carefully considered in their design and fabrication. Metal-plate-connected floor trusses are also increasingly used (similar to wooden I-beam joists) to increase the spans of the members and eliminate support beams and columns.

Lumber for the various framing members in a shearwall must be selected with care. The shearwall capacity tables in the building codes assume the wood density of Douglas-Fir or Southern Pine framing. If wood members with lower density are used, such as treated Hem-Fir species sill plates, the allowable shearwall capacity values when "Structural 1" grade plywood is used must be adjusted down from the capacity table values.

J.1.6 Shearwall Sheathing for Wind and Seismic Forces

The Uniform Building Code allows a variety of sheathing materials in the Conventional Construction provisions. Because these provisions cannot be used where the design wind speeds exceed 80 mph (fastest mile), most coastal construction cannot be built to these provisions and will require high-capacity shearwall sheathing. The high-capacity sheathing material choices include both those that can also act as the building envelope, and those that are placed behind the building envelope. Panels rated "Exterior" can withstand permanent exposure. Panels rated "Exposure 1" can withstand only exposure during construction.

High-capacity sheathing materials that also act as the building envelope include plywood panels with suitable exterior finishes. Those that are placed behind the building envelope include plywood and OSB structural panels. A "Structural 1" panel with higher shear capacity is available for more demanding locations.

J.1.7 Subflooring

Wood structural panels are typically used for subflooring and to create the floor horizontal diaphragm for lateral load collection and distribution. The wood structural panels may be of plywood or OSB. Panels rated "Exposure 1" can withstand exposure during construction. The compatibility of OSB panels with the floor finishes to be placed over them should be checked. Guidelines for thickness and methods of attachment in relation to joist spacing can be obtained from the Engineered Wood Association. The requirements for panel orientation, nailing, and blocking to achieve the needed horizontal diaphragm capacity are given in the building code.

J.2 Reinforced Concrete

Reinforced concrete foundations (including walls, columns, piers, piles, and prestressed elements) may be used in coastal construction, particularly in A zones and in areas where wood piles cannot readily be driven or in cases where the superstructure is going to be constructed of concrete, masonry, or a combination of these materials. As an example, in the Florida Keys, concrete foundations are often socketed into a hole augered into the limestone or other bedrock. The concrete mix selection is an important factor in obtaining durable reinforced concrete in many different environments.

Reinforced concrete typically has 1-1/2 or 2 inches of concrete over the steel reinforcement. This concrete cover, specified by the American Concrete Institute (ACI), must resist both the salt-laden and the freeze-thaw environment. Usually, the steel reinforcement is protected against corrosion by the thickness of the concrete cover and the concrete's natural alkalinity. In a coastal environment, chloride ions may penetrate the concrete cover over the reinforcement, lowering the alkalinity and allowing the steel to corrode. The expansion of the corrosion cracks and spalls the concrete cover, allowing more salt penetration and corrosion. Thus, concrete mixes for coastal construction must have superior durability properties to resist this action in addition to the required strength properties.

The IBC and IRC require that the durability of a concrete mix subjected to salt intrusion be enhanced by a higher design strength and a lower water-cement ratio. Admixtures for the mix can be chosen to reduce the mix water-cement ratio for improved durability while maintaining workability. Both the coarse and fine aggregates should be chosen for even gradation and to avoid chemical reactions. If this durable concrete mix is correctly batched, placed, and cured, it is much less likely that the chloride ions will penetrate the concrete cover and cause the steel to corrode.

Usually, standard bare reinforcing steel is used in coastal concrete construction with acceptable results if the concrete mix is selected in accordance with the guidelines given above and the placement is done in accordance with the guidelines in Chapter 16 of the IBC. The reinforcing steel should be free of loose corrosion and salt at the time of placement. Additional durability may be achieved by using epoxy-coated reinforcing steel as designed and specified by a qualified engineer.

Concrete piles are commonly used in coastal mid- to high-rise structures when higher capacity or longer length is required than is available in round wood piles. In some coastal areas, concrete piles are also routinely used for elevated single-family structures. Concrete piles are also used where termite infestation of even preservative-treated wood piles appears likely. Concrete piles are normally precast offsite, with either conventional or prestressed reinforcement, and are available in a variety of sizes and lengths. The concrete piles used must be suitable in durability characteristics for a coastal environment. Concrete piles cannot easily be used for elevated structures in the higher seismic zones because the seismic requirement for close stirrup confinement reinforcement in a vertical member is difficult to achieve in a concrete pile.

J.3 Steel Foundations

Steel piles and sheet piles are commonly used in industrial waterfront construction, but their use has been limited in residential coastal construction. Most steels corrode in a salt-laden environment and thus require a protective coating. Even the weathering steels are not immune to corrosion. Certain stainless steels under the right conditions are resistant to corrosion, but their cost and other considerations make them unsuitable for foundation elements. Steel piles may be considered where dense soils or gravels make the placement of concrete or wood piles difficult.

J.4 Masonry Foundation, Pier and Wall Construction

As in concrete construction, salt-laden moisture entering reinforced masonry construction through cracks, defects, or a thin masonry or concrete cover can cause the steel reinforcement to corrode, leading to spalling and loss of strength. Therefore, the choice of masonry unit, mortar, grout, and reinforcement materials is critical.

For concrete masonry units, choosing Type I “moisture controlled” units and keeping them dry in transit and on the job site will minimize shrinkage cracking. Usually, for optimum crack control, Type S mortar would be chosen for below-grade applications, and type N mortar used for aboveground applications. Horizontal ladder-type joint reinforcement, when used, is placed close to the wall surface in the mortar joint and is therefore vulnerable to corrosion. This reinforcement, and other metal reinforcement accessories, should be hot-dip galvanized. Distributed horizontal and vertical reinforcement, which should have at least 2 inches of masonry shell and grout cover, may be of plain steel with all loose corrosion and salt removed. The IBC and IRC require, as a minimum, certificates for the materials used in masonry construction indicating compliance with construction documents.

Reinforced masonry and concrete constructed as foundation walls must be supported by either a concrete footing or pile in order to transfer the dead, live, and environmental loads to the soil. When a footing is used, the footing must be placed on undisturbed soil with a bearing capacity sufficient to support the building loads with minimal and/or differential settlement. The footing should be reinforced with sufficient concrete cover as discussed above.