

PART IA391 – Review of Structural Design

Subpart A – Review of Structural Design Documentation Deliverables from Technical Service Providers and Non-NRCS Engineers

July 2025

IA391.0 Purpose

This Iowa Instruction provides NRCS engineering staff guidance for reviewing structural design completed by non-NRCS engineering service providers.

IA391.1 Background

Non-NRCS engineering service providers designing structural practices as part of a conservation plan, or for which financial assistance is provided, must provide deliverables as specified in the applicable Conservation Practice Standard Statement of Work. Common conservation practices for structural work include 313 (Waste Storage Facility) and 367 (Roofs and Covers), among others. NRCS engineering staff must determine whether the documents submitted meet the requirements of the Statement of Work.

IA391.2 Procedure

- A. Large structures such as animal waste storage facilities may have multiple components and connections that must be properly sized to ensure the structure will withstand the required design loadings for its full design life. While design details will vary depending on the practice, materials, and site conditions, certain information will apply to most structural designs. Roof design will have additional requirements. Things to look for when evaluating the completeness of a structural documentation packet include:
 - 1. Minimum design loads must meet ASCE 7. The design must specify which edition was used. A summary of the required load cases and load combinations evaluated, with site-specific loading conditions (live, dead, wind, snow, lateral earth, manure, etc.) must be provided.
 - 2. Risk: Most animal waste structures will be Risk Category I, as defined in ASCE-7 (low risk to human life). Risk Category affects design snow, ice, seismic and wind load magnitudes. Agricultural storage structures “intended only for incidental human occupancy” (i.e. Risk Category I) do not require

seismic analysis. Documentation of Risk Category selection is warranted if the structure usage might entail more frequent or lengthy human occupancy, or other threat to human life in the event of failure.

3. Building Enclosure Classification: For wind load computations, buildings (structures with a roof) are classified as enclosed, partially-enclosed, or open, depending on the percentage of open areas in the building envelope (determined using equations from ASCE 7). A typical agricultural roof structure could fall under any of the three categories. Open is like a picnic shelter with no walls; Enclosed is more like a garage (but can still have a significant amount of open area). Partially Enclosed falls in between. Enclosed is the least conservative.
 4. Wind load (for buildings): A complete design evaluates wind loads from all four directions on each wall and roof, with both positive and negative internal pressure distributions, and applies these load cases simultaneously with snow, dead, live, etc., in the combinations specified by ASCE 7 (there may be over 100 load combinations). Different load combinations may govern for different parts of the structure.
 5. Appropriate code or design specification and year of edition used in design must be indicated for each component (e.g. ACI 318-11 for concrete, NDS-12 for wood, etc.). Most NRCS practice standards now specify use of the most recent version of each code or specification.
 6. Design method must be as indicated below. If design was completed using a computer program, include software name and version.
 - a. For concrete – unified (load factors matching ASCE 7), strength design, or working stress design.
 - b. For wood – Allowable Stress Design (ASD) or Load and Resistance Factor Design (LRFD).
 - c. For steel – Allowable Strength Design (ASD) or Load and Resistance Factor Design (LRFD).
 7. Material strengths, such as concrete compressive strength, steel yield strength, or wood species and grade, must be shown on plans and in computations.
 8. Foundation strength: If a soil bearing strength greater than 2,000 psf is used, design value must be justified by geologic investigation, testing or other evaluation.
 9. Stability: Walls or structures resisting lateral loads must be checked for factor of safety against sliding or overturning where appropriate.
 10. Results: Documentation may include resulting maximum net distributed loads on surfaces; maximum shears, moments and axial forces on members; and required member sizing, as appropriate.
- B. Each of the common engineering materials will have certain design requirements, such as:

1. Structural concrete design typically evaluates shears and bending moments at critical locations such as corners and the base of walls, along with other requirements such as temperature and shrinkage steel, bar spacing limits, development lengths, splice lengths, concrete cover over bars, and corner detailing.
2. Concrete paving slabs which have continuous soil support and no attached walls inducing moments in the slab do NOT fall under ACI 318. Agricultural slabs rarely have the vehicle frequency or axle load size to require a detailed pavement thickness design. 5" or 6" thickness is usually adequate unless subgrade is very poor. Important elements for paving and floor slabs include subgrade uniformity, joint detailing, edge treatments, and steel reinforcement requirements (based on subgrade drag formula). Guidance for a typical outdoor paving slab may be found in ACI 330R.
3. Sawn lumber and timber are designed for shear, bending, tensile and compressive strengths both parallel and perpendicular to grain, for various wood species and grades. Strengths are modified for site conditions by using various adjustment factors, such as load duration, wet service, and temperature factors.
4. Structural panels (plywood, oriented strand board) are designed for bending stress in strong and weak direction of panel, rolling shear, thickness shear, tension and compression in plane of panel, as appropriate. Material strengths are based on wood species, glue type and grade, with adjustment factors such as wet service, etc. Design requirements for manufactured wood panels are found in the National Design Specifications for Wood Construction (NDS).
5. Fasteners for wood are designed for withdrawal, shear, bending and bearing. Design requirements are found in the NDS. Fastener type, diameter, and length of penetration are defined. Values vary depending on whether fastener is parallel or perpendicular to the grain. Specialty hardware such as joist hangers may be designed based on manufacturer's allowable load tables (which also specify the number and type of nails/screws to be used with that hardware).
6. Anchor bolts for concrete are designed in accordance with Appendix D of ACI 318, which covers both cast-in-place and post-installed anchors.