



# APPENDIX C CODE CHANGE PROPOSAL NORTH CAROLINA BUILDING CODE COUNCIL

**B-2**

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Petition for Rule Making

Item Number \_\_\_\_\_

Granted by BCC \_\_\_\_\_  
Denied by BCC \_\_\_\_\_

Adopted by BCC \_\_\_\_\_  
Disapproved by BCC \_\_\_\_\_

Approved by RRC \_\_\_\_\_  
Objection by RRC \_\_\_\_\_

PROPONENT: David B. Rittlinger PHONE: (919) 647-0008  
REPRESENTING: NC Office of State Fire Marshal: Codes and Interpretations Section  
ADDRESS: 1429 Rock Quarry Road, Suite 105  
CITY: Raleigh STATE: NC ZIP: 27610  
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## 2024 NC Building Code, Section 3608 Docks, Piers, Bulkheads and Waterway Structures in Estuarine Waters.

**CHECK ONE:**  Revise section to read as follows:  Delete section and substitute the following:  
 Add new section to read as follows:  Delete section without substitution:

~~LINE THROUGH MATERIAL TO BE DELETED~~

UNDERLINE MATERIAL TO BE ADDED

Please type. Continue proposal or reason on plain paper attached to this form. See reverse side for instructions.

See attached. Sections 3601 through 3607 is edited and applies to docks, piers, bulkheads and waterway structures not included in North Carolina General Assembly Session Law 2023-137, Section 35 and not in estuarine waters as defined within the definition of "Coastal Fishing Waters" within North Carolina General Statute 113-129(4). Section 3608 is edited and applies to docks, piers, bulkheads and waterway structures included in North Carolina General Assembly Session Law 2023-137, Section 35 and in estuarine waters as defined within the definition of "Coastal Fishing Waters" within North Carolina General Statute 113-129(4). Section 3608 represents a reprint of Chapter 36 of the 2009 North Carolina Building Code.

Will this proposal change the cost of construction? Decrease  Increase  No   
Will this proposal increase to the cost of a dwelling by \$80 or more? Yes  No   
Will this proposal affect the Local or State funds? Local  State  No   
Will this proposal cause a substantial economic impact (≥\$1,000,000)? Yes  No

- Non-Substantial – Provide an economic analysis including benefit/cost estimates.
- Substantial – The economic analysis must also include 2-alternatives, time value of money and risk analysis.
- Pursuant to §143-138(a1)(2) a cost-benefit analysis is required for all proposed amendments to the NC Energy Conservation Code. The Building Code Council shall also require same for the NC Residential Code, Chapter 11.

**REASON:** Code change required by North Carolina General Assembly Session Law 2023-137, Section 35 to reinstate 2009 NC Building Code, Chapter 36 Docks, Piers, Bulkheads and Waterway Structures for docks, piers, bulkheads and waterway structures built within estuarine waters.

## INSTRUCTIONS

**Each proposed Code change request shall comply with the following policies:**

**Rule 1:** The Original and twenty-two (22) copies of the proposed Petition for Rule-Making along with supporting documentation shall be filed with the Building Code Council Secretary. Submit one (1) electronic copy via email.

**Rule 2:** The filing shall be received by the first day of the month prior to the quarterly scheduled meeting date. Example: A December meeting date will require filing by November 1 prior to the meeting.

**Rule 3:** Each request shall be typewritten on this form and shall contain the following:

- (1) The proposed rule change must be set forth in full and contain explicit reference to the affected section or sections of the Code.
- (2) The request shall state the reasons for the proposed rule change with supporting documentation.
- (3) The proposed rule change shall comply with the standards set forth in GS 143-138(c) and reference to the particular standards shall be set forth in the request for the amendment.
- (4) The proposed rule change shall contain an economic impact analysis as required by GS 143-138(a).
- (5) A proposed rule change to the NC Energy Conservation Code shall have an accompanying cost-benefit analysis as required by GS 143-138(a1)(2).

**Rule 4:** When a request is improperly filed or not in accordance with all the rules listed above, the BCC Secretary shall reject the submittal and notify the applicant of the proper procedure to follow.

**Rule 5:** Upon the proper filing of a request, the BCC Secretary shall forward one copy of said request to each council member prior to the scheduled meeting date. Persons filing proposed petitions are hereby notified of the place and time of the scheduled hearings. The BCC Secretary shall cause to be published the notice of public hearing as specified in GS 143-138(a).

**Rule 6:** The Council shall either Grant or Deny the proposed Petition for Rulemaking at the meeting following receipt of the proposed rule change. The Council will take no further action on items that are Denied. Granted items may be referred to Committee for review.

**Rule 7:** The Council will hold a public hearing on Granted items at the next quarterly scheduled meeting. The Council will take final action on Granted items at the next quarterly scheduled meeting after the public hearing.

**Timeline Example**

<b>Petition received:</b>	<b>February 1</b>
<b>Petition Granted:</b>	<b>March BCC meeting</b>
<b>Notice of Hearing published:</b>	<b>April NC Register</b>
<b>Committee review:</b>	<b>May - June</b>
<b>Hearing held:</b>	<b>June BCC meeting</b>
<b>Final Adoption:</b>	<b>September BCC meeting</b>
<b>Rules Review Meeting:</b>	<b>November RRC meeting</b>
<b>Approved:</b>	<b>December 1</b>

# CHAPTER 36

## DOCKS, PIERS, BULKHEADS AND WATERWAY STRUCTURES

*This chapter is a North Carolina addition to the 2021 International Building Code.*

Sections 3601 through 3607 applies to docks, piers, bulkheads and waterway structures not included in North Carolina General Assembly Session Law 2023-137, Section 35 and not in estuarine waters as defined within the definition of “Coastal Fishing Waters” within North Carolina General Statute 113-129(4).

Section 3608 applies to docks, piers, bulkheads and waterway structures included in North Carolina General Assembly Session Law 2023-137, Section 35 and in estuarine waters as defined within the definition of “Coastal Fishing Waters” within North Carolina General Statute 113-129(4).

Section 3608 represents a reprint of Chapter 36 of the 2009 North Carolina Building Code.

### SECTION 3601

#### GENERAL AND SCOPE

**3601.1 General.** The intent of ~~this chapter~~ Sections 3601 through 3607 is to provide minimum standards for the design, construction and maintenance of docks, piers, bulkheads and waterway ~~structures~~ structures in non-estuarine waters. The guidelines in ~~this chapter~~ Sections 3601 through 3607 address minimum standards for foundations, design forces, structural integrity, material selection and utilization and construction techniques.

**3601.2 Scope.** The following structures shall be designed in accordance with the requirements of ~~this chapter~~ Sections 3601 through 3607:

1. Docks, piers, gangways and catwalks, other than residential and farm docks and piers exempted from ~~this chapter~~ Sections 3601 through 3607 in the exceptions below, shall be designed by a *registered design professional*.
2. All bulkheads having an exposed height greater than 5 feet or with a superimposed load shall be designed by a *registered design professional* and require special inspection. Special inspection shall be waived for bulkheads of any height constructed from property line to property line of one- and two-family dwellings and including attachment to neighboring bulkheads.
3. ~~Oceanfront retaining~~ Retaining walls, bulkheads and other types of retaining walls used by the public ~~on the coastline of the ocean or adjacent inlets~~ shall be designed by a *registered design professional*.
4. ~~Marine terminal~~ Terminal or port facilities in non-estuarine waters for berthing, mooring, docking and servicing ships, barges or tug boats that handle cargo of all types, including bulks, containers, liquids, fuels and people, which shall be designed by a *registered design professional* in accordance with accepted industry standards.

5. Groins not exempted below, jetties, breakwaters, ~~oceanfront seawalls~~, and ~~oceanfront~~ revetments which shall be designed by a *registered design professional* in accordance with accepted industry standards.

**Exceptions:** The following structures are exempt from the requirements of ~~this chapter~~ Sections 3601 through 3607:

1. Sill structures combined with marsh plantings and certain groins in accordance with the Department of Environmental and Natural Resources general permit requirements.
2. ~~Oceanfront and inlet sandbag~~ Sandbag revetments in accordance with the Department of Environmental and Natural Resources general permit requirements.
3. Revetments constructed on single-family residential property having a height no greater than 10 feet and slope greater than 1.5 horizontal: 1.0 vertical and in accordance with the Department of Environmental and Natural Resources general permit requirements.
4. Farm structures exempted from building rules by North Carolina General Statute 143-138(b4).
5. Piers and docks associated with one- and two-family dwellings meeting the exceptions of the *NC North Carolina Residential Code*.
6. Docks, piers, bulkheads and waterway structures included in North Carolina General Assembly Session Law 2023-137, Section 35 and in estuarine waters as defined within the definition of “Coastal Fishing Waters” within North Carolina General Statute 113-129(4).

## **SECTION 3602 DEFINITIONS**

**ADDITIVES.** Substances added to a polymer resin or vinyl chloride material to aid in processing the material.

**BOAT SLIP.** A berthing place for one or two watercraft where the watercraft can be securely moored to cleats, piling, or other devices while the boats are in the water. Boat slips are commonly configured as “side-ties” or as single- or double loaded “U” shaped berths.

**BULKHEAD.** A vertical wall structure designed to retain shoreline material and prevent erosion due to wave activity.

**CATWALK.** A narrow footway platform extending alongside a structure.

**DESIGN WAVE.** A wave that is potentially most damaging to an economically feasible structure, or wave for which a structure is designed.

**DOCK.** A structure extending alongshore or out from the shore into a body of water, usually accommodating multiple boat slips, to which boats may be moored in order to load or unload people or cargo, or to provide access to the water.

**ESTUARINE WATERS.** “The Atlantic Ocean; the various coastal sounds; and estuarine waters up to the dividing line between coastal fishing waters and inland fishing waters agreed upon by the Marine Fisheries Commission and the Wildlife Resources Commission”, as defined within the definition of “Coastal Fishing Waters” within North Carolina General Statute 113-129(4).

**EXTRUSION.** Manufacturing process whereby a material is pushed through a die to form a shape of constant cross section. Vinyl Chloride sheet piling is generally manufactured using an extrusion process.

**FETCH.** Open water exposure over which waves are generated.

**FIBER.** One or more glass, carbon, or aramid filaments in the form of a continuous strand or roving in an FRP material.

**FIBER ARCHITECTURE.** Construction of a composite material from layers with different types and orientations of fibrous material.

**FIBER ORIENTATION.** Fiber orientation is the alignment of the longitudinal axis of a fiber in an FRP material with respect to the stated reference axis.

**FIBER REINFORCED POLYMER (FRP).** A polymeric composite material consisting of reinforcement fibers, such as glass, impregnated with a fiber-binding polymer which is then molded and hardened. Fiber-reinforced polymers are permitted to contain cores laminated between fiber-reinforced polymer facings.

**FIBER VOLUME FRACTION.** The volume of reinforcement fiber in a cured composite divided by the volume of the composite section.

**FILLER.** Substance added to the matrix of a FRP material intended to alter its engineering properties, performance, and/or cost.

**GANGWAY.** A footway bridge extending from the *dock, pier, bulkhead* or shore, usually to a floating structure.

**GLASS TRANSITION TEMPERATURE ( $T_g$ ).** Temperature at which the polymer matrix of an FRP material changes from a glassy state to a rubbery state.

**KING PILE.** The primary structural member that supports horizontal panels to form a vertical wall sometimes used in bulkhead or groin construction.

**LAMINA.** A layer of fibers and resin in an FRP material.

**MARINE BORERS.** ~~Water borne organisms (mollusks, crustaceans, worms) that live in saltwater and brackish water. These organisms damage exposed timber structures and vessels. Marine borers typically enter timber and cause damage from the inside out—leaving the exterior appearing unaffected. Dimensional lumber is more susceptible to damage from marine borers than round timber piles.~~

**MATERIAL LONGITUDINAL DIRECTION.** Direction in an FRP material parallel to the direction of pultrusion (pulling) during the manufacture of a plate or structural shape.

**MATERIAL TRANSVERSE DIRECTION.** Direction in an FRP material orthogonal to the longitudinal direction.

**MATRIX.** Continuous constituent of an FRP material surrounding the reinforcing fibers and consisting of a polymer resin with any fillers and additives.

**PIER.** An elevated deck structure, usually pile supported, extending out into the water from the shore.

**PILE.** A timber, concrete, metal, or composite member embedded into the ground to support or brace a structure. “Piles” or “piling” are plural forms of “pile.”

~~**PILE WRAPS.** Protective and strengthening coverings for marine piles. Pile wraps are made of a variety of materials. Pile wraps protect timber piles from marine borers by limiting damage after they are installed.~~

**PRIVATE WATERFRONT STRUCTURES.** A *dock, pier, bulkhead*, or associated structure that does not meet the definition of *public waterfront structure*.

**PUBLIC WATERFRONT STRUCTURES.** A *dock, pier, bulkhead*, or associated structure located on residential property serving more than 10 boat slips, and on public property or commercial property.

**PULTRUSION.** Manufacturing process whereby a material is pulled through a die to form a shape of constant cross section. FRP plates and structural shapes are generally manufactured using a pultrusion process.

**RESIN.** An organic polymer possessing indefinite and often high molecular weight and a softening or melting range that exhibits a tendency to flow when subjected to stress.

**REVETMENT.** A sloping structure usually constructed of stone or concrete and placed on a shoreline to protect it against erosion by wave and current action.

**ROVING.** In an FRP material a roving is a large number of continuous parallel filaments or a group of untwisted parallel strands.

**SHEET PILE.** A pile with a generally slender flat cross section to be embedded into the ground or seabed and meshed or interlocked with like members to form a diaphragm, wall or bulkhead.

**SYMMETRIC COMPOSITE.** A symmetric composite is a composite material in which the sequence of lamina below the laminate mid-plane is a mirror image to those above the laminate mid-plane.

## **SECTION 3603 PERMITS AND APPROVALS**

**3603.1 General.** In addition to a building permit, permits may be required from federal, state or county agencies such as, but not limited to, the United States Army Corps of Engineers or the North Carolina Department of Environmental Quality. In cases of structures to be built on lakes operated by an electric utility for the generation of power, a permit from the operating utility may also be required.

## **SECTION 3604 MINIMUM DESIGN LOADS**

**3604.1 General.** Every structure shall be of sufficient strength to support the imposed dead, live, snow, wind, impact and seismic loads without exceeding the prescribed stresses for the various materials described elsewhere in this code. Adequate consideration shall be made for forces imposed by earth, water, docking and mooring.

**3604.2 Dead loads.** The weight of the component parts of a structure shall be used in the design when it will influence the strength of the structural elements. All utilities, permanent furniture, dock boxes and mooring hardware should be considered as dead load.

**3604.3 Live loads.** Design live loads shall be the greatest load that will likely be imposed on the structure, including superimposed loads on retained material which exert horizontal loads on the structure. Where vehicles are allowed, actual weight of vehicles and wheel loads as specified in the latest edition of *Standard Specifications for Highway Bridges of the American Association of State Highway and Transportation Officials* or obtained from the vehicle manufacturer shall be used. The design load shall be posted at the dock or pier approach where vehicles are allowed. Minimum live loads are:

1. Fixed piers, docks, catwalks - Private waterfront piers: 40 psf or 300 pounds concentrated load on any 2 foot by 2 foot area. Public waterfront piers: Design loads shall be the greatest combinations of loads exerted on the structure but not less than 60 psf or 300 pounds concentrated load on any 2 foot by 2 foot area.
2. Floating docks - Private waterfront docks: 20 psf, public waterfront docks: 30 psf, or 300 pounds concentrated load on any 2 foot by 2 foot area. Under dead and live load, all floating docks shall have a minimum of 3 inches freeboard from the top of the flotation device, other than low freeboard watercraft (e.g. kayak) launching facilities. Floating docks with roofs shall have a minimum of 3 inches freeboard from the top of the flotation device under a combination of dead, snow and 75% of live load. All floating docks subject to this chapter shall have not more than 6 degrees tilt from the horizontal under uniform live loading on one-half of the dock width or under concentrated load of 400 pounds applied within 12 inches of any side.
3. Gangways - Gangways shall be designed for a live load of for 100 psf. Flotation for gangway landing shall be designed for 50 psf, live load.
4. Bulkheads, revetments - Design loads shall be the greatest combinations of loads exerted on the structure. Consideration shall be given to horizontal loads exerted by superimposed loads on the retained earth and by inclined surface slopes. Superimposed loads shall be considered when exceeding 50 psf and located within a horizontal distance of three times the height of the bulkhead from the face of the bulkhead.

**3604.4 Snow Loads.** Design snow loads shall be as prescribed in Chapter 16.

**3604.5 Wind loads.** Design wind loads shall be as prescribed in Chapter 16 without moored vessels. In wind regions with a design wind speed greater than 90 mph, the design wind speed with moored vessels shall be no less than 90 mph (3 second gust). This gust wind speed shall be adjusted for duration and height (not restricted to 15 feet minimum) for wind pressures applied to vessels moored at the facility in accordance with Chapter 16.

**3604.6 Impact loads.** Design impact loads shall be as prescribed in Chapter 16 but not less than 1.25 times the kinetic energy exerted by a striking vessel or vehicle.

**3604.7 Seismic Loads.** Design seismic loads shall be as prescribed in Chapter 16. Seismic loads are not applicable for any structure exempted from design by a *registered design professional*.

**3604.8 Water loads.** Hydrostatic and hydrodynamic loadings shall be considered as follows:

**3604.8.1 Hydrostatic Pressures.** Hydrostatic pressures shall be considered in conjunction with the equivalent fluid pressure of soil and any surcharge acting on the structure. For bulkheads hydrostatic pressures shall be estimated based on maximum difference between retained and offshore water surface elevations.

**3604.8.2 Current Loads.** Current loads for structures and vessels shall be determined from records on current velocity using accepted engineering practice.

**3604.8.3 Anchorage for Uplift.** Sufficient anchorage against uplift between all components, except elements specifically designed to break away shall be provided. Resisting forces shall be not less than 1.5 times the applied uplift force.

**3604.8.4 Wave Forces.** Wave forces shall be determined from wave records where available. Where no wave records are available, the design wave shall be determined from probable wind speed, direction, fetch and water depth that will yield a critical wave. Forces shall then be calculated using accepted engineering practice.

**3604.8.5 Forces due to Passing Vessels.** All *piers*, floating *docks*, *bulkheads* and revetments shall be designed for water loading generated by wind and passing vessels. Adjacent to federal designated channels, water loading shall be based on commercial and recreational vessels with minimum passing speeds of 10 and 20 knots, respectively.

**3604.9 Earth loads.** Lateral earth pressures shall be determined by considering the specific soil properties and applying earth pressure theories generally accepted for soil mechanics in engineering practice. A geotechnical investigation or other adequate consideration shall be given by the *registered design professional* for the effect of probable varying levels of retained water, tide and flood water. Pressures exerted by the earth shall be checked for dry, moist, and saturated conditions as applicable.

**3604.10 Erosion.** The effects of reasonably predictable erosion, propeller wash-induced scour, and wave-induced scour shall be given ample consideration.

**3604.11 Water Levels.** The ability to accommodate dead, live, wind, current and wave loadings for the range of water levels (from low water to base flood level) anticipated at the site shall be given ample consideration. For public and private floating docks, guide piling systems shall be capable of accommodating water levels extending a minimum of 2 feet above base flood elevation plus the freeboard of the dock structure.

## SECTION 3605 MATERIALS

**3605.1 General.** The quality of materials and fasteners used for load-supporting purposes shall conform to good engineering practices.

**3605.2 Piling and Foundations.** Materials used for piling and repairing piling shall comply with applicable provisions of Chapter 18 and the material requirements of Sections 3605.3 through 3605.7.

**3605.2.1 Helical Anchors.** Helical anchors shall be hot dip galvanized or stainless steel. A representative number of helical anchors subjected to tensile loading shall be load tested in accordance with ASTM D 3689 to two times their design load capacity. Load testing of anchors in tension shall include creep testing of a representative number of the anchors. Helical anchors shall be designed and installed as determined by a *registered design professional*.

**3605.3 Wood.** Wood shall be pressure treated with a preservative recommended by the American Wood Preservers' Association for the specific application. Wood species, preservative treatment, minimum lumber size, and lumber grade shall be in accordance with Table 3605.3. Handrails, guardrails, wallcaps, and decking may be constructed of naturally durable species where located above the normal high water mark.

**3605.3.1 Wood Connections.** All steel bolts, rods and other hardware shall be hot-dipped galvanized or protected with an equivalent system. All bolts, rods and other metal materials shall be no smaller than 5/8 inch in diameter. Beams, girders or pile caps shall be attached to the piling with a minimum of two 5/8-inch hot-dip galvanized steel bolts per beam member through bolted at each piling connection. Piling shall not be notched so that the cross-section is reduced below 50 percent. Threaded fasteners shall not be tightened directly against wood surfaces but used only in conjunction with standard ogee or flat washers. Cold formed metal connectors shall not be used in wet applications or applications subject to wetting and drying cycles. Mooring hardware, including cleats, and pile guides shall be through bolted using sizes recommended by the manufacturer.

**Table 3605.3: SPECIFICATIONS FOR SOUTHERN PINE<sup>2</sup> LUMBER IN FRESH AND SALT WATER SERVICE**

Location	Component	AWPA Use Category <sup>1,4</sup>		Dimensions	Lumber Grade		Moisture Content at Treatment
		Saltwater	Freshwater		Saltwater	Freshwater	
Above Normal High Water	Decking <sup>3</sup>	3B	3B	<sup>5</sup> / <sub>4</sub> “ 2” Nominal Min.	<del>Premium</del> <del>No. 2</del>	Premium No. 2	Surfaced Dry 19%
	Guardrails	3B	3B	2” Nominal Min.	<del>No. 2</del>	No. 2	Surfaced Dry 19%
	Wallcaps	3B	3B	2” Nominal Min.	<del>No. 2</del>	No. 2	Surfaced Dry 19%
	Walers	3B	3B	4x6 Nominal	<del>No. 2</del>	No. 2	KD 20% or less or Dry 23%
	Cross Bracing	3B	3B	2” to 4” Nominal	<del>No. 2</del>	No. 2	Surfaced Dry 19%
Splash Zone	Split Pile Caps	4B	4B	2” to 4” Nominal	<del>No. 2</del>	No. 2	Surfaced Dry 19%
	Stringers	4B	4B	2” Nominal	<del>No. 2</del>	No. 2	Surfaced Dry 19%
Below Normal High Water	Sheet Piles	5B	4C	2” to 4” Nominal	<del>Marine No. 1<sup>7</sup></del>	No. 2	Surfaced Dry 19%
	Walers	5B	4C	4x6 Nominal	<del>Marine No. 1<sup>7</sup></del>	No. 2	KD 20% or less or Dry 23%
	Cross Bracing	5B	4C	2” to 4” Nominal	<del>Marine No. 1<sup>7</sup></del>	No. 2	Surfaced Dry 19%
	Rectangular Timber Piles	<del>Not Allowed<sup>6</sup></del>	4C	6x6 Nominal	<del>Not Allowed<sup>6</sup></del>	No. 2	KD 20% or less or Dry 23%
	Round Timber Piles	5B <sup>6</sup>	4C	ASTM D25	<del>ASTM D25</del>	ASTM D25	KD 25% or Less
Engineered Lumber	Glulam Timber	5B	4B	4” Nominal Min.	<del>Note 5</del>	Note 5	12% Average
	Parallel Strand Lumber	5B	4B	3½” Minimum	<del>1.8E or Better</del>	1.8E or Better	Per Manufacturer’s Specifications

**Footnotes:**

1. Lumber shall be pressure treated with preservative treatment in accordance with AWP A U1.
2. At the discretion of the Building Official, lumber species other than Southern Pine may be approved when span tables for wet use conditions are submitted, and the lumber is treated for comparable service life to the treatment specifications required by Table ~~3605.1.3605.3.~~
3. Wood composite decking, treated or untreated, shall provide equivalent service life to the treated decking specified in Table ~~3605.1.3605.3.~~
4. All notches, holes, and field cuts shall be field treated in accordance with AWP A M4.
5. Glulam grade shall be specified as a layup combination or stress class in accordance with the National Design Specification or the manufacturer's published data. Layup combinations shall consist of species and grades capable of the treatment retentions equivalent to the AWP A use categories specified in Table ~~3605.1.3605.3.~~
- ~~6. Commercial pile wraps may be used to extend the life expectancy of timber piles exposed to marine borers.~~
- ~~7. AWP A requirements for Marine No. 1 specify that no heartwood be exposed on any face prior to preservative treatment.~~

**3605.4 Concrete.** Concrete components shall comply with applicable provisions of Chapter 19 and ACI 318. Minimum concrete strength, air entrainment, maximum chloride content, and maximum water cement ratio shall be determined from ACI 318 on the basis of required structural strength, required resistance to freeze-thaw exposure, required abrasion resistance, and required resistance to water ~~penetration and salt water intrusion.~~ penetration. Minimum concrete cover shall be increased and reinforcing steel spacing shall be decreased in accordance with ACI 350, to reduce crack size. All steel embedments, other than reinforcing steel, shall be stainless, hot dip galvanized or coated for corrosion protection. Field welds and abrasions of coatings on embeds shall be touch coated in the field.

**3605.5 Structural Steel.** Steel components shall comply with applicable provisions of Chapter 22 and AISC 360. All structural steel members, fasteners, and fittings shall be protected from corrosion by coating or cathodic protection for the specific exposure. Steel bulkhead components and dock components shall be hot dip galvanized or coated to achieve the corrosion protection required for the degree of exposure of corrosive elements. Field welds and abrasions to coatings shall be touched up after erection or installation is completed. Cold formed metal joists, girders, columns and studs shall not be used in applications where the members are constantly wet or subject to wetting and drying cycles.

**3605.6 Aluminum.** Aluminum bulkhead sheets or aluminum bulkhead or dock components shall be of proper alloy to resist corrosive elements in the adjacent water and soil. Bulkhead components and hardware shall be aluminum or stainless steel. Aluminum shall be galvanically and physically isolated from concrete and galvanically isolated from steel. Connection hardware and fasteners for aluminum components may be stainless steel or galvanized steel if isolated from aluminum structural elements.

**3605.7 Plastics and Composites.** Bulkheads, structural shapes, plates, and guardrail systems manufactured from vinyl chloride based materials or fiber reinforced polymer (FRP) materials shall be designed to comply with manufacturer's published load tables or manufacturer's published mechanical properties subject to the requirements for specific materials in Sections 3605.7.1, 3605.7.2, and 3605.7.3. Plastic and composite members shall contain additives to inhibit ultra violet radiation degradation or shall be protected from ultra violet radiation by an appropriate coating.

**3605.7.1 Sheet Piling Manufactured from Vinyl Chloride Based Materials.** Vinyl chloride materials for sheet piling shall be specified and tested for conformance in accordance with ASTM D4216, including weathering tests in accordance with ASTM D1435. Mechanical properties shall be established in accordance with the tests specified in Table 3605.7.1. Design values of the tabulated properties shall conform to the limiting values specified in the table. The manufacturer of the sheet piling shall produce a certificate of analysis from a third party testing agency certifying the vinyl chloride material from which the sheet piling is manufactured conforms to the physical properties specified. The third party testing agency shall be accredited in accordance with ISO 17025 to conduct the specified tests. Testing programs shall address changes in material sources and composition over time, and test data shall accurately represent the properties of the product produced at any given time.

**3605.7.1.1 Deflection of Vinyl Chloride Based Sheet Piling.** Deflection of vinyl sheet pile bulkheads shall not exceed the lesser of 1/60 times the height from the mud line to the top of the wall or 2 inches. Effects of in-service temperatures exceeding 80°F on

modulus of elasticity shall be considered in deflection calculations and selection of materials.

**3605.7.1.2 Service Stresses for Vinyl Chloride Based Sheet Piling.** Service load stresses in the vinyl sheet piling shall not exceed 3200 psi.

**3605.7.1.3 Ultra Violet Light Stabilization.** Vinyl chloride based materials shall be compounded with stabilizing agents. Addition of stabilizers during the extrusion process is prohibited.

**3605.7.1.4 Impact Resistance of Vinyl Materials.** Vinyl sheet pile bulkheads shall have sufficient impact resistance, determined in accordance with ASTM D256 and ASTM D4226, to resist impact from vessels traveling at mooring speeds, resist wave impact ~~when installed in high velocity flood zones (V-Zones on Flood Insurance Rate Maps),~~ and to resist impact from debris likely to collide with the bulkhead at flood ~~stage or in areas subject to storm surge stage.~~

**3605.7.1.5 Fire, Smoke, and Toxicity.** Vinyl materials shall be tested for the in-service thickness in accordance with ASTM D635 with a resulting burning rate of 2½ inches per minute or less.

**Table 3605.7.1: LIMITATIONS ON MECHANICAL PROPERTIES FOR VINYL CHLORIDE BASED SHEET PILING**

<b>Mechanical Property</b>	<b>Test Protocol</b>	<b>Limitations on Property</b>
Notch Impact Resistance	ASTM D256	2.0 ft-lb./in minimum
Drop Dart Impact Resistance, Procedure A	ASTM D4226	1.0 in-lb./mil minimum
Drop Dart Impact Resistance, Procedure B	ASTM D4226	2.0 in-lb./mil minimum
Tensile Strength	ASTM D638	6500 psi minimum
Modulus of Elasticity in Tension	ASTM D638	377,000 psi minimum
Deflection Temperature under 264 psi	ASTM D648	158 psi minimum
Linear Coefficient of Expansion	ASTM D696	4.4x10 <sup>-5</sup> in/in/ <sup>0</sup> F maximum

**3605.7.2 Pultruded Fiber Reinforced Polymer (FRP) Sheet Piling, Shapes and Plates.**

Mechanical properties for FRP structural components shall be established in accordance with the tests specified in Table 3605.7.2. Each manufacturer shall publish the characteristic values for the product in accordance with ASTM D7290. The manufacturer of the FRP shall produce a certificate of analysis certifying the FRP material and constituent materials from which the FRP components are manufactured conform to the physical properties specified. Testing programs shall address changes in material sources and composition over time, and test data shall

accurately represent the properties of the product produced at any given time. Manufactured components shall be inspected in the plant in accordance with ASTM D3917 for dimensional tolerances and according to ASTM D4385 for visual defects. Inspection reports shall be provided.

**Table 3605.7.2: LIMITATIONS ON PHYSICAL AND MECHANICAL PROPERTIES FOR FIBER REINFORCED POLYMER COMPONENTS**

<b>Property<sup>1</sup></b>	<b>ASTM Test Method</b>	<b>Minimum Number of Tests</b>
Barcol Hardness	D2583	5
Glass Transition Temperature T <sub>g</sub>	D4065	5
Coefficient of Thermal Expansion	D696	5
Moisture Equilibrium Content	D570	5
Longitudinal Tensile Strength	D638	10
Transverse Tensile Strength	D638	10
Longitudinal Tensile Modulus	D638	10
Transverse Tensile Modulus	D638	10
Longitudinal Compressive Strength	D6641	10
Transverse Compressive Strength	D6641	10
Longitudinal Compressive Modulus	D6641	10
Transverse Compressive Modulus	D6641	10
Longitudinal Flexural Strength	D790	10
Transverse Flexural Strength	D790	10
Longitudinal Flexural Modulus	D790	10
Transverse Flexural Modulus	D790	10

In-Plane Shear Strength	D5379	10
In-Plane Shear Modulus	D5379	10
Inter-laminar Shear Strength	D2344	10
Longitudinal Pin Bearing Strength	D953 <sup>2</sup>	10
Transverse Pin Bearing Strength	D953 <sup>2</sup>	10
Pull Through Strength per Fastener  $t = \frac{3}{8}$ " $t = \frac{1}{2}$ " $t = \frac{3}{4}$ "	D7332, Proc. B	10

**Footnotes:**

1. Property requirements for shapes apply to sheet piles.
2. Tests shall be conducted for material thicknesses,  $t$ , tabulated and bolt sizes from 3/8 inch to 1 inch in diameter. No more than 1/3 of the bolt shank within the thickness of the connection material may be threaded. Bolts shall be installed snug tight

**3605.7.2.1 Maximum Service Temperature.** Service temperature of FRP structural components shall not exceed  $T_g - 40^{\circ}\text{F}$ , where  $T_g$  is the glass transition temperature determined in accordance with ASTM D4065.

**3605.7.2.2 FRP Constituent Materials.** Fibers and matrix constituents shall comply with the following requirements:

**3605.7.2.2.1 Fiber Type.** Fibers shall be glass, carbon, aramid, or hybrid combinations of these fiber types. Glass fibers shall conform to ASTM D578.

**3605.7.2.2.2 Fiber Architecture and Content.** The fiber architecture of any pultruded element comprising the cross section of a pultruded FRP structural member shall be symmetrical and balanced. Each pultruded FRP structural element shall contain a minimum total fiber volume fraction of 30%.

**3605.7.2.2.3 Fiber Orientations.** Each element of a pultruded FRP structural member shall have fibers oriented in a minimum of two directions separated by a minimum of 30 degrees. In the direction of the longitudinal axis of the member the percentage of continuous fiber in each pultruded element shall be a minimum of 30% of the total fiber reinforcement by volume for shapes and a minimum of 25% of the total fiber reinforcement by volume for plates. When multiple elements share a common edge in the direction of pultrusion, at least 50% of the non-roving reinforcement in the element having the largest percentage of non-roving reinforcement shall extend through the junction connecting the elements.

**3605.7.2.2.4 Minimum Fiber Tensile Strength.** Determined in accordance with ASTM D7290, the characteristic value of the tensile strength of the fiber strands, yarns, and rovings shall be at least 290,000 psi. Tensile tests shall be conducted in accordance with ASTM D2343.

**3605.7.2.2.5 Resin.** A commercial grade thermoset resin shall be used for fabricating pultruded FRP structural members.

**3605.7.2.2.6 Other Constituent Materials.** Additives to the resin system that influence processing or curing, such as fillers, promoter, accelerators, inhibitors, UV resistant agent, and pigments shall be compatible with the fiber and resin system.

**3605.7.2.3 Durability and Environmental Effects.** Materials for FRP structural components shall be selected, designed, and manufactured to tolerate long term environmental effects anticipated during the service life of the structure.

**3605.7.2.3.1 Factors Considered in Material Selection.** The following factors shall be considered in selecting FRP materials for ~~marine~~ structures:

- a. Performance criteria for the structure;
- b. Intended service life of the structure;
- c. Expected environmental conditions, including likelihood of exposure to alkalis or organic solvents;
- d. Protective measures;
- e. Feasibility of maintenance and repair during service.

**3605.7.2.3.2 Adjustment of Material Properties to Account for Environmental Effects.** Unless the glass transition temperature determined in accordance with ASTM D4065 and the tensile strength of the composite in the longitudinal and transverse directions determined in accordance with ASTM D638, can be shown to retain at least 85% of their characteristic values after conditioning in the environments listed below, the nominal strength and stiffness shall be reduced for design purposes in accordance with test data produced from testing simulating the anticipated environment. Materials that cannot retain at least 15% of their characteristic values after conditioning the listed environments are prohibited in structural applications. Design tensile strength shall be reduced in accordance with material specific tests when in-service temperatures exceed of 90°F. Condition test samples as follows:

**a. Water:** Samples shall be immersed in distilled water having a temperature of 100 + 3°F and tested after 1,000 hours of exposure.

**b. Alternating Ultraviolet Light and Condensing Humidity:** Samples shall be exposed according to Cycle No. 1 (0.89 W/m<sup>2</sup>/mm, 8 hours UV at 60°C, 4 hours condensation at 50°C) using UVA-340 lamps in an apparatus meeting the requirements of ASTM G154. Samples shall be tested within two hours after removal from the apparatus.

**3605.7.2.4 Deleted(Deleted).**

**3605.7.2.5 Deflection of FRP Sheet Piling.** Deflection of vinyl sheet pile bulkheads shall not exceed the lesser of 1/60 times the height from the mud line to the top of the wall or 2 inches. Effects of in-service temperatures in excess of 90°F on modulus of elasticity shall be considered in deflection calculations.

**3605.7.2.6 Fire, Smoke, and Toxicity.** FRP materials shall be tested for the in-service thickness in accordance with ASTM D635 with a resulting burning rate of 2 ½ inches per minute or less.

**3605.7.3 Carbon Fiber Reinforced Polymer Repair Products.** Carbon Fiber Reinforced plate and wrap used for flexural and shear reinforcement of existing concrete structures shall be designed in accordance with the design procedures specified in ACI 440.2R. Mechanical properties of Carbon Fiber Reinforced plate and wrap shall be established in accordance with the tests specified in ACI 440.3R.

**3605.8 Masonry.** Masonry used in bulkheads and dock work shall comply with Chapter 21.

**SECTION 3606**  
**CONSTRUCTION OF PIERS, DOCKS, CATWALKS,**  
**GANGWAYS, AND FLOATING DOCKS**

**3606.1 Fixed piers.** Fixed piers shall be constructed in accordance with Sections 3606.1.1 through 3606.1.4.

**3606.1.1 Required depth of piles.** Fixed piers shall be supported by pilings with tip penetrations dependent on the soil conditions and the total applied load. Piers support by shallow piling, legs or columns with point bearing on rock shall have provisions to resist horizontal forces and overturning, as well as flotation uplift. Piles shall be installed in accordance with the requirements of Chapter 18 and inspected in accordance with the requirements of Chapter 17.

**3606.1.2 Structural steel and concrete members.** Structural steel members shall be designed in accordance with AISC 360, Chapter 22 of this code, and the material requirements of this chapter. Concrete members shall be designed in accordance with ACI 318, Chapter 19 of this code, and the materials requirements of this chapter.

**3606.1.3 Size of wood piles.** Piles shall be sized in accordance with the American Wood Council National Design Specification. In no case shall round timber piles be less than 7 inches in diameter at the butt and have a minimum tip diameter of less than 5 ½ inches. Rectangular timber piles shall not be less than nominal 6 inches x 6 inches.

**3606.1.4 Bracing of wood piles.** Where required by design, bracing shall be sized to limit stresses in the piles from lateral loads in accordance with the American Wood Council National Design Specification to prevent buckling.

**3606.1.5 Wood girder and joist spans.** Maximum spans for pier pile caps or girders and joists or stringers shall be determined in accordance with the American Wood Council National Design Specification considering the member to be subject to wet use.

**3606.1.6 Connections.** Connections between piling or legs to pile caps, stringers, beams, bracing and deck shall have sufficient capacity to safely support all applied loads and provide transfer of load to adjoining members.

**3606.1.7 Gangways.** ~~On coastal waterways, the maximum slope permitted shall be 3:1 at 0.0 mean low water or above and 2½:1 below 0.0 mean low water.~~ On lakes and other inland waters, the maximum slope shall be 3:1 not less than 90% of the time and 2½:1 not more than 10% of the time.

**3606.2 Flotation units.** Flotation units shall be foam filled encapsulated floats or polystyrene billets securely wrapped with Class I woven geotextile fabric in accordance with AASHTO

M288. The use of metal barrels not specifically designed for use as flotation devices and unwrapped polystyrene billets are prohibited.

**3606.3 Electrical service.** All electrical service to ~~marine~~ structures shall be in accordance with the *North Carolina Electrical Code*.

**3606.4 Fire protection.** All fire protection for ~~marine~~ structures shall be in accordance with applicable provisions of the *North Carolina Fire ~~Prevention~~ Code*.

**3606.5 Fuel docks.** Fuel docks and other ~~marine~~ facilities handling flammable liquids shall comply with the *Flammable and Combustible Liquids Code*, NFPA 30 and the *North Carolina Fire Code*. All fuel installations shall be designed to prevent fuel spillage from entering the water. The fuel docks or floats shall be isolated to the extent that fire or explosion would have minimal opportunity to spread to or from the fuel dock to the berths. Storage tanks for public facilities shall be located a minimum distance of 50 feet from the dispenser with a shutoff valve at the tank.

**3606.6 Guardrails.** For walkways, access piers, steps or ramps, guardrails or other safety provisions shall be provided along the edges where the vertical drop to the lesser of the mean low water level, ~~normal low water level (sounds)~~, normal pool (lakes and rivers) or mud line exceeds 6 feet. Edges having a primary function other than walks or access ways, such as docking frontage and swimming access shall not require guardrails. Guardrails shall be designed in accordance with Chapter 16 for balconies. Guardrails shall be a minimum of 42 inches high and shall prevent the passage of a 21 inch sphere except where required otherwise by Chapter 11. Edge protection shall be provided as required by other regulations.

**Exception:** For private waterfront piers and docks, guardrails or other safety provisions shall be provided along the edges where the vertical drop to the lesser of the mean low water level, ~~normal low water level (sounds)~~, normal pool (lakes and rivers) or mud line exceeds 8 feet. Guardrails shall be a minimum of 36 inches high and shall prevent the passage of a 21 inch sphere. Edge protection shall be provided as required by other regulations.

**3606.7 Accessibility.** Piers, docks, catwalks, gangways, and floating docks shall comply with Chapter 11 and ANSI/ICC A117.1 for accessibility.

**3606.8 Egress.** Piers and docks shall be provided with means of egress in accordance with Sections 3606.8.1 through 3606.8.4.

**3606.8.1 Occupant Load.** Occupant load for piers and docks shall be calculated as follows:

**3606.8.1.1 Piers and Boardwalks.** Occupant load for piers and boardwalks intended for recreational fishing shall be calculated based on 3 linear feet of rail per person on the perimeter plus 50 square feet per person on a net area with a perimeter 3 feet inside the rail. Occupant load for piers and boardwalks intended for other uses shall be in accordance with Chapter 10.

**3606.8.1.2 Public Waterfront Docks.** Occupant load for docks constructed a public marinas intended for mooring of private pleasure craft shall be calculated based on 30 square feet of net dock area per person.

**3606.8.1.3 Private Waterfront Docks.** Occupant load for private waterfront docks shall be calculated based on 20 square feet per person.

**3606.8.2 Piers.** Piers intended for recreational fishing, assembly, or educational purposes with travel distance to exit discharge exceeding 600 feet and greater than 15 feet above mean low water shall have emergency access ladders at 200 feet intervals and at the end of the pier.

**3606.8.3 Public Waterfront Docks.** Public waterfront docks intended for mooring of private pleasure craft with travel distance to exit discharge in excess of 600 feet shall have a second means of egress or a means of rescue from the water. Construction for these docks shall be noncombustible with the exception that wood walers may be embedded in the dock edges for attachment of mooring hardware.

**3606.8.4 Buildings Constructed on Piers and Docks.** Buildings constructed on public waterfront piers and docks shall comply with the requirements of all applicable provisions of the *North Carolina State Building Code*.

## **SECTION 3607 CONSTRUCTION: BULKHEADS AND REVETMENTS**

**3607.1 Bulkheads.** Bulkheads shall be constructed in accordance with Sections 3607.1.1 through 3607.1.5.

**3607.1.1 General.** Bulkheads shall be constructed in a manner to be effective against erosion and provide for bank stabilization. The bulkhead system may consist of either of the following or combinations thereof: braced sheet pile walls with tie backs, king piles and horizontal panels, gravity walls, cantilever and counterfort retaining walls. Bulkhead walls shall be constructed to prevent passage of fine material (See ASTM D 2487) through joints or cracks from the fill side to the stream side.

**3607.1.2 Systems.** Local site conditions and performance of bulkheads in service shall govern in selection of a system. The potential for erosion and scour at the mud line shall also be investigated, and compensating features shall be reflected in the construction. Bulkheads shall be terminated by either tying into adjoining structures or by extending the bulkhead line a minimum of 10 feet in a landward direction at an angle of not less than 45 degrees to the shoreline in order to protect against end erosion or flanking by wave action. No structure shall be terminated without regard for end anchorage and stabilization.

**3607.1.3 Guardrails.** Where designated public walkways, steps or ramps run adjacent to bulkheads within 6 feet, guardrails or other safety provisions shall be provided along the top of the wall where the vertical drop to the lesser of the mean low water level, ~~normal~~

~~low water level (sounds)~~, normal pool (lakes and rivers) or mud line exceeds 6 feet. Guardrails shall be designed in accordance with Chapter 16 for balcony guardrails. Guardrails shall be 42 inches high and shall prevent the passage of a 21 inch sphere except where required otherwise by Chapter 11. Edge protection shall be provided as required by other regulations.

**Exception:** For private waterfront bulkheads with designated walkways within 6 feet, guardrails or other safety provisions shall be provided along the edges where the vertical drop to the lesser of the mean low water level, ~~normal low water level (sounds)~~, normal pool (lakes and rivers) or mud line exceeds 8 feet. Guardrails shall be a minimum of 36 inches high and shall prevent the passage of a 21 inch sphere. A wall cap 30 inches or less in width shall not be considered a designated walkway unless it is connected to a walkway. Edge protection shall be provided as required by other regulations.

**3607.1.4 Wood Construction.** For wood grades, member sizes, preservative treatment, and protection of metal fasteners and fittings see Section 3605.3.

**3607.1.5 Bulkheads of Materials Other than Wood.** Vinyl, fiber reinforced polymer, aluminum, concrete and steel bulkheads shall be constructed in a manner to ensure performance. Connections shall be designed to resist the full applied load. For materials and corrosion protection reference Sections 3605.4 through 3605.7.

**3607.2 Revetments.** Revetments shall be constructed in accordance with Sections 3607.2.1 through 3607.2.2

**3607.2.1 Rigid revetments.** Rigid revetments shall be founded on a firm foundation to prevent undermining and progressive instability. Provisions shall be made to provide for adequate toe protection to compensate for known or anticipated scour. Additional protection may be needed in active areas and may consist of sheet piling along the toe or stone rip rap. An adequate pattern of weep holes shall be provided in the face to relieve hydrostatic pressure behind the wall. Joints shall be sealed or provided with a properly designed filter to prevent loss of fines from the protected slope.

**3607.2.2 Flexible revetments.** Adequate provisions shall be made to prevent migration of fine materials through the structure. The face shall not be steeper than one unit horizontal to one unit vertical. Flatter slopes may be needed for stability depending on the construction materials and site conditions. The face may consist of armor stone, rip rap, or individual interlocking concrete units or poured concrete. Toe protection provisions shall be provided as discussed for the rigid type and the top of slope shall be detailed to prevent erosions under the revetment from surface water runoff. Flexible revetments shall be provided with a filter layer designed to prevent loss of fines from the protected slope and to relieve hydrostatic pressure behind the face.

## **SECTION 3608**

**SPECIAL INSPECTIONS FOR DEEP FOUNDATION OF MARINE  
STRUCTURES  
DOCKS, PIERS, BULKHEADS AND WATERWAY STRUCTURES IN  
ESTUARINE WATERS**

*Section 3608 applies to docks, piers, bulkheads and waterway structures included in North Carolina General Assembly Session Law 2023-137, Section 35 and in estuarine waters as defined within the definition of “Coastal Fishing Waters” within North Carolina General Statute 113-129(4).*

*Section 3608 represents a reprint of Chapter 36 of the 2009 North Carolina Building Code.*

**3608.1 Special inspector qualifications.** Qualification for special inspector shall be in accordance with Section 1704.2.1

**3608.2 Building permit and report requirement.** Statement of special Inspections shall be in accordance with Section 1704.1.1. Approved Special Inspection report shall be in accordance with Section 1704.2.4 and shall be issued prior to issuing a Certificate of Compliance.

**3608.3 Content of statement of special inspections.** The statement of special inspections shall be in accordance with Section 1704.3.1.

**3608.4 Required Special Inspections & Tests.** Special Inspections of deep foundation of marine structures shall be performed in accordance with Tables 3608.4.1 thru 3608.4.9

**3608.5 Coatings.** Coatings to be designed by the registered design professional as required to extend the life of marine structural components.

**Table 3608.4.1**

**REQUIRED SPECIAL INSPECTIONS FOR MATERIALS IN MARINE STRUCTURES**

TYPE	NC Building Code Section	REFERENCED STANDARD*
Steel Elements, perform additional special inspection in accordance with:	Section 1705.2	AISC 360
Concrete	Section 1705.3	ACI 318
Grout		ACI 318: 26.10
Precast		
Aluminum	Chapter 20	AA-ASM 35 AA-ADM 1
Stainless Steel		Design Manual for Structural Stainless Steel
Plastics & Composites	Table 3605.7.2	
Masonry	Section 1705.4	TMS 402 & 602
Vinyl		ASTM D256 ASTM 4226

		ASTM 4587— UV Resistance
Wood	Section 1705.5 Section 3605.3	AWC AWPA

**Table 3608.4.2**

**REQUIRED SPECIAL INSPECTIONS OF DEEP FOUNDATIONS (PILES AND SHEETPILES) IN MARINE STRUCTURES**

TYPE	CONTINUOUS SPECIAL INSPECTION	PERIODIC SPECIAL INSPECTION
1. Verify element materials, sizes and lengths comply with the requirements.	X	—
2. Determine capacities of test elements and conduct additional load tests, as required.	X	—
3. Inspect driving operations and maintain complete and accurate records for each element.	X	—
4. Verify placement location and plumbness, confirm type and size of hammer, record number of blows per foot of penetration (if vertical capacity is required), determine required penetrations to achieve design capacity, record tip and butt elevations and document any damage to foundation element.	X	—
5. For specialty elements, perform additional inspections as determined by the registered design professional in responsible charge.	—	—

**Table 3608.4.3**

**REQUIRED SPECIAL INSPECTIONS OF GROUTED ANCHORS IN MARINE STRUCTURES**

TYPE	CONTINUOUS SPECIAL INSPECTION	PERIODIC SPECIAL INSPECTION
1. Inspect drilling operations and maintain complete and accurate records for each element.	X	—
2. Verify placement locations and plumbness, confirm element diameters, bell diameters (if applicable), lengths, embedment into bedrock (if applicable) and adequate end bearing strata capacity. Record concrete or grout volumes.	X	—

**Table 3608.4.4**

**REQUIRED SPECIAL INSPECTIONS OF JETTED PILES IN MARINE STRUCTURES**

TYPE	CONTINUOUS	PERIODIC
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	SPECIAL INSPECTION	SPECIAL INSPECTION
1. Verify element materials, sizes and lengths comply with the requirements.	X	—
2. Inspect driving operations and maintain complete and accurate records for each element.	X	—
3. Verify placement location and plumbness, record tip and butt elevations and document any damage to foundation element.	X	—
4. For specialty elements, perform additional inspections as determined by the registered design professional in responsible charge.	—	—

**Table 3608.4.5**

**REQUIRED SPECIAL INSPECTIONS OF HELICAL ANCHORS IN MARINE STRUCTURES**

TYPE	CONTINUOUS SPECIAL INSPECTION	PERIODIC SPECIAL INSPECTION
1. Record installation equipment, helical anchor materials and components, installation angle, pile dimensions, tip elevations, final depth, final installation torque.	X	—
2. Review equipment calibration certification.	—	X
3. For specialty elements, perform additional inspections as determined by the registered design professional in responsible charge.	—	—

**Table 3608.4.6**

**REQUIRED SPECIAL INSPECTIONS OF PULL-DOWN PILES IN MARINE STRUCTURES**

TYPE	CONTINUOUS SPECIAL INSPECTION	PERIODIC SPECIAL INSPECTION
1. Record installation equipment, helical anchor materials and components, pile dimensions, tip elevations, final depth, final installation torque.	X	—
2. Review equipment calibration certification.	—	X
3. Perform concrete elements, perform test and additional special inspections in accordance with Table 3608.4.1.	—	X
4. For specialty elements, perform additional inspections as determined by the registered design professional in responsible charge.	—	—

**Table 3608.4.7****REQUIRED SPECIAL INSPECTIONS OF PERCUSSION DRIVEN EARTH ANCHORS IN MARINE STRUCTURES**

TYPE	CONTINUOUS SPECIAL INSPECTION	PERIODIC SPECIAL INSPECTION
1. Record installation equipment, anchor materials and components, pile dimensions, tip elevations, final depth, pull back length, full lock out strength.	X	—
2. Review equipment calibration certification.	—	X
3. For specialty elements, perform additional inspections as determined by the registered design professional in responsible charge.	—	—

**Table 3608.4.8****REQUIRED SPECIAL INSPECTIONS OF DEADMAN CONSTRUCTION IN MARINE STRUCTURES**

TYPE	CONTINUOUS SPECIAL INSPECTION	PERIODIC SPECIAL INSPECTION
1. Record installation anchor, length, and verify tie rods are snug to supported elements.	—	X
2. Record soil compaction supporting deadman.	X	—
3. Perform concrete elements, perform test and additional special inspections in accordance with Table 3608.4.1.	—	X
4. For specialty elements, perform additional inspections as determined by the registered design professional in responsible charge.	—	—

**Table 3608.4.9****REQUIRED SPECIAL INSPECTIONS OF COATINGS IN MARINE STRUCTURES**

TYPE	CONTINUOUS SPECIAL INSPECTION	PERIODIC SPECIAL INSPECTION
1. Review material preparation design requirements.	—	X
2. Review application certifications.	—	X
3. Verify that damaged coatings are repaired.	—	X

## **SECTION 3601**

### **GENERAL**

The intent of this chapter is to provide minimum standards for the design, construction and maintenance of piers, bulkheads and waterway structures that are not covered by other existing codes or design standards. This chapter exempts farm structures not on public waters, marine terminal or port facilities for berthing, mooring, docking and servicing ships, barges or tug boats which handle cargo of all types including bulks, liquids, fuels and passengers.

The design of piers, bulkheads and waterway structures is essential for the protection of life and property without causing adverse effects to the shoreline. These structures by their very nature result in some modification of physical environment and therefore require minimum design standards. The guidelines in this chapter address minimum standards for foundations, design forces, structural integrity, material selection and utilization, and construction techniques.

## **SECTION 3602**

### **PERMITS AND APPROVALS**

The construction of any pier, bulkhead or waterway structure in public waters or the placement of dredged materials in waters or wetlands, generally requires the owner to obtain permits prior to construction. A permit from the United States Army Corps of Engineers is generally required for all marine construction. In addition to the permit issued by the Corps of Engineers, additional permits may be required from municipal, county or state governments and/or local marine commissions. In cases of structures to be built on lakes operated by an electric utility for the generation of power, a permit from the operating utility may also be required.

## **SECTION 3603**

### **MINIMUM DESIGN LOADS**

**3603.1 General.** Every structure shall be of sufficient strength to support the imposed dead, live, wind and impact loads without exceeding the allowable stresses prescribed for the various materials elsewhere in this code. Adequate consideration shall be made for forces imposed by earth, water, docking and mooring.

**3603.2 Dead loads.** The weight of the component parts of a structure shall be used in the design when it will influence the strength of the structural elements.

**3603.3 Live loads.** Design live loads shall be the greatest load that will probably be imposed on the structure including superimposed loads on retained material which exert horizontal loads on the structure. Where vehicles are allowed, use actual weight of vehicles and wheel loads as specified in the latest edition of *Standard Specifications for Highway Bridges* of the American Association of State Highway Bridges: of the American Association of State Highway and Transportation Officials. The design load shall be posed at the dock or pier approach where vehicles are allowed. Minimum live loads are:

1. FIXED PIERS, DOCKS, CATWALKS—40 pounds per square foot (psf) (1915 Pa) or 300 pounds (1335 N) concentrated load on any area 2 foot (610 mm) square.
2. FLOATING PIERS, DOCKS, FINGERS—20 psf or 300 pounds (1335 N) concentrated load on any area 2 feet (610 mm) square. Under dead load, floating piers shall have a minimum of 15 inches (381 mm) freeboard. The pier shall have not more than 6 degrees (0.11 rad) tilt from the horizontal under uniform live loading on one-half of the pier width or under concentrated load of 600 pounds (2669 N) applied on any side.

3. BULKHEADS, SEAWALLS, REVETMENTS—  
Design loads shall be the greatest combinations of loads exerted on the structure. Consideration shall be given to horizontal loads exerted by superimposed loads on the retained earth and by inclined surface slopes.

4. PUBLIC FISHING PIERS

4.1. Mean low water line to land—100 psf (4788 Pa).

4.2. Mean low water line to end of pier—50 psf (2304 Pa).

**3603.4 Wind loads.** As prescribed in Chapter 16.

**3603.5 Impact loads.** As prescribed in Chapter 16 but not less than 1.25 times the kinetic energy exerted by a striking vessel or vehicle.

**3603.6 Water loads.** Hydrostatic horizontal pressures along with the equivalent fluid pressure of soil and any surcharge thereon shall be considered. Provide sufficient anchorage against uplift between all components and between the structure and its support of not less than 1.5 times the uplift force. Wave forces shall be determined from wave records where available. Where no wave records are available, the design wave shall be determined from probable wind speed, direction, fetch and water depth which will yield a critical wave. Forces shall then be calculated using current coastal engineering practice.

**3603.7 Earth loads.** Lateral earth pressures shall be determined by considering the specific soil properties and applying earth pressure theories generally accepted for soil mechanics in engineering practice. Except for simple and inexpensive structures this normally requires the services of specialists in soil mechanics and/or foundations design. Adequate consideration shall be given for the effect of probable varying levels of ground water, tide and flood water. Pressures exerted by the earth shall be checked for dry, saturated and submerged conditions as applicable.

**3603.8 Erosion.** The effects of reasonably predictable erosion and wave-induced scour shall be given ample consideration.

## **SECTION 3604 ENGINEERED DESIGNS**

**3604.1 Docks, piers and catwalks.** Docks, piers and catwalks used by the public or are intended for use by vehicles shall be designed by a professional engineer or architect.

**3604.2 Bulkheads and other type retaining walls.** Bulkheads and other types of retaining walls used by the public having an exposed face above the ground or above mean low water of 5 feet (1524 mm) or greater shall be designed by a professional engineer or architect.

**3604.3 Ocean-front retaining walls, bulkheads and retaining walls.** Ocean-front retaining walls, bulkheads and other types of retaining walls used by the public on the coastline of the ocean or adjacent inlets shall be designed by a professional engineer or architect.

## **SECTION 3605**

### **MATERIALS**

**3605.1 General.** The quality of materials and fastenings used for load-supporting purposes shall conform to good engineering practices. In areas subject to attack from wood borers such as termites, teredoes or limnoria, the wood used shall be approved wood having natural resistance or shall be pressure treated with a preservative recommended by the American Wood Preservers Association for the specific application. Piling shall comply with applicable provisions of Chapter 18.

Wood components shall comply with applicable provisions of Chapter 23. Concrete components shall comply with applicable provisions of Chapter 19. Steel components shall comply with applicable provisions of Chapter 22. In areas of severe corrosion such as salty or brackish waters, all metal components shall be protected by coating, cathodic protection or be oversized accordingly to allow for the specific exposure. Aluminum bulkhead sheets or aluminum bulkhead or dock components shall be of proper alloy to resist corrosive elements in the adjacent water and soil. Galvanized bulkhead components and dock components shall be coated by the “hot dip” process to sufficient cover to provide corrosion protection equal to the degree of exposure of corrosive elements. Masonry used in bulkheads and dock work shall comply with Chapter 21.

## **SECTION 3606**

### **CONSTRUCTION OF PIERS, DOCKS, CATWALKS AND FLOATING DOCKS**

**3606.1 Fixed piers.** Fixed piers for coastal areas shall be supported by pilings with tip penetrations of not less than 8 feet (2438 mm) dependent on the total applied load. Less penetration is approved only if other means of resisting flotation uplift is provided. Pier support by shallow piling, legs or columns with point bearing on rock shall have provisions for horizontal forces and overturn as well as flotation uplift. Connection between piling or legs to cap beams, stringers, beams and deck shall have sufficient capacity to safely support all applied loads and provide transfer of load to adjoining members. Maximum spans for pier joists shall be in accordance with the *Span Table for Joists and Rafters*, as published by the National Forest Products Association or may be designed in accordance with accepted engineering practice.

**3606.2 Metal barrel flotation units.** The use of metal barrels not specifically designed for use as flotation devices is prohibited.

**3606.3 Decomposable flotation units.** Floating docks or piers using exposed polystyrene billets (or other foam material) shall be designed for 125 percent of tabulated loads to allow for deterioration from environmental effects.

**3606.4 Electrical service.** All electrical service to marine structures shall be in accordance with the *North Carolina State Electrical Code*.

**3606.5 Fuel docks.** Fuel docks and other marine facilities handling flammable liquids shall comply with the *Flammable and Combustible Liquids Code*, NFPA 30 and the *North Carolina Fire Code*. All fuel installations shall be designed to prevent fuel spillage from entering the water. The fuel docks or floats shall be a separate structure from berths and shall be isolated to the extent that fire or explosion would have minimal opportunity to spread to or from the fuel dock to the berths. Storage tanks for public facilities shall be located a minimum distance of 50 feet (15 240 mm) from the dispenser with a shutoff valve at the tank.

**3606.6 Handrails.** For walkways, access piers, steps or ranges, personnel handrails or other safety provisions shall be provided along the edges where the vertical drop to the mean low water level or mud line exceeds 6 feet (1829 mm). Edges which have a primary function other than walks or access ways, such as docking frontage and swimming access shall not require railings. Railings shall be designed in accordance with Chapter 16 for balcony railings.

**3606.7 Maintenance of public structures.** The building official shall have the authority to condemn and close to the public any structure which is considered unsafe, and it shall not be used by the public until the deficiencies are corrected. Before the structure is reopened to the public, a certification by a professional engineer or architect shall be required. Each owner shall be responsible for the proper and satisfactory maintenance of any public structure covered by this section. All such structures shall be subject to inspection at any time by the building official.

**SECTION 3607**  
**CONSTRUCTION: BULKHEADS, SEAWALLS**  
**AND REVETMENTS**

**3607.1 Bulkheads.**

**3607.1.1** Bulkheads shall be constructed in a manner to be effective against erosion and provide for adequate bank stabilization. The bulkhead system may consist of either of the following combinations thereof: braced sheet pile walls with tie backs, king piles and horizontal panels, gravity walls, cantilever and counterfort retaining walls. Bulkhead walls shall be constructed to prevent passage of fine material through joints or cracks from the fill side to the stream side.

**3607.1.2** Local site conditions and performance of bulkheads in service should govern in selection of a system. The potential for erosion and scour at the mud line shall also be investigated, and appropriate compensating features shall be reflected in the construction. Bulkheads shall be terminated by either tying into adjoining structures or by extending the bulkhead line a minimum of 10 feet (3048 mm) in a landward direction at an angle of not less than 45 degrees (0.79 rad) to the shoreline in order to protect against end erosion or flanking by wave action. No structure shall be terminated without regard for end anchorage and stabilization. Sheet pile bulkheads with an exposed vertical height of 4 feet (1219 mm) or greater shall be stabilized at the top by providing adequate anchorage, such as the use of batter piles or tie backs. Anchor blocks for tie backs shall be located landward of the soil wedge formed by the wall and a line projected on an angle of the material being retained.

The tie back anchor shall be located no closer than twice the height of the exposed vertical surface of the wall. Sheet pile embedment shall be determined by analysis and design, but shall not be less than the length of the pile exposed above ground. Cantilever and gravity wall bulkheads shall be founded on a firm foundation with special construction given to undermining and progressive instability.

**3607.1.3** Where public walkways, steps or ramps run adjacent to bulkheads, personnel handrails or other safety provisions shall be provided along the top of the wall where the vertical drop to the mean low water line or mud line exceeds 6 feet (1829 mm). Handrails shall be designed in accordance with Chapter 16 for balcony railings.

**3607.1.4** Wood members used for permanent features shall be not less than 2 inches (51 mm) in nominal thickness. All steel bolts, rods and other hardware shall be hot dipped galvanized or protected with an equivalent system. Bolts, rods and other metal materials shall be no smaller than  $\frac{1}{2}$  inch (12.7 mm) in diameter or thickness. Threaded fasteners shall not be tightened directly against wood surfaces but used only in conjunction with standard ogee or flat washers.

**3607.1.5** Concrete, steel and cement asbestos bulkheads shall be constructed in a manner to assure adequate performance. Connections shall be designed to resist the full applied load. Adequate attention shall be given to material protection against corrosion and concrete cover for reinforcing steel. Concrete shall have a 28-day minimum compressive strength of 3,000 pounds per square inch (20 685 kPa) and shall be “air-entrained” type concrete.

**3607.2 Seawalls.** Seawalls may be constructed of concrete or stone rubble mound or other suitable materials. They shall be founded on a firm foundation and may require the use of piling or other suitable support. The face shall be shaped and supported to withstand the full force of the design wave. A provision shall be provided to prevent undermining and progressive instability by installing a sheet pile wall along the toe and/or by placing adequate stone rip rap protection.

### **3607.3 Revetments.**

**3607.3.1 Rigid revetments shall be founded on a firm foundation to prevent undermining and progressive instability. Provisions should be made to provide for adequate toe protection by extending the face a minimum of 2 feet (610 mm) below the mud line plus a depth to compensate for known or anticipated scour. Additional protection may be needed in active areas and may consist of sheet piling along the toe and/or stone rip rap. An adequate pattern of weep holes shall be provided in the face to relieve hydrostatic pressure behind the wall. Joints shall be sealed to prevent loss of fines from the protected slope.**

3607.3.2 Flexible revetments may be utilized where foundations will produce minor consolidation and settlement. Adequate provisions shall be made to prevent migration of fine materials through the wall. The face shall not be steeper than one unit horizontal to one unit vertical. Flatter slopes may be needed for stability depending on the construction materials and site conditions. The face may consist of stone rip rap or individual interlocking concrete units or poured concrete. Toe protection provisions shall be provided as discussed for the rigid type. Flexible revetments must be porous enough to allow for water passage and thereby relieve hydrostatic pressure behind the face.

## **SECTION 3608** **CONSTRUCTION OF GROINS AND JETTIES**

### **3608.1 Groins.**

3608.1.1 Groins are designed and constructed for the purpose of building or maintaining a protection beach by trapping littoral drift (beach materials) or to retard the recession of an eroding shoreline. The planning and design of a groin/groin system shall be based on wave height, period and direction, characteristics of beach material and beach slope.

3608.1.2 Location. Groins shall extend landward a sufficient distance to prevent flanking.

3608.1.3 Types. Groins shall be either (1) very low, impermeable and nonadjustable or (2) impermeable and adjustable.

**3608.1.4 General specifications.** Adjustable groins shall be maintained at elevations in accord with actual beach needs and development of desirable changes of the beach profile, and so as to avoid damage to adjacent beaches. In no case shall the top of such groins be set higher than 2 feet (610 mm) above the beach profile. Impermeable, nonadjustable groins shall not extend seaward beyond the mean low water line, and their top elevation shall not be higher than 6 inches (152 mm) above the beach profile. Considerations of the degree of beach protection to be provided by proposed groins, and the acceptability of such installations, will be based primarily on the following factors: direction and volume of littoral drift; wave force and direction; wind force and direction; land usage; type of bulkhead; type of groin; and spacing and lengths of groins.

A complete coastal engineering study may be required before approval is given to the number, type and length of groins. The design should account for the wave and current forces focused on the beach. The groin/groin system should not adversely modify the littoral drift to the extent to cause severe erosion on the lee side of the structure.

**3608.2 Groins and jetties.** There is no universal type of groin/groin system or jetty because of the wide variations in conditions at each location. It is incumbent on the owner of a groin or jetty type structure to recognize the legal implications of the coastal structure and to plan, design, construct and maintain the structure accordingly. It is thus prudent to seek the advice of a professional engineer or architect with coastal engineering experience.

## **SECTION 3609** **DEFINITIONS**

**BASIN, BOAT.** A naturally or artificially enclosed or nearly enclosed harbor area for docking and securing small craft.

**BULKHEAD.** A vertical wall structure designed to retain shoreline material and prevent erosion due to wave activity.

**BULKHEAD LINE.** The line formed along the shore by the most seaward elements of the bulkhead.

**CATWALK.** A narrow footway platform extending alongside a structure.

**DATUM, PLANE.** The horizontal plane to which soundings, ground elevations water surface elevations are referenced.

**DOCK.** A pier, wharf or platform for the unloading of materials or living beings.

**FETCH.** The area in which waves are generated having a rather constant direction or speed.

**GANGWAY.** A narrow footway bridge extending from the shore, usually to a floating structure.

**GROIN.** A shore protection structure built (usually perpendicular to the shoreline) to trap littoral drift or retard erosion of the shore.

**GROIN SYSTEM.** A series of groins that function to protect a section of shoreline.

**JETTY.** A structure designed to protect and/or stabilize a navigation entrance.

**KING PILE.** The primary structural member that supports horizontal panels to form a vertical wall sometimes used in bulkhead or groin construction.

**LITTORAL DRIFT.** The sedimentary material transported along the shore by waves and currents.

**LONGSHORE TRANSPORT.** The movement of littoral drift (material) running parallel to the shoreline.

**PIER.** An elevated deck structure, usually pile supported, extending out into the water from the shore.

**PIERHEAD LINE.** The limiting line to which any pier or dock structure can extend into the water.

**PILE.** A cylindrical timber, concrete or metal member embedded into the ground to support or brace a structure.

**PILE, SHEET.** A pile with a generally slender flat cross section to be embedded into the ground or seabed and meshed or interlocked with like members to form a diaphragm, wall or bulkhead.

**REVETMENT.** A flexible structure usually constructed of stone or concrete and placed on a bank slope to protect it against erosion by wave and current action.

**SEAWALL.** A massive structure built along and parallel to a shoreline for the purpose of protecting and stabilizing the shore against erosion resulting from heavy wave activity.

**WAVE, DESIGN.** A wave that is potentially most damaging to an economically feasible structure, or wave for which a structure is designed.