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Research Article

Estimation of shear force for blind shear ram blowout preventers

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Abstract

In this study, the estimation of shear force for blind shear ram type blowout preventer was investigated by using Finite Element Method (FEM). So, the effect of the blowout preventer working condition on shear force requirement for shear operation could be accurately approximated by simulating the entire process, and ram geometry could be optimized to reduce force and energy used to shear the tube by plastic deformation...

1. Introduction

During drilling operations, all formations' high pressure fluids and gases of the earth are controlled by borehole pressure, which consists of hydrostatic pressure of drilling mud, pump pressure, and friction pressure loss in the annulus. If, for any reason, the borehole pressure falls below the formation fluid/gas pressure, the formation fluids/gases will enter the hole and a pressure "kick" will occur. If a kick cannot be controlled properly, uncontrolled formation fluids/gases will reach to surface where the drilling rig is located. Such a catastrophic event is known as blowout [1].

To prevent formation fluids/gases to reach the surface of the well, blowout preventers are used as safety valves. When they are activated, they are supposed to close off the wellbore and seal it (in some cases, the sealing pressures are 20,000 Psi which is 1360 bar) in an emergency to control and balanced formation fluids and gases [2,3].

In a blowout preventer stack, two types of blowout preventers are used; annular and ram. Annular BOPs are used in combination with hydraulic system that can seal off different sizes of annulus whether drill pipe is in use in the wellbore or not. Upon command, high-pressure fluid is directed to the closing hydraulic ports positioned in the lower side of the piston. This causes the operating piston to move upward; therefore, the moving piston compresses the packer [2-43]. Because of a cap at the top of annular blowout preventer, the packer can only move toward the center of the wellbore to pack off a drill pipe or seal off the wellbore.

2. The Effect of Factors on Shear Force

The Distortion Energy Theory shear equation might not be sufficient with newly-developed drill pipes that have highly advanced material properties....

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2.1. Temperature Gradien

In the offshore drilling operation, subsea blowout preventer is placed on the seabed; and seawater temperature at this depth might be around 3-5°C, while the formation fluid temperature that flows through the wellbore in case of blowout could be higher than 150°C. Therefore, the temperature difference between seawater that enclosed the BOP stuck and formation fluid could be significant when the blind shear ram is activated (Fig. 1). This temperature difference will cause the material properties to change and create a thermal stress on the pipe and shear ram as well….

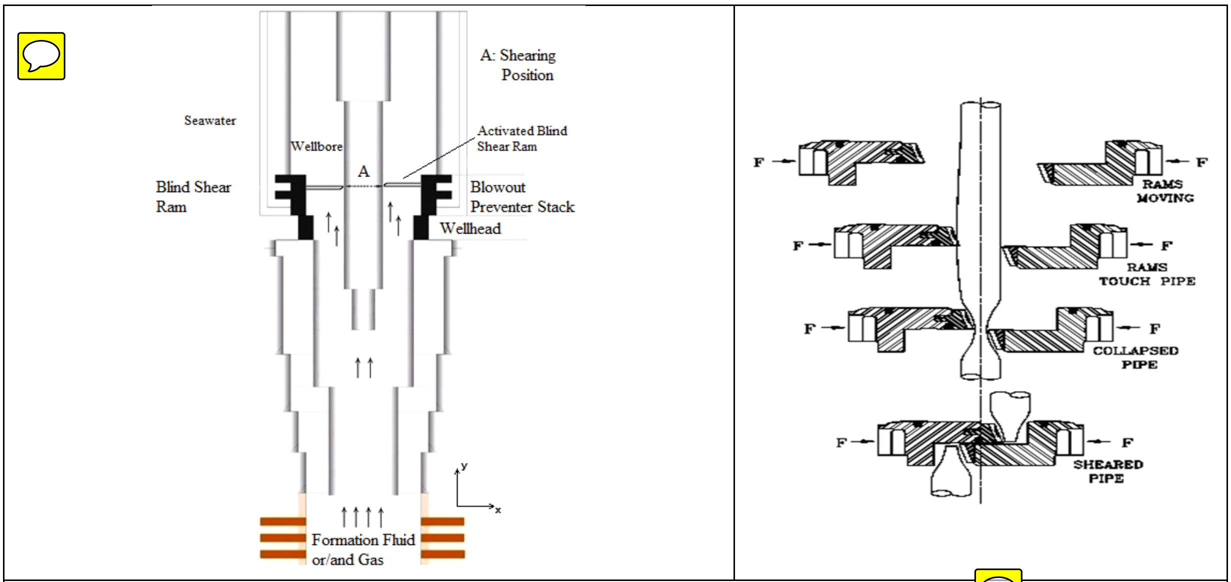

Fig. 1. Activated blind shear ram and shear sequence [5]

2.1.1 Modelling Procedure

Throughout this study, FEM (Deform 3D) is used as a tool to determine required shear force to shear a specific drill pipe and evaluate the effect of weight of drill string on the shearing operation. Drill pipe dimensions and properties were given in Table 1.

Table 1. Drill pipe dimensions and properties [4]

#	Material	Dimensions		Thickness (mm)	Area (cm2)	Weight/ length ratio (kg/m)	Yield strength (MPa)	Ultimate tensile strength (MPa)	Elong %
		O.D. (mm)	I.D. (mm)						
110	S-135	5” (127)	108.61	9.195	34.03	29.02	1014.22	1099.71	23.1
135	S-135	5.5” (139.7)	121.30	9.169	37.60	32.59	1052.83	1101.78	20.0

Since the original flow stress curve of materials was not available, it was approximated by using the Eq (1):

$$Y_f = K\varepsilon^n \quad (1)$$

where, Y_f: Flow stress, ε: True strain, K: Strength coefficient, n: Strain hardening exponent [10]…

A finite element model is developed to represent a cracked beam element of length d and the crack is located at a distance d1 from the left end of the element as shown in Figs. 2-3. Substituting Eqs. (3)-(4) in Eq. (7) yields the….

3.3 Friction Factor and Mesh Condition

Constant shear friction is used as a friction theory. The friction factor was taken as 0.12 since it is the average friction factor for stainless steel.

- Two types of mesh conditions were used
- On the shearing position
- Tetrahedral mesh
- 3.5 mm element size
- Other position
- Tetrahedral mesh
- 10 mm element size

As can be seen in Fig. 5, to get more accurate result, element size on effective shearing position…

4. Results and Discussion

The simulation parameters of Task 1 and Task 2 are shown in Table 2…

5. Conclusions

In this experimental and numerical study; the thickness of plate, the diameter of circular cutout, distance between circular cutouts and rowing orientation effect on the critical buckling behavior of pultruded E-glass/vinylester composite beams with single or double circular cutouts were investigated. From the results of this study, the following conclusions can be drawn:

- The maximum critical buckling load was achieved in specimen having 0o rowing orientation angle.
- The specimens having small cutout diameter were showed the maximum strength against to buckling. So that, the maximum critical buckling load was achieved in specimen with 2 mm cutout diameter.

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References

[1] ledzki AK, Gassan J. Composites reinforced with cellulose base fibres. Progress Polymer Science, 199[illegible]4: 221 – 274.
[2] Harris DC. *Quantitative Chemical Analysis*, W.H. Freeman and Company, New York, NY, USA,2007.
[3] Kerciku AA, Bhattacharya S. Fixity of pile foundation. Proceedings of the 14th World Conference on Earthquake Engineering, Bejing, China, October, 2008.
[4] Sajjad M. Evaluation of bacterial strategie. Ph.D. Dissertation, Michigan State University, Michigan. 2005.