Drop Inlet Failures
Client

● Natural Resources Conservation Service
  
● Federal agency that provides assistance to private landowners.

● Helps improve and protect the soil, water, and natural resources of the land.
Introduction

- During a storm event, runoff volumes are high over agricultural land.

- This results in an increase of:
  - Surface runoff
  - Rill and gully erosion
  - Peak discharge rate

http://www.soils.agri.umn.edu/academics/classes/soil2125/img/10riller.jpg

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Grade Stabilization Structures

- GSSs stabilize grades by moving runoff through artificial or natural channels.

- GSSs are effective in:
  - Controlling runoff volumes
  - Preventing advancement of gullies
  - Stabilizing land forms
Grade Stabilization Structures
Profiles of Inlet Structures

- Requires high heads for full pipe flow
- Ineffective for GSSs
- Initial design in 1950s
- Low heads produce full pipe flow
- Less vortex formation than blunt

Canopy Inlet
- Canopy provided more strength
- Effective for vortex formation than sliced

Sliced Inlet
Current Design Specifications

- NRCS spec. for canopy inlet dimensions.
  - slope less than 15%: $W=0.2D; L=0.75D$
  - slope greater than 15%: $W=0.3D; L=1.25D$
Canopy and Sliced Inlets

- Effective in moving large volumes of water at low heads
- Widely used in Oklahoma for GSSs
- As sizes increased, failures began occurring
Failure Definition

- Inlet folds inward, creating a blockage of flow.
- Always occurring on the left side
- Typically 48” diameter or greater; 16 gauge thickness.
Current Repair Options

Methods currently in use:

- Angle-iron on rim
- Angle-iron top of inlet
- Anti-vortex baffles
- Convert sliced inlets to canopy inlets
NRCS Desired Results

- Identify causes of inlet failures
- Determine pipe sizes, corrugations, and gauges that need increased strength
- Develop new design standards
The NRCS also requests:

- alternative methods for strengthening
- cost comparison of retrofit options
Why Corrugated Metal Pipe?

- Corrugation increases the stiffness of steel plates and improves strength.
- Lightweight and durable.
- The application determines corrugation size and type.
The ability of CMP to support a load is derived from:

- **Dead Loads**: embankment or trench backfill, stationary superimposed surface loads, uniform or concentrated.

- **Live Loads**: Moving loads, including impacts (AISI, 1994).
Load Distributions

- Loads are distributed uniformly over top and bottom of pipe.
- Loads caused by passive pressures of the earth are said to be greater toward the center of the pipe.
Preliminary Calculations

- Calculated hydraulic (HGL) and energy grade line (EGL).

\[ gV = HGL + EGL^2 \]

\[ HGL = CLP + z + h \]

![Graph showing HGL and EGL vs. Pipe Length](image)
Initial Investigation

- Field Tour of Installation Sites
  - Toured several installation sites in western Oklahoma
  - Viewed failed and reinforced inlet structures
Initial Investigation

- Demonstration Flume
  - Located at the USDA ARS Hydraulics Lab in Stillwater, Ok.

- Made observations of pipe flow characteristics through pipe inlets.
Demonstration Models

- Plexiglas inlet models include:
  - Blunt
  - Sliced
  - Canopy
  - Red film
Red Film Observation

- Modeled same failures as seen in the field
- Exhibited similar characteristics
Manometer Test

- Manometer constructed of flexible clear plastic tubing and an air pump needle.

- Pressure measurements taken at increments around circumference.

- Pressure measured by changes in water level.
Manometer Test Results

Canopy Inlet Model
Pressure Distribution

Blunt Inlet Model
Pressure Distribution
Future Investigation

- Physical modeling
  - Redesign flume
  - Plastic corrugated tubing
  - 3” – 6” diameters

- Numerical modeling
Investigation is ongoing into the forces that the pipe is experiencing

Further testing of inlet structures with physical models

Determine reinforcement methods that need to be implemented
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