CONFIDENTIAL REPORT

Fiberglass Well Cap Tests

for

GP Fiberglass Ltd.
Melfort, Saskatchewan

by

Small Industry Services

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SRC Publication No. 10177-2C00

November, 2000

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1 INTRODUCTION

GP Fiberglass Ltd, located near Melfort, Saskatchewan, manufactures 30-inch diameter corrugated well casing in 25 foot lengths and also fiberglass caps which fit over the end of the well casing. Each component is provided with a serial number and associated with each serial number is production data including manufacturing times for each phase, amount and type of resin, amount and type of glass and catalyst used.

Tests conducted on fiberglass well casing and caps on June 12, 2000 showed that the well casing without any backfill could support vertical loads ranging from 33,200 to 38,000 pounds. Similar tests on the cap with a hole resulted in vertical support loads of 3100 to 25,300 pounds. The loads on the caps varied considerably because of differences in the thickness of the fiberglass material and the procedure used to load the caps in the laboratory.

Based on the earlier tests it was concluded that a test procedure simulating field load conditions should be employed to test the caps. In this procedure a foot or more of pea gravel would be placed above the cap to ensure more uniform loading on the cap. The well cap mold was modified recently and new caps with thicker rims were molded.

Mr. Gregg Phillips, President of GP Fiberglass Ltd., requested that the tests on the new well caps using the new test procedure be witnessed by engineering personnel from the Product Design and Development Group of the Saskatchewan Research Council. This report outlines the tests that were conducted and the data that was obtained on November 27, 2000 by Tony Kaminski, P. Eng, PhD, a principal engineer at the Saskatchewan Research Council in Saskatoon.

2 OBJECTIVE

The objective of the tests was to obtain the following data on redesigned well caps:

(1) load data when the cap is positioned on a vertical casing and covered with at least one foot of pea gravel
(2) load data on the new cap without any pea gravel on top

3 TEST PROCEDURE

Tests were conducted using both 6-inch and 12-inch lengths of well casing. The shorter well casing was used when pea gravel was placed over the cap, whereas, the longer well casing was used in tests without any pea gravel. The following data was obtained for the well caps.

(1) component weight using a Toledo platform scale
(2) wall thickness using a Mitutoyo 8-inch digital micrometer
(3) product temperature using a infrared thermometer
(4) test time using a digital stop watch
(5) product length or diameter using a tape measure

(6) vertical test force using a CDK RL9000 100,000 lb capacity load cell with a Rice Lake Weighing System Model IQ + 355-2A indicator supplied by Norac Systems in Saskatoon

Each component was loaded using a Model 36-60-100, 100-ton hydraulic press manufactured by Fasoli Industries Ltd., having a 36" x 60" bed. The vertical well cap tests were tested with pea gravel as shown in Figure 1.

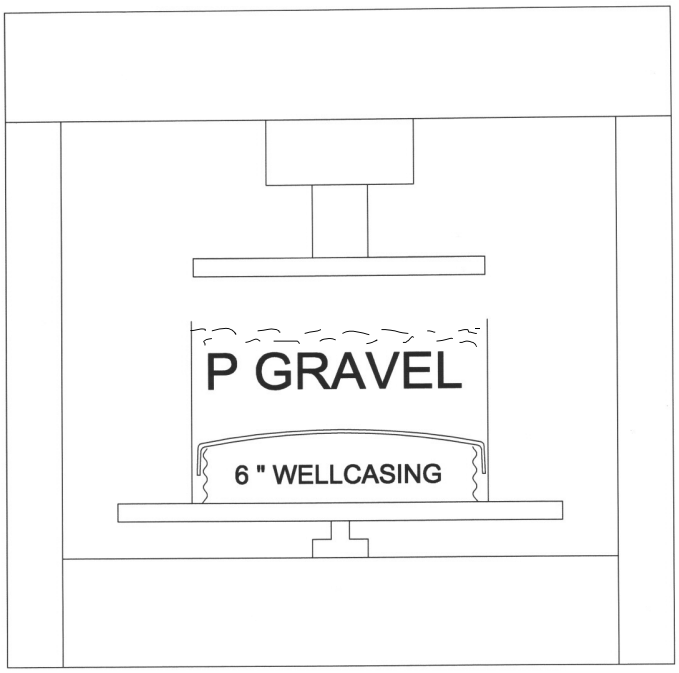

Figure 1 Vertical Loading of Well Cap with 14" of Pea Gravel on Top

A total of 640 pounds of dry pea gravel was used for each test. A 6-inch length of well casing was placed inside a steel pipe having a diameter varying from 31⅝ inches to 32 inches. The piston diameter was 31½ inches. Both the well casing and well cap were centered inside the steel pipe with 35 pounds of pea gravel placed between the fiberglass well components and the steel pipe. The remaining 605 pounds of pea gravel was placed above the well cap which filled the top of the 21-inch length of steel pipe. The gravel was leveled at the top before the hydraulic piston was lowered to load the cap. Tests with pea gravel were conducted on four well caps with 6 11/16 inch diameter holes at the top and on two well caps without holes in the center. For the caps with holes a 9-inch diameter fiberglass disc with an average thickness of 0.295 inches was used to cover the hole and prevent pea gravel from passing through the hole during a test.

The well casing caps were also tested without any pea gravel as shown in Figure 2.

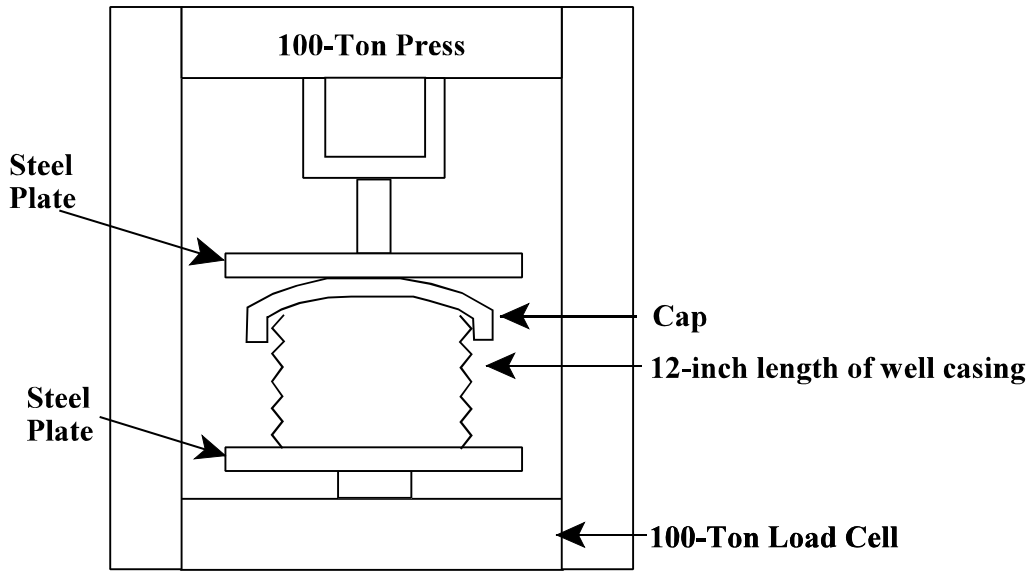

Figure 2: Vertical Loading of Well Casing Cap Without Gravel

In tests without pea gravel a 12-inch length of well casing was used. Tests without pea gravel were conducted on three well caps and on the last two tests vertical height data was taken both between the lower steel base plate and the bottom of the rim on the cap and also between the top piston plate and the lower steel base plate. From this information it was possible to estimate both the deflection of the well casing and the deflection of the well cap. Each well cap had approximately 1⅜ inches of crown at the top.

The general test procedure consisted of the following:

(1) record serial number, weight, dimensions, and temperature
(2) mount the cap and well casing inside the steel pipe and place pea gravel around casing then on top and level. For tests without pea gravel use the longer well casing and eliminate the steel pipe.
(3) start stop watch, apply initial load and measure distance between steel plates. For some cap tests measure the distance from bottom of rim to the lower steel plate
(4) increase load in varying increments and take length data between each load change
(5) record the maximum observed load prior to failure
(6) read time on stop watch
(7) perform calculations such as average wall thickness, and in some cases average piston pressure

For caps with holes on the top, four thickness readings were also taken at the top of the cap next to the hole. Four rim thickness measurements were also taken for each cap. Data sheets for all the tests are included in Appendix A.

4 TESTS WITH VERTICAL LOADING OF WELL CASING CAPS

The data sheets for the nine well cap tests are in Appendix A. Six caps were tested with pea gravel to provide more uniform loading on the cap which had a dome height of about 1⅜ inches. In the cap tests conducted earlier on June 12, 2000, no pea gravel was used. In order to determine the approximate increase in load carrying capacity of the new cap with a thicker rim three caps were also tested without pea gravel.

The results of the well cap tests are summarized in Table 1.

Table 1 Test Data with Vertical Loading on 30⅝" OD Well Cap

Cap Identification	Cap Type	Average Thickness Top	Average Thickness Rim	Loading Configuration	Deflection Prior to Loading	Fracture Load	Average Piston Pressure
2000100411 (4 lb of glass)	with hole	0.447	0.360	14" of pea gravel (uniform loading)	1.56"	57,640 lb	73.8 lb/in^2
2000100407 (4 lb of glass)	with hole	0.424	0.351	14" of pea gravel (uniform loading)	1.50"	60,270 lb	77.4 lb/in^2
2000100408 (4 lb of glass)	with hole	0.430	0.354	14" of pea gravel (uniform loading)	1.75"	67,230 lb	86.3 lb/in^2
2000091503 (4 lb of glass)	no hole	-	0.349	14" of pea gravel (uniform loading)	1.81"	76,150* lb	97.8* lb/in^2
2000092115 (3 lb of glass)	no hole	-	0.344	14" of pea gravel (uniform loading)	1.87"	71,110 lb	91.3 lb/in^2
2000092113 (5 lb of glass)	no hole	-	0.344	14" of pea gravel (uniform loading)	1.56"	76,120* lb	97.7* lb/in^2
2000091504 (4 lb of glass)	no hole	-	0.349	no gravel (center loading)	1.19"	7,400 lb	-
20000100421 (4 lb of glass)	no hole	-	0.354	no gravel (center loading)	1.06"	5,300 lb	-
20000100329 (4 lb of glass)	no hole	-	0.353	no gravel (center loading)	0.81"	4,830 lb	-

* Denotes that cap did not fail but test was stopped and cap was inspected.

The test time for caps covered with pea gravel varied from 4.5 to 6 minutes whereas the tests without pea gravel required 1.5 to 2 minutes. The caps tested with pea gravel tests had temperatures ranging from 71 to 75°F. The caps tested without pea gravel had temperatures of 40 to 74°F.

The results of the 9 well cap tests indicated the following:

1) Addition of 14" of pea gravel above the cap enabled more uniform loading on the caps and very dramatically increased the load carrying capacity to a minimum of 57,640 lbs and a maximum of over 76,150 lb.

2) With pea gravel loading on the caps they could support average vertical pressure of 73.8 lb/in^2 to about 100 lb/in^2.
3) The loading on two caps without center holes was stopped at just over 76,000 lbs without failure. However removal of the caps and subsequent inspection indicated that some small cracks had formed in the rim and above the side bend.
4) The presence of a 6 11/16" diameter hole at the center of the caps tested with pea gravel appeared to weaken the cap slightly when compared to caps tested without a hole.
5) With pea gravel loading the caps deflected from 1.5 to 1.87 inches before failure.
6) The failed caps usually had one crack in the rim and one or more cracks above the rim.
7) The caps without holes tested without pea gravel were loaded only at the center and failed at loads of 4830 to 7400 pounds. Similar tests conducted months earlier showed that the caps with thinner rims cracked at loads of 3030 to 3100 pounds. Hence increasing the rim thickness from about 0.18 inches to 0.35 inches increased the cap load carrying capacity considerably.
8) The caps tested without pea gravel failed at deflections of 0.81 to 1.19 inches.
9) During each test the majority of vertical deflection was in the cap with only about 1/16 inch deflection of the well casing.

5 SUMMARY AND CONCLUSIONS

A total of nine laboratory tests were conducted on redesigned fiberglass well caps using an instrumented hydraulic press. Six caps were tested with 14 inches of pea gravel on top to provide more uniform loading of the caps and three caps were tested without pea gravel.

The results of these tests showed the following:

1) the maximum vertical load that a fiberglass well cap could support with pea gravel above providing uniform loading varied from 57,640 lbs to over 76,150 lbs.
2) The maximum vertical load a fiberglass cap could support without pea gravel and only center loading varied from 4830 to 7400 lbs.
3) uniform loading over the entire well cap increased the load carrying capacity by about ten times when compared to non-uniform center loading at the center of the cap
4) the redesigned well caps with heavier rims supported significantly higher loads than caps tested earlier with thinner rims.

APPENDIX A

Data Sheets for 9 Tests with Vertical Loading on Well Caps Positioned on Well Casing

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