



SHEAVE STUDY REPORT

Caribou Mine, Nova Scotia

Project #: AV107853

Prepared by:

Mathieu Rosa, jr. Eng.

GENIVAR Limited Partnership

Mathieu Rosa, jr. Eng.

Checked by :

Jean Béliveau, Eng.

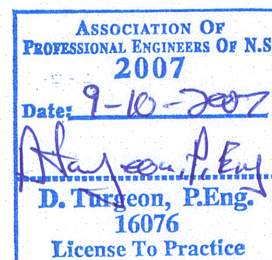
GENIVAR Limited Partnership

Jean Béliveau, Eng.

Approved by :

Dominick Turgeon, P. Eng.

GENIVAR Limited Partnership



For:

Scorpio Gold Corporation

995 Germain street,
Val-d'Or, Quebec
J9P 7H7

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Introduction

Scorpio Gold Corporation has initiated the re-opening of the Caribou Mine located near Musquodoboit, Nova Scotia. One of the most important surface installation equipment is the sheave on the headframe sheave deck.

Two sheaves were previously bought by Scorpio Gold Corporation and the maximum sheave load rating must be calculated. The sheave ID numbers are DOL 7322-1 and DOL 6657-1. GLV (Dorr Oliver), the sheaves manufacturer, was not able to confirm this value. GENIVAR picked up the mandate and this report shows the results from the sheave certification analysis.



Figure 1: Sheaves (ID#: 7322-1 and 6657-1) stored in Ross Finlay's courtyard

Sheave specifications

Owner:	Scorpio Gold Corporation
Mine localization:	Caribou mine, Musquodoboit, Nova Scotia
Manufacturer:	GLV (Dorr Oliver)
Manufacturing date:	February, 1970
Serial numbers:	DOL 7322-1 and DOL 6657-1
Pitch diameter:	72 inches
Rope diameter:	1 1/8"
Wrap angle:	120°
Maximum fleet angle:	1° 29' 28''

Results

Referring to some preliminary studies and to some discussion with GLV, the most critical sheave parts are the spokes and the shaft. Both are made of materials with a yield strength of 207 MPa. Three critical cases may lead to sheave failure :

- 1- Stress exceeding the yield strength;
- 2- Spoke buckling;
- 3- Fatigue failure.

The preliminary results showed that the most critical case is the spoke buckling which occurs with a compressive stress of 172 MPa in the spoke. Therefore, numerical analyses were conducted to meet this case and a maximum rope pull of 250 kN (56 200 lbs) has been determined. The following pictures show the results based on a rope pull of 250 kN.

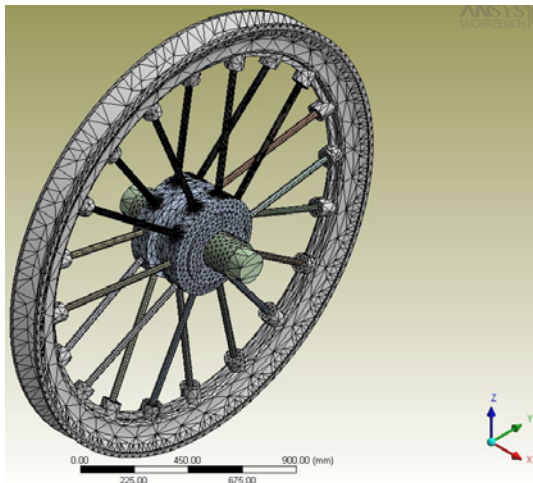


Figure 2: Sheave global mesh

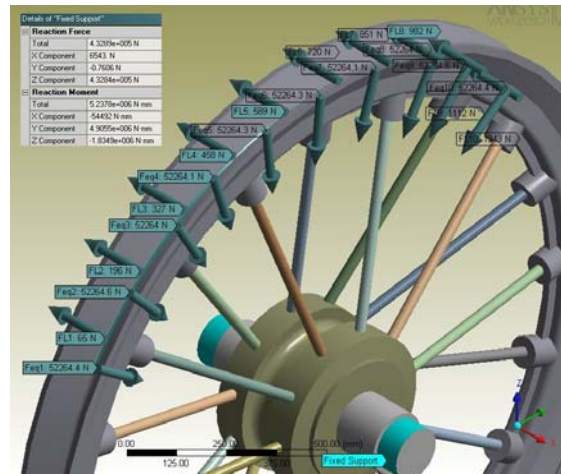


Figure 3: Sheave numerical load



Figure 4: Equivalent stress
(192.2 < 207 MPa)

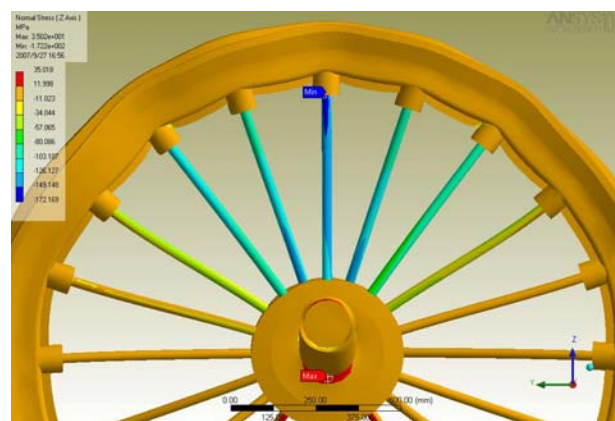


Figure 5: Compressive stress
(172.2 ≈ 172 MPa)

Results analysis

The sheave design was checked to Nova-Scotia Mine Hoisting Plants, Section 309 (1) (c), 326 (1) and 326 (3). A copy of these regulations is enclosed in appendix 1.

Referring to regulation 326 (3), the maximum rope pull was reduced by 10% to consider stress concentration and corrosion effects. Also, a 10% increased to consider impact and acceleration effects was applied on the maximum sheave rated load.

Referring to regulation 326 (1), a safety factor of 4 was used for the analysis. The maximum sheave rated load can be calculated as follow :

$$\frac{(\text{maximum rope pull})0.90}{(\text{maximum sheave rated load})1.10} = 4$$

where the maximum rope pull is 250 kN (56 200 lbs).

That equation gives a **maximum sheave rated load of 51.13 kN (11 495 lbs)**.

Referring to the regulation 309 (1) (c), the rope breaking strength for which the sheave is designed must be included on the sheave certificate. Considering a rope breaking strength of 560 kN (126 000 lbs)** , **the safety factor on the rope breaking strength is 0.45 (250 kN / 560 kN) where the minimum value is 1.**

** Value taken from Wire Rope Industries, model Minepro TRI-MAX FS.

Conclusion

The sheave design was checked to Nova-Scotia Mine Hoisting Plants, Section 309 (1) (c), 326 (1) and 326 (3). Even though regulations 326 (1) and 326 (3) requirements are met, the **sheaves DOL 7322-1 and DOL 6657-1 do not comply with Nova-Scotia Mine Hoisting Plants, Section 309 (1) (c)** and cannot be certified as such.

APPENDIX 1 : Nova-Scotia critical regulations

Certificate required for sheave

- 309 (1) Before a sheave is first used or relocated, an employer must obtain a certificate for the sheave from the manufacturer of the sheave or an engineer certifying as to
- (a) the maximum rated load of the sheave;
 - (b) the diameter of shaft rope for which the sheave is designed;
 - (c) the breaking strength of the shaft rope for which the sheave is designed; and
 - (d) the maximum amount of groove wear that is permitted for the sheave.
- (2) An employer must ensure that no person is permitted to use a sheave other than in compliance with the limits certified under subsection (1).

The intent of this section is to have the required tests performed **before** a sheave is first used; or if it has been moved to a new location, the tests would have to be repeated before its first use. The tests are not required for the first use by the sheave after these mining regulations became force. For greater clarity if a sheave has been used, has not been relocated, and was simply inactive when these regulations came into being the tests are not required. (February, 2005)

Sheave construction and identification

- 310 An employer must ensure that a sheave
- (a) is made of materials that will withstand the ambient temperatures;
 - (b) is fitted with a groove to fit the shaft rope being used; and
 - (c) bears a serial number and the date of its manufacture.

Testing of shaft of sheave

- 311 An employer must ensure that a competent person tests the shaft of a sheave for flaws, by a non-destructive test
- (a) before being installed in a particular location;
 - (b) immediately after installation in a particular location; and
 - (c) annually, or as recommended by the manufacturer, whichever is less.

- (5) No employer is permitted to allow a shaft conveyance to be loaded in excess of the maximum number of persons or maximum weight of materials that the conveyance is permitted to hold.
- (6) At least once every 5 years of use, an employer must ensure that a competent person examines each shaft conveyance and counterweight and records the results of the examination.
- (7) An employer must ensure that the record referred to in subsection (6) is kept for at least 2 years after the date the equipment referred to in subsection (6) is no longer used at the mine.

Maximum allowable design stresses for shaft conveyance

- 326 (1) An employer must ensure that each part of a shaft conveyance or counterweight that carries the rated load is capable of withstanding at least 4 times the maximum allowable design stresses without permanent distortion to any part of a shaft conveyance or counterweight.
- (2) An employer must obtain a certificate from an engineer certifying that all parts of a shaft conveyance or counterweight meet the requirements of subsection (1).
- (3) When determining the maximum allowable design stresses for the purpose of subsection (1), an engineer must refer to the maximum allowable design stresses established by generally accepted engineering principles and consider for each shaft conveyance or counterweight
- (a) its weight;
 - (b) its rated load;
 - (c) any impact load;
 - (d) any dynamic load;
 - (e) stress concentration factors;
 - (f) corrosion;
 - (g) metal fatigue; and
 - (h) effects of the use of different materials in contact with each other.