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An Alternative Solution of CBL-VDL, Sump Packer and GR-CCL Correlation Deployment in High Deviated Gravel Pack Well for Well Cost Optimization

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Abstract. This paper describes the development and use of Impact Selector equipment with specifications developed specifically for the Handil Field environment with highly deviated wells. An alternative solution to convey Sump Packer, CBL-VDL, GR-CCL correlation in highly deviated Gravel Pack Well that was initially deployed using conventional drill pipe or costive tractor conveyor. The initial approach will consume massive rig time cost up to 1.5 days minimum to run equipment with drill pipe while tractor utilization is equivalent to one-day rig cost. The paper also discusses the planning considerations, wireline engineering assembly plan and simulation, and the implementation of lessons successful conveying of approximately 750 m of conveying logging, correlation tool and packer referential depth setting process for multizones sand control. An assembly of Impact Selector Roller Bogie selected to run in hole (RIH) the equipment assembly by wireline engineering simulations to ensure the success of the operations and guarantee the deployment process without any potential restriction. The simulation was done by Impact Selector Smart Planner simulation software in both scenarios with and without roller bogie as comparison. The results are excellent, this achievement opened a new envelope for high inclination gravel pack wells and it is concluded by saves up to at least USD 70,000 per well or 24 hours rig time (~USD 120,000) saving minimum. This shows that proper planning of conveyor utilization is very important for cost optimization strategy.

Keyword: High Inclination Well; Cost Optimization; Gravel Pack; Roller Bogie; Deployment; Assembly

1 Introduction

Mahakam Block is an oil and gas concession area in East Kalimantan which is operated by Pertamina Hulu Mahakam (PHM). This block is divided into 2 types of assets, namely offshore and swamp asset. In Mahakam, wells with high inclination are frequently encountered. This becomes one of the challenges when carrying out drilling, completion and logging activities. Engineering must be done carefully to solve this challenge while still considering the cost optimization.

H-Lx-17x is one of the wells in Swamp's assets with very high inclination profile, with maximum inclination of 75 degrees. This well was completed with gravel pack completion and categorized as a shallow well with a total depth of 795mMD / 523mTVD. The well profile of H-Lx-17x is shown in **Figure 1**. In the process of completing this well, it has several challenges, especially when planning the conveyance of CBL/VDL-GR/CCL tool and sump packer to its target depth. As deviation increases along the wellbores, the resulting friction between these tools and the casing surface can restrict conventional wireline conveyance or even make it impossible.

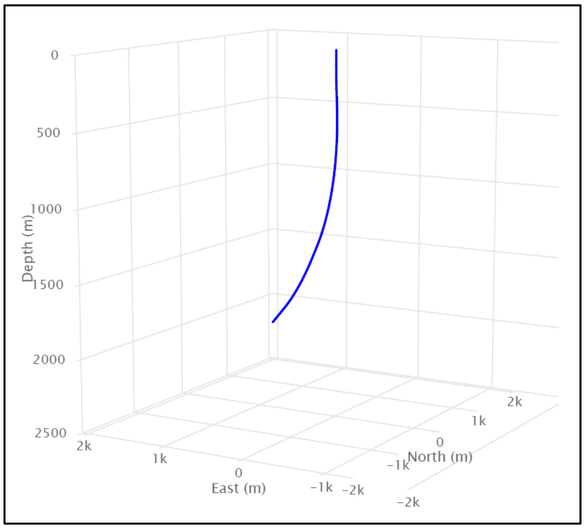

Figure 1. Isometric view of H-Lx-17x

Usually, the solution to convey these tools in highly deviated well is to deploy it by using conventional drill pipe or costive tractor conveyor. The wireline tractor is powered electrically & hydraulically, it has drive/wheel sections to push the passenger tool downhole as the cable is spooled off the unit and may allowing the tool to reach the end of horizontal or deviated wells. But, the initial approach will consume massive rig time cost up to 1.5 days minimum to run equipment with drill pipe, while tractor utilization is equivalent to one-day rig cost.

An assembly of Impact Selector Roller Bogie was selected to run in hole (RIH) the equipment assembly based on simulation result by Impact Selector Smart Planner simulations to ensure the success of the operations and guarantee the deployment process without any potential restriction.

Roller Bogie & I-Wheel tool was used to reduce those frictions by lifting the whole tool string by adding roller in the string so that contact points only in those roller which reduce the friction significantly. The roller body may rotate freely around the mandrel which is connected to the host tool string. The unique body shape also ensures the rollers are at all times oriented at the low side of the tubing. The tools are shown in the **Figure 2**.

Figure 2. Roller Bogie (left) & I-Wheel (right)

2 Methodology

There are several steps that are taken before the bogie roller is implemented in the string tool set used. The tool implementation flowchart processes are shown in **Figure 3**.

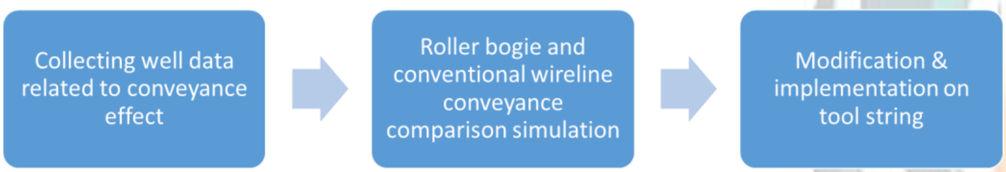

Figure 3. Working Flowchart for Roller Bogie Implementation

2.1 Collecting Data Related to Conveyance Effect

To achieve accurate & precise simulation, all required input data for the simulation need to be collected accurately. The data taken was not only from the well, but also from the tool string configuration that will be utilized. The well data consist of trajectory, temperature, hydraulics, casing geometry & friction coefficient. While the tool string data consist of cable used, tool string configuration and running/pulling speed. The data obtained will be simulated with Smart Planner simulation software. This software will simulate the capability of conveyor tool to deliver the tool string inside the casing.

2.2 Roller Bogie and Conventional Wireline Conveyance Simulation Comparison

After all the required input data for simulation obtained, first pass simulation run based tool configuration data provided by wireline service company. Second pass simulation was run with additional Roller Bogie – I-wheel, the tool string configuration will be designed and simulated by Impact Selector Smart Planner software. The simulation results of the two scenarios is compared to get an overview of the work to be performed. For sump packer simulation, Smart Planner has special features to calculate the effective OD of the sump packer which considering the flow area of fluid pass through sump packer and total area of fluid passing through adapter kit as shown in **Figure 4**. This will give results of effective outer diameter of the sump packer which is smaller than the actual OD. This step is very important because the consideration of the "piston effect" that will be generated by the packer when running into the well. This piston effect causes a greater fluid resistance when the input OD size of the packer increases. The effect of this fluid resistance can cause the tension of the cable to decrease, so that the packer cannot be deployed properly. This simulation capability was expected to predict the simulation very close to actual down hole condition.

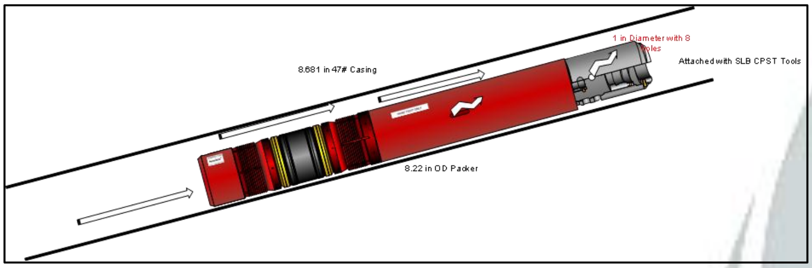

Figure 4. Sump packer flow simulation schematic

2.3 Modification & Implementation on Tool String

Modification on tool string was required to achieve best result for the deployment. Several changes in tool string configuration was done with the result from simulation. This changes on tool string configuration was also considering the additional Roller Bogie in the tool string will not affect data quality of CBL/VDL-CCL-GR & sump packer string. Finally, the deployment of sump packer & CBL/VDL-GR/CCL tool was successfully done in H-Lx-17x.

3 Result and Discussion

3.1 Wireline Engineering

The Roller Bogies wireline engineering as shown in **Figure 5** is equally as effective in cased hole environments to extend wireline access for cement logging, packer setting and other cased hole operations with larger tools. The roller body rotates freely around the mandrel which is connected to the host of tool string. The high-lift roller design stands the tool string off the side wall to ensure maximum friction reduction and to manage the risk of differential sticking. Various size roller body sets can be supplied depending upon the hole, casing size and tool string lowercase outside diameter and are clamped around the mandrel, without the need for re-wiring.

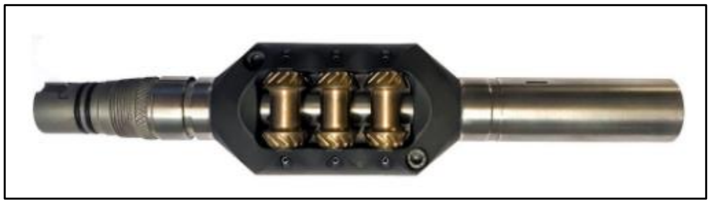

Figure 5. Roller Bogie Intelligent Conveyance

While I-wheel as shown in **Figure 6** is an innovative conveyance device used to convey any tool string into highly deviated wellbores. I-Wheels can be placed anywhere along the tool string as easily clamp on to tool assembly as required. I-Wheels create low contact areas that keep the tool body off the low side of the casing wall, with a gap to pass over problem areas. Tool are efficient, consistent, and reliable tools in highly deviated wells and reduce modelled friction by up to 80%. A wide range of I-Wheel designs are available for any tubing, casing, or even borehole size. Optional in-line or over-body variants enable the best tool configuration for optimum deployment.

Figure 6. I-Wheel Intelligent Conveyance

3.2 CBL/VDL-GR/CCL Deployment Simulation Result

3.2.1 Tool String Configuration

The tool string configuration was simulated in 2 kind of scenario, first without Roller Bogie as shown in **Table 1**. From the table can be seen that that the modelled configuration gives 100% friction multiplier in each tool. This is because all surface of the tools is assumed to be in contact with the casing surface.

Tool String :

Description	Nom OD (in)	Hyd OD (in)	Length (m)	Weight (lb)	Friction
LEH-QT	3.375	3.375	0.890	37	100 %
CAL-YA	3.375	3.375	1.067	81.5	100 %
EDTC-B	3.625	3.625	1.981	124.601	100 %
DSLC	3.625	3.625	2.000	100	100 %
DSLT-H (SLS)	3.625	3.625	4.096	222.3	100 %
			10.034	565.401	

Table 1. CBL/VDL-GR/CCL tool string without Roller Bogie

In second scenario, Roller Bogie and I-wheel was added in the configuration as shown in **Table 2**. Additional Roller Bogie and I-wheel reduce the tool string modelled friction up to 80%. Roller Bogie also adds weight to the tool string, the weight of the tool string increases by about 319lb compared to before utilizing the Roller Bogie. This frictional reduction and weight increase was expected to give more ability for the tool to achieve target depth.

Tool String :

Description	Nom OD (in)	Hyd OD (in)	Length (m)	Weight (lb)	Friction
LEH-QT	3.375	3.375	0.890	37	**10 %**
Roller Bogie	**8.3**	**7.47**	**0.707**	**116.001**	**20 %**
CAL-YA	3.375	3.375	1.067	81.5	**10 %**
EDTC-B	3.625	3.625	1.981	124.601	**10 %**
Roller Bogie	**8.3**	**7.47**	**0.707**	**116.001**	**20 %**
DSLC	3.625	3.625	**1.770**	100	**10 %**
I-Wheel	**8.3**	**7.47**	**0.230**	**25**	**20 %**
DSLT-H (SLS)	3.625	3.625	4.096	222.3	**10 %**
Roller Bogie	**8.3**	**7.47**	**0.707**	**116.001**	**20 %**
			12.155	**938.404**	

Table 2. CBL/VDL-GR/CCL Tool String with Roller Bogie

3.2.2 Simulation Result

From the results obtained in **Figure 7**, it can be seen that without addition of Roller Bogie and I-wheel, the maximum achievable depth of the tool string is at 640mMD (straight blue line), about 112m above the target depth. The hold-up margin value shows a result of -1.1lb at 670.56mMD, this indicates that the tool string is completely "sit" in the casing at this depth and cannot go down anymore.

After additional Roller Bogie & I-wheel in the configuration, the simulation shows that the tool string able to reach the target depth smoothly and all margins are above its minimum value (dashed blue line). This is because the Roller Bogie reduces friction of the entire tool string by lifting the string and focusing the contact point of the string on the Roller Bogie wheel only.

From the graph it can also be seen that when the tool string is pulled from the well, there are no issue either before the Roller Bogie is installed or after it is installed (straight & dashed green line).

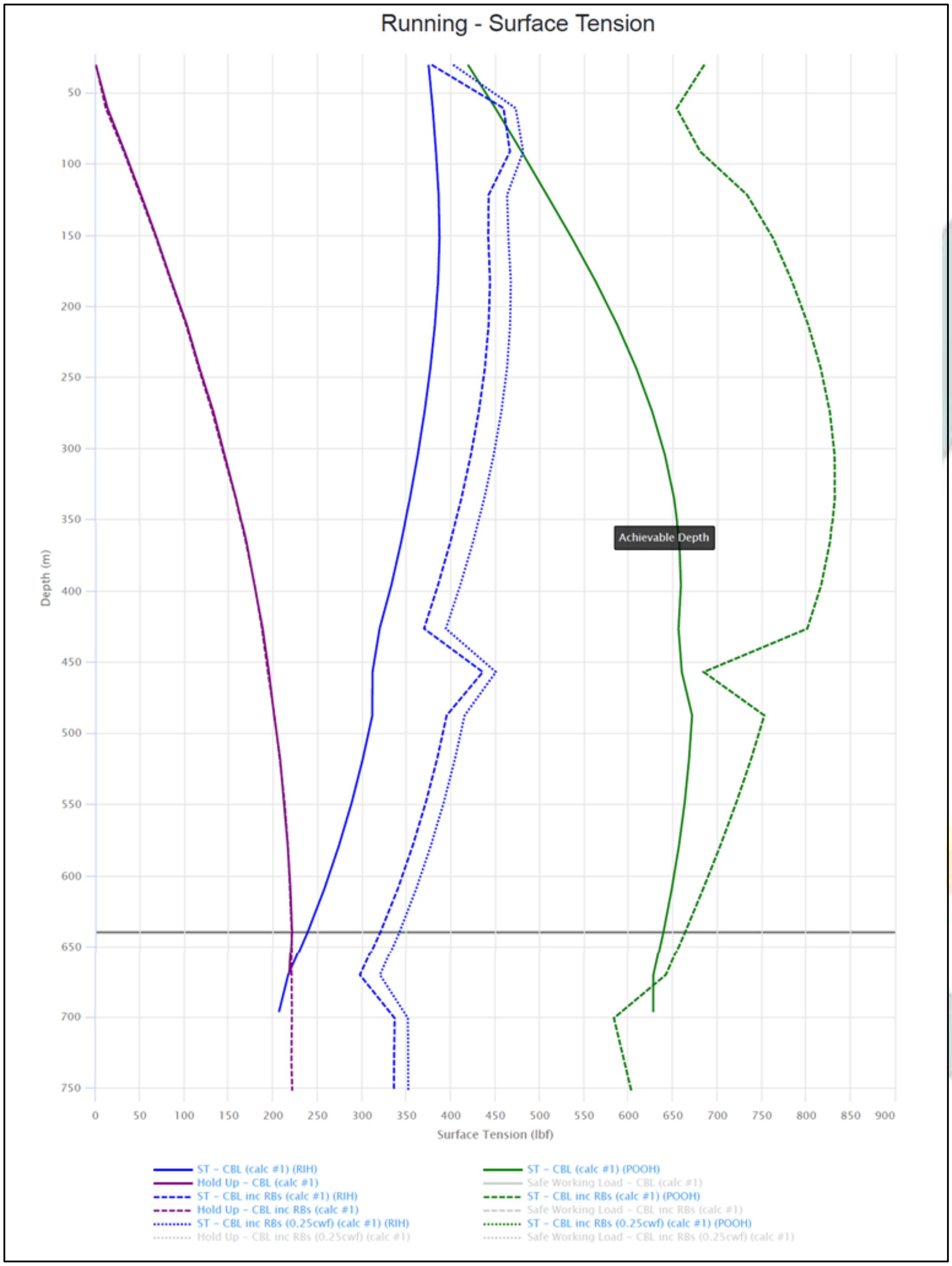

Figure 7. CBL/VDL-GR/CCL Simulation Result

3.3 Sump Packer Deployment Simulation Result

3.3.1 Tool String Configuration

The tool string configuration for sump packer was also simulated in 2 kind of scenario, first with Roller Bogie as shown in **Table 3**. From the table can be seen that that the modelled configuration gives almost 100% friction multiplier in each tool. The CPST-AA tool & the packer adapter accepts less friction modeling due to the support from sump packer which has a larger OD. In this simulation the packer OD size is 7.8in, this is the value of the effective OD that has been calculated so that the value is smaller than the actual OD, which is 8.22in.

Tool String :

Description	Nom OD (in)	Hyd OD (in)	Length (m)	Weight (lb)	Friction
CHD	3.375	3.375	0.890	37	100 %
EQF-48	3.625	3.625	2.438	250	100 %
PGGT-D	3.625	3.625	1.783	60.001	100 %
CPST-AA	3.625	3.625	2.286	180	50 %
Adapter	3.81	3.81	0.259	7	10 %
Packer	7.8	7.8	1.515	85	100 %
			9.171	619.001	

Table 3. Sump Packer Tool String without Roller Bogie

The tool string was added with Roller Bogie in second scenario configuration as shown in **Table 4**. Additional Roller Bogie and I-wheel reduce the tool string modelled friction up to 80%. In this configuration more weight bar (EQF-48) was added to give more weight to the tool string, the weight of the tool string increases by about 482lb compared to before utilizing the Roller Bogie. This combination of added weight and reduced modelled frictional contact was expected to increase the tool string ability to deploy the packer properly.

Tool String :

Description	Nom OD (in)	Hyd OD (in)	Length (m)	Weight (lb)	Friction
CHD	3.375	3.375	0.890	37	**50 %**
Roller Bogie	**8.3**	**7.47**	**0.710**	**116**	**20 %**
EQF-48	3.625	3.625	2.438	250	**10 %**
EQF-48	**3.625**	**3.625**	**2.438**	**250**	**10 %**
Roller Bogie	**8.3**	**7.47**	**0.710**	**116**	**20 %**
PGGT-D	3.625	3.625	1.783	**60**	**10 %**
CPST-AA	3.625	3.625	2.286	180	**10 %**
Adapter	3.81	3.81	0.259	7	10 %
Packer	7.8	7.8	1.515	85	100 %
			13.029	**1101**	

Table 4. Sump Packer Tool String with Roller Bogie

3.3.2 Simulation Result

It can be seen from the result as shown in **Figure 8**, that without addition of Roller Bogie, the tool is still able to reach the target depth at 752mMD (straight blue line), but at the depth of 702mMD, the surface tension value is getting very close to the hold-up value (purple line), the hold-up margin is only 4.5lbf. This is outside the minimum tolerance for the hold-up margin of 50lbf. So even though in the simulation it was still able to achieve the target, in actual conditions it was very possible to stuck.

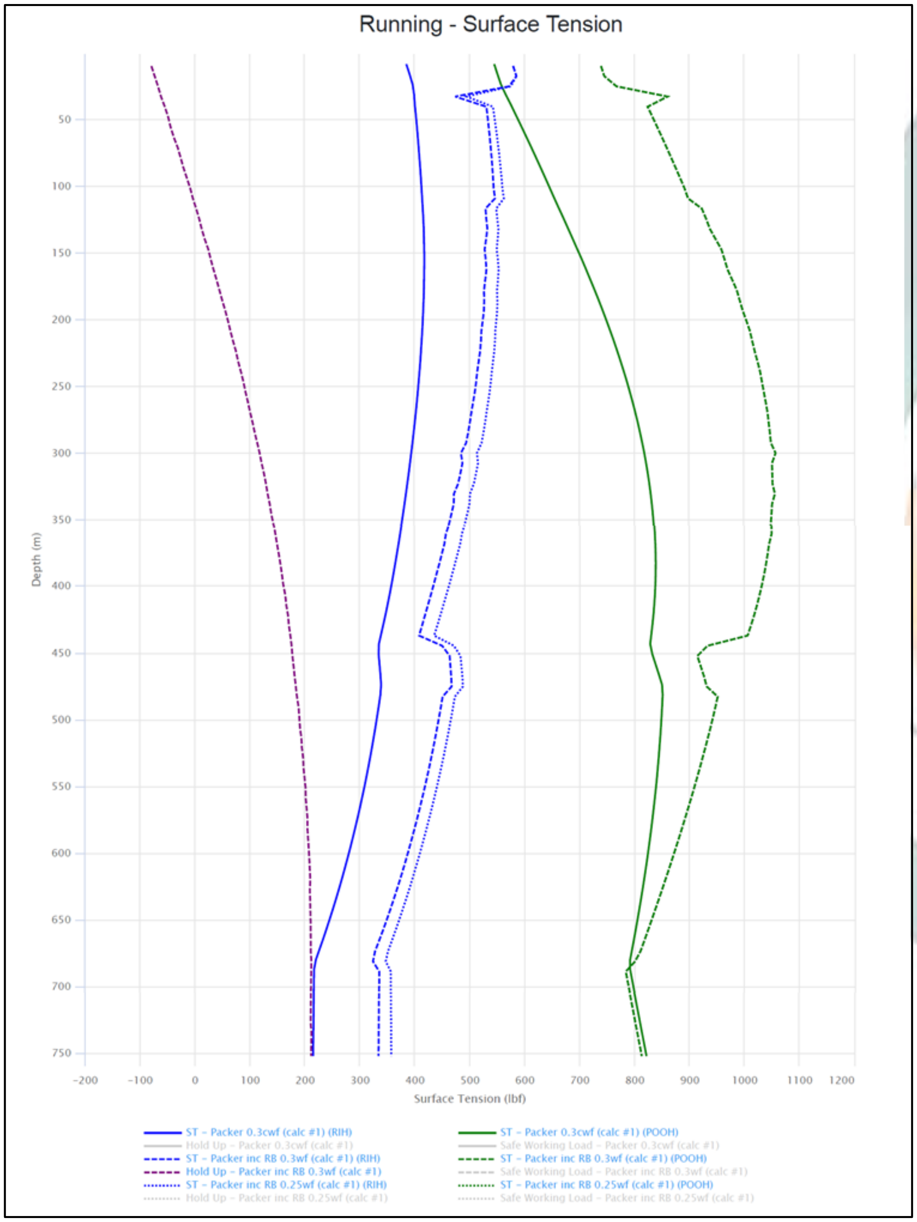

Figure 8. Sump Packer Simulation Result

Additional Roller Bogie & weight bar in the configuration shows that the tool string able to reach the target depth and all margins are above its minimum value (dashed blue line). Additional weight & frictional reduction in tool string helps to increase the tension of the strings so as to keep the strings from the risk of being held up.

From the simulation result, it can also can be seen that there is no issue either before Roller Bogie is installed or after it installed (green straight & dashed line) when pulling out of hole the tool string.

3.4 Actual vs Simulation Result

There were no significant problems when CBL / VDL-GR / CCL and the sump packer was run and deployed. This shows that the addition of a Roller Bogie and I-wheel to the two series plays an important role in getting the tool string to the target depth properly.

The actual result of simulated data of cable head tension (straight line), either while running in hole or pulling out of hole match very close to the actual data on the field (dashed line) as shown in **Figure 9**.

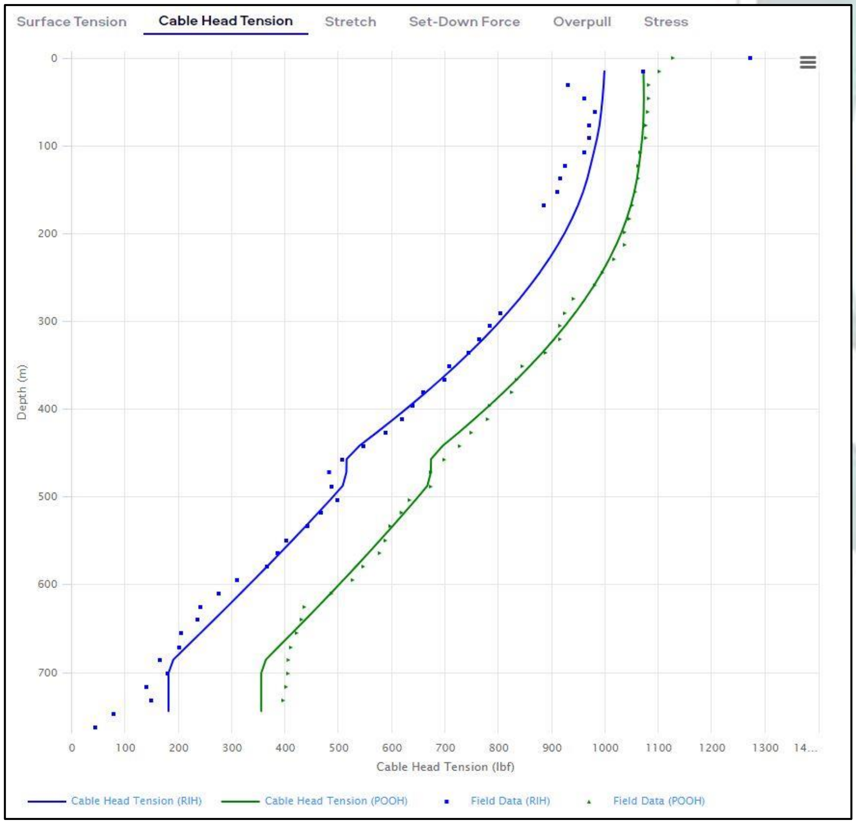

Figure 9. Actual sump packer cable head tension simulation result

This shows that the simulation carried out is very precise and thorough. It can be said that the addition of a roller bogie and I-wheel to the configuration of the tools used and also the simulation that takes into account all the parameters related to the well and the tool string are very well processed. Implementation of these wireline engineering technologies to the tools, successfully saves up about USD 70,000 per well if it compared to tractor utilization and save at least 24 rig hours (~USD 120,000) compared to drill pipe conveyance.

4 Conclusion

From the results that have been obtained, shows that proper planning of conveyor utilization is very important for cost optimization strategy. It can be seen that the addition of Roller Bogie on the tool string to deploy CBL / VDL-GR / CCL & sump packer in very high inclination well can be achieved very well. This achievement opened a new envelope for gravel pack wells & brings new opportunities to optimize the cost of gravel pack wells which have very high inclination with innovative wireline engineering.

Roller Bogie utilization saves at least USD 70,000 per well compared to tractor and it is concluded by 24 hours rig time (~USD 120,000) saving if compared to drill pipe conveyance.

This challenge of tools deployment in one of highest inclination well in Mahakam was solved flawlessly in collaboration between PHM engineer with Impact Selector team. A new breakthrough of intervention activities limitation of tools deployment in Mahakam field could be achieved. This is also increase morale of the team by selection of simpler and easy alternative strategy.