Factors Contributing to Poultry House Structural Failures

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Acknowledgements

- Georgia Farm Bureau Insurance

Poultry house failures

- Most poultry house structural failures are not caused by a single structural issue or weather event.
- Failures are typically caused by a combination of a weakened structure and a major weather event.
- The fact is that major snow storms or high winds (not tornados) typically only bring down houses that have serious underlying structural issues.
- Structural issues that were very evident before the failure.

1) Foundations

- The integrity of the foundation is critically important to the overall strength of a structure.
- The foundation should not be neglected because problems with foundations can cause problems throughout the entire structure.

Often what looks like a truss failure, is actually a foundation failure

Even when it is not the root cause...it is often a contributing factor
1) Foundations

- A foundation is only as strong as the soil underneath and around the foundation.

  - The soil on which a foundation sits should be:
    - 1) well-drained
    - 2) free of organic matter
    - 3) have a uniform bearing capacity

If the soil beneath the foundation is substandard:

- The overall structural integrity of the building will be compromised.
- The soil must be able to carry the weight of the structure, equipment, and snow without significant compression.

When soil compression occurs...

- The structure moves...

To help insure overall house stability:

- The minimum depth of a poultry house foundation should be 12 inches.
- The depth of the footing is measured from the surface of the ground to the bottom surface of the footing.
A concrete stem wall is a house's foundation

- The stem wall is the foundation and therefore the bottom of the stem wall should be 12” below the surface of the soil.

In post houses the posts are the foundation

- It is generally recommended that side wall posts be buried a minimum of 36”.
- It is preferred that the bottom of the post be embedded in concrete to increase “foundation” area.
- Ideally with bolts through the bottom portion of the posts into the concrete to bind the concrete to the post.

Concrete stem wall houses

- A trench can help to insure proper foundation depth

Soil drainage around a foundation is very important

- Saturated soil has little strength to support a poultry house foundation in the vertical direction so a house will tend to settle over time.

Leading to a weakened structure
Soil drainage around foundation is very important
- Saturated soil also has little strength to support a poultry house foundation in the horizontal directions

The lack of horizontal foundational support...

Both of which can lead to failure when a load (snow/wind) is applied to the structure

can lead to rotation of the entire side wall or...

Drainage
- If the soil in the immediate vicinity of a poultry house is chronically saturated with water, foundations are prone to settling and rotation issues which can lead to a structural failure when loaded.
Foundations – exterior grading/erosion

- The bottom portion of a poultry house foundation must remain covered with soil.

Potential problem

Foundations – exterior grading/erosion

- The ground around a poultry house should slope away gradually (i.e., 1/12) to help direct water from the roof away from the foundation to prevent erosion.

Proper slope

Foundations – exterior grading/erosion

- It is generally recommended that the horizontal distance from the edge of foundation to the face of any steep slope (i.e., 3/12+) be a minimum of five feet.

Steep slope near foundation
Foundations – exterior grading/erosion

- Ground in the immediate vicinity of the foundation should be protected from scouring due to rain water flowing off the roof of the poultry house through the use of vegetative ground cover...

Or gutters

- Over time, scouring can lead to erosion of soil near the house foundation thereby effectively reducing foundation depth or possibly undermining the foundation

rocks/stone

- Large rocks near steep slope to prevent erosion

Erosion
Foundation above grade

When scouring has occurred it is important that proper grade is reestablished as soon as possible to prevent movement of the foundation.

Interior grading is equally important

- It is important that an interior foundation depth of 8" to 12" must be maintained in order to maintain proper vertical and lateral support.

Foundation – Interior grading

- Differences between interior and exterior grades can result in uneven loads being applied to the foundation possibly leading to foundation rotation.

Foundation – exterior grading/erosion

- The foundation must be protected from damage from clean-out equipment or exposure of the foundation due to removal of soil from the floor.
Top of block wall foundation at interior grade

Minimal interior foundation depth of concrete stem wall

Foundation - cracking
- Unequal or differential settlement of a foundation can cause the structure above to lean, become unstable or produce large stresses and forces in the structural members throughout the structure (i.e., trusses).

Cracking in block wall

Foundation - cracking
- Cracking is normally a sign of settlement or rotation in the wall. Settlement is not an adverse characteristic of a structure, provided it is uniform or equal all around the structure and is not excessive.

Cracking in concrete stem wall
Rotation of the foundation wall is normally caused by poor soil conditions. In many cases this rotation is caused either by the poor underlying soil or by poor grading/erosion around the foundation.

Based on observations the following criteria are suggested...

<table>
<thead>
<tr>
<th>Rotation of the foundation (degrees)</th>
<th>Suggestion</th>
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<tbody>
<tr>
<td>Less than 5 degrees</td>
<td>Not a major concern</td>
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Approximately 9 degrees of rotation

Approximately 7 degrees of rotation
House damage by concrete block wall rotation

Severe block wall rotation

Severe concrete block wall rotation

Concrete block wall rotation

Severe concrete block wall rotation

32 degree concrete block wall rotation
Keep in mind that concrete stem walls are tapered (85 – 87 degrees)

2) Damaged concrete blocks
- Concrete block walls can be degraded by the ammonia in the litter.
- Litter has a higher PH than concrete and also contains salts and moisture.
- Continuous exposure to manure can lower the strength of concrete
3) Connections

- In order to maintain the structural integrity of a poultry house it is important that the foundation and the side wall act as a single unit.
- Post houses are a prime example of a single structural unit.

In the case of houses with concrete blocks, the foundation must be positively connected to the blocks which in turn must be positively connected to the remainder of the side wall.

Ideally the cores of the concrete blocks should be filled occasionally.

Concrete block side walls have multiple structural units.

Unfilled cores
Unfilled cores

Filled cores with J-bolt to tie wall, sill plate, and foundation together.

Unfilled cores

Filled cores with J-bolts

And J-bolts tying the foundation to the sill plate.

Sound foundation
Connection of the walls to the foundation/footers

- In houses with concrete stem walls the concrete stem wall must be firmly attached to the wooden portion of the wall.

Stem wall with J-bolts

Proper washer size should be used

Washers too small
Connection of the walls to the sill plate

- The wall must be positively connected to the sill plate to prevent problems during up-lift caused by wind loads. Where wall framing is not continuous from the foundation sill to roof, the members must be secured to ensure a continuous load path.

4) Knee braces

- Knee braces are VERY important to the structural integrity of a poultry house.
- Knee braces eliminate rotation at the truss to wall connection.

Tornado damage

Wind causes lateral loads on the side walls

Sheathing and metal tie side wall together

Knee braces help to keep the side wall vertical
Knee braces help to keep the wall straight when the foundation has rotated.

Steel knee braces attached with lag screws are even better.

Toe nailed knee braces help, but ideally...

Steel knee braces – lag screwed.

Knee braces should be attached using lag screws to prevent movement.

Knee braces attached to upper and lower cords of trusses are stronger but are very difficult to install.
Knee braces attached to upper and lower cords of trusses

5) Weak connection of the truss to the side wall

- The truss must be positively connected to the wall to prevent problems during up-lift caused by wind loads.
- The truss must be positively connected to the wall by straps, clips or connectors made of corrosion resistant material not less than 0.040 inch in thickness.
5) Weak connection of the truss to the side wall

- Where wall framing is not continuous from the foundation sill to roof, the members must be secured to ensure a continuous load path.

6) Trusses

- Most trusses are manufactured by truss manufacturers using steel connector plates. Most of these trusses are pre-engineered…in many cases the only “engineered” component of a poultry house structure.
6) Trusses

- However, most pre-engineered trusses are designed as individual member components and may not take into account the interaction between members within the structure.

- The truss may be able to handle a 40 lb/ft² snow load but the structure may not.

House failed...trusses did not.

- Often times these trusses are not designed to interact with the walls of the structure which are used to carry the lateral loads caused by wind down to the foundation.

Factors that can lead to truss failure

- Connector plates should be located on both faces of the truss and nails fully embedded in the wood.

Factors that can lead to truss failure

- The trusses must be braced such that the truss remains in a straight and plumb position.

If installed and maintained properly trusses generally do not fail.

Side view of poultry house
Trusses not in the vertical plane

A few out of plumb trusses can cause a chain reaction

Trusses must be braced properly to remain in the vertical plane

“X – Bracing”

Properly installed lathing is required for the truss to stand up to its rated capacity.

The load carrying capacity of a truss is dramatically reduced when it is out of plumb
Signs of possible truss problems

- The roof line should be straight and horizontal inside and outside.

Variations in ridge line are typically an indicator of truss “failure”

Roof line

- From visual inspection of the house if the roof line is not horizontal then a detailed inspection of the trusses and house must occur in the region of the house where this settlement has occurred.
- In that region the trusses must be inspected for:
  - Straightness
  - Problems associated with truss plates, twisting of members, etc.
  - The region to be inspected must extend in both directions past the point where settlement has occurred a sufficient distance to make sure no additional problems exist.
  - Damaged trusses must be repaired

Dip in ridge line near end wall

Dip in ridge line in center of the house

Improper truss repair
Improper truss repair

Signs of possible truss problems

- The condition of the roof should be inspected to make sure all the roof tin is adequately attached to the purlins and that no leaks occur in the roof. No sagging of the roof tin should be observed in the roof material between trusses.

Take-Home Points

- Proper construction and maintenance are much cheaper than corrective actions
- Failures are usually the result of structural problems + bad weather
- Look for problems before they occur
- Start with the foundation and work up

Signs of possible truss problems

- Holes in tri-ply
  - From visual inspection of the house ceiling, all holes in the tri-ply must be repaired.
  - Holes in the ceiling result in moisture and ammonia-laden air entering the attic space where it condenses on structural members and corrodes metal surfaces sometimes leading to the loss of the structure.