Bridge Failures in Alberta

Introduction

- Bridges are inspected for three primary reasons
  - safety of bridge system
  - maintenance of bridges
  - management of bridge system
- Inventory or management of the system can be just as important as safety and maintenance

Need to Know

- Which bridges are:
  - substandard and not adequate to carry full legal loads
  - susceptible to flooding
  - high priority for replacement

Causes of Failure

- 70% of failures are caused by factors related to water flow
  - scouring of piers
  - undermining of the support elements
- Structural failure
  - element failure due to excess load or material deterioration
- Lack of knowledge or good judgment
  - Operation
  - Construction
  - design

Contributing Factors

- Structural engineering is a science
  - applied truckloads are known
  - material behavior is known and can be accurately predicted
  - everything can be accurately calculated and predicted
- River engineering is more of an art
  - the effects of a flood cannot simply be calculated
  - the effects of Mother Nature are not easily predicted
  - the velocity and angle of flow, the duration of flooding, etc.

Bear Creek on 84 Ave in Grande Prairie

- SPCSP HE 5.5 x9m
- Installed in 1973
- Total collapse of structure in 1988
- No inspection after installation

Bear Creek on 84 Ave in Grande Prairie

Structure on 84 Avenue in Grande Prairie

Bear Creek on 84 Ave in Grande Prairie

Total collapse of culvert. Only headwall intact

Bear Creek on 84 Ave in Grande Prairie

Inside of collapsed culvert

Bear Creek on 84 Ave in Grande Prairie

Outlet of culvert

Bear Creek on 84 Ave in Grande Prairie

Backfill characteristics

Bear Creek on 84 Ave in Grande Prairie

Water and sewer line in embankment

Beaver Ranch Creek on Hwy 58 East of Vermilion

- SPCSP HE 4.8 x 7.3
- Installed in fall of 1987
- Extensive deformation in 1988
- Total collapse in 1989 while fill being removed for repair of culvert

Beaver Ranch Creek on Hwy 58 East of Vermilion

Outlet showing intact end treatment

Beaver Ranch Creek on Hwy 58 East of Vermilion

Inlet with culvert still connected to headwall

Beaver Ranch Creek on Hwy 58 East of Vermilion

Overview of culvert inlet

Weed Creek on Highway 39 Near Thorsby

- Arch culvert
- Constructed in 1960
- Washed out July 3rd, 1990.

Weed Creek on Hwy 39 Near Thorsby

Concrete arch culvert in 1989

Weed Creek on Hwy 39 Near Thorsby

Water on U/S end up to shoulder of road

Weed Creek on Hwy 39 Near Thorsby

Hole in side slope on d/s side

Weed Creek on Hwy 39 Near Thorsby

Water now coming out of d/s fill

Weed Creek on Hwy 39 Near Thorsby

Road gone

Weed Creek on Hwy 39 Near Thorsby

Upstream inlet

Weed Creek on Hwy 39 Near Thorsby

d/s outlet

Weed Creek on Hwy 39 Near Thorsby

Centre section of culvert

Weed Creek on Hwy 39 Near Thorsby

Erecting 8.5 m SPCSP

Weed Creek on Hwy 39 Near Thorsby

u/s inlet of new culvert

BF 77496 – Hwy. 40 over Lineham Creek in Kananaskis

- 4.3M diameter Structural Plate Ellipse (SPE) culvert installed in 1983.
- 53M invert length.
- 9.1M road to streambed height.
- Washed out during 2013 flood event.

BF 77496 – Looking D/S at scale of washout (30m wide vs. 4.3M pipe).

BF 77496 – Drift blockage across inlet and heaved barrel.

BF 77496 – Inlet blockage and barrel heave

BF 77496 – Outlet and barrel floor folded and heaved nearly to roof

BF 77496 – Replaced in 2015 with new 8-14-8 M SLW girder bridge

Red Willow River on Local Road near Rio Grande

- 150' through truss built in 1927
- Bridge posted for 17 tons
- Bridge collapsed 1977
- Failure of rotten abutment corbel

Red Willow River on Local Road near Rio Grande

Collapsed bridge

Red Willow River on Local Road near Rio Grande

Abutment end of bridge showing timber deck etc.

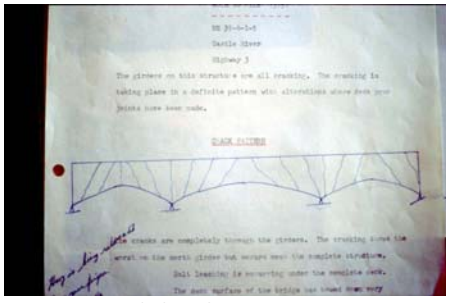
Red Willow River on Local Road near Rio Grande

Abutment end of truss dropped and buckled the bottom chord

Castle River Bridge on Local Road West of Pincher Creek

- built in 1951 designed by consultant in Toronto
- Concrete T girder poor condition in 1961
- replaced in 1981

Castle River Bridge on Local Road West of Pincher Creek



Recorded crack pattern in 1964

Castle River Bridge on Local Road West of Pincher Creek

Bridge condition in 1979 (28 years old)

Castle River Bridge on Local Road West of Pincher Creek

Shear crack in girder and efflorescence from cracks

Castle River Bridge on Local Road West of Pincher Creek

Shear crack at girder end

Castle River Bridge on Local Road West of Pincher Creek

Removing bridge in August 1980

Castle River Bridge on Local Road West of Pincher Creek

Bridge down

Castle River Bridge on Local Road West of Pincher Creek

Bridge remains

Simonette River Bridge on Forestry Trunk Road (South of Debolt)

- Timber and Bailey built in 1960 deck to s/b 3m
- 1982, 2 through trusses 60.96m 9m deck to s/b
- Washed out in 1987 (Tornado Flood)
- Rebuilt in 1988

Simonette River Bridge on Forestry Trunk Road (South of Debolt)

Forestry bridge built in 1960, 380 ft. long bridge

Simonette River Bridge on Forestry Trunk Road (South of Debolt)

Forestry Double Bailey, chord reinforced 2 @ 100 ft.

Simonette River Bridge on Forestry Trunk Road (South of Debolt)

Bridge built in 1982, 122m bridge

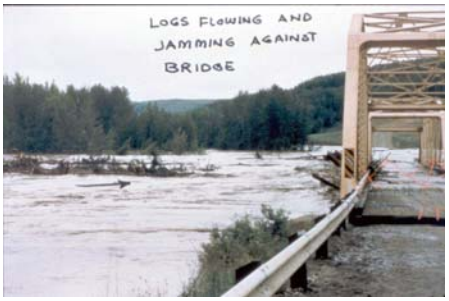
Simonette River Bridge on Forestry Trunk Road (South of Debolt)

Forestry road with river in flood, 1987

Simonette River Bridge on Forestry Trunk Road (South of Debolt)

Truss partly under water

Simonette River Bridge on Forestry Trunk Road (South of Debolt)



Drift jamming under bridge

Simonette River Bridge on Forestry Trunk Road (South of Debolt)

Bridge floating and starting to shift

Simonette River Bridge on Forestry Trunk Road (South of Debolt)

Bridge starting to move laterally

Simonette River Bridge on Forestry Trunk Road (South of Debolt)

Bridge floating downstream

Simonette River Bridge on Forestry Trunk Road (South of Debolt)

One span tipped in middle channel and other one around near shore

Simonette River Bridge on Forestry Trunk Road (South of Debolt)

Bridge gone

Simonette River Bridge on Forestry Trunk Road (South of Debolt)

New bridge

Beaverhill Creek on Local Road North of Lamont

- 3-28' Precast Concrete
- Constructed in 1959
- North pier cap failure in August 1980

Beaverhill Creek on Local Road North of Lamont

Local road with gravel truck pup remaining on bridge

Beaverhill Creek on Local Road North of Lamont

Pup tandem axle in hole left by dropped girder

Beaverhill Creek on Local Road North of Lamont

Sheared timber cap. One girder hung up on pile.

Beaverhill Creek on Local Road North of Lamont

Failed pier cap

Beaverhill Creek on Local Road North of Lamont

Failed pier cap with girder dropped to pile top level

Beaverhill Creek on Local Road North of Lamont

Bottom of cap with piles punching (North pier)

Little Smoky Bridge on SH 744

- Constructed in 1954
- 150 span failed in 1980 by cat and blade on high boy

Little Smoky Bridge on SH 744

Severed batter post U7 - L8

Little Smoky Bridge on SH 744

Broken hanger U7 - L7 and first diagonal U7 - L6

Little Smoky Bridge on SH 744

Members L6 - U5 and U5 - L5 buckled

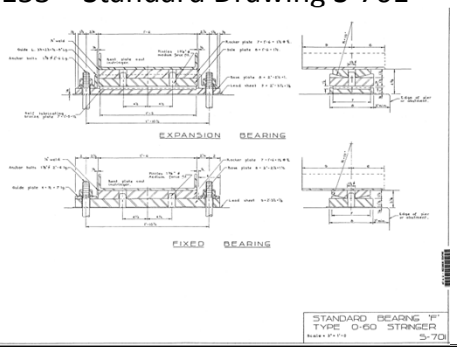
Little Smoky Bridge on SH 744

Inside of truss, sagged 2’-0 leaning 10”

BF 1153 – Hwy. 22 over Oldman River near Lundbreck

- 3 span Type PO girders on concrete substructure -built 1959.
- Span lengths of 20.7 – 29 – 29 M.
- Typ. Sliding Plate Bearing with Self-Lubricating Bronze Plates.
- Expansion Bearings at P1 and P3. Deck height is 18.5M.
- Routine Level 1 BIM inspection of December 2015 noted frozen bearings at the west end of P1 under Span 1 - G1 and G2.
- Significant portion of concrete pier cap under G1, G2 bearings had failed due to induced stresses into pier from frozen bearings resulting in G1 un-supported and near collapse.
- Lane above immediately closed and truck traffic detoured.
- Subsequent BIM Advisory bulletin #3 issued January 20, 2016.

BF 1153 – Standard Drawing S-701



BF 1153 – Failed concrete at west end of P1 from frozen bearings under G1, G2.

BF 1153 – Failed pier concrete and un-supported bearing under Sp. 1-G1.

BF 1153 – 30mm drop in rail and curb over Sp.1-G1.

Questions??