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Question 2.5: It is worth to make a CBA (cost-benefit analysis) regarding the proposed SBTACFR conductor by including the capital expenditure, installation costs, and transmission capacity gain regarding conventional conductors?

Contribution for Q 2.5 : <u>The worth of a CBA (cost-benefit analysis) of the SBTACFR</u>

An Aluminum Conductor Fiber Reinforced (hereinafter, ACFR) is a High-Temperature-Low Sag conductor, which allows utilities to operate the line at the higher temperature or lower transmision loss in compartison with conventional ACSR.

The key elements of ACFR is the use of Carbon Fiber Composite Cable (hereinafter, CFCC) as the tension bearing reinforcing member of the conductor insted of the conventional galvanized steel wire. CFCC weighs 1/5 of steel which allows utilities to increase the amount of aluminum within the same diameter, or conductor can be much lighter or smaller with same amount of aluminum. Conventional design of SBTACFR (SB :smooth body) employes trapezoidal shaped aluminum strands to further increase the cross sectional area of aluminum to increase the current carrying capacity or reduce electrical resistance.

Also, CFCC is resistant to thermal energy so the sagging of the line is kept lower above certain operating temperature, leaving more room for clearance.

In addition, stranded construction of the CFCC provides flexibility to the conductor which allows installer to employ conventional ACSR installation method for SBTACFR installation.

While the cost of SBTACFR and its fittings tend to be higher than conventional ACSR, there are various ways to benefit from incorporating SBTACFR when other associated costs such as structure, ROW, construction period are taken into consideration. (The cost of SBTACFR may become more competitive as the conductor becomes more widely used in a future.)

The examples of advantages and disadvantages of installing SBTACFR in comparison with convensional ACSR conductor are described hereinafter. In order for utilities to fully optimize the unique charactoristic of SBTACFR, Cost Benefit Analys incorporating all the cost impacting aspects of building and/or upgrading transmission line is necessary.

1. Characteristics of SBTACFR :

Notable characteristics of SBTACFR in comparison with conventional ACSR are as follows :

- Larger cross sectional area of aluminum → Increased current carrying capacity or lowered transmission loss.
- Lighter weight → Lower initial sag at the same tension.
- The conductor core is resistant to thermal energy → the core does not sag when the line is energized.
- Anti-corrosive core → Assures longevity in corrosive environments.
  *Resurch on the longevity of ACFR is also shown in Paper B2-10631.

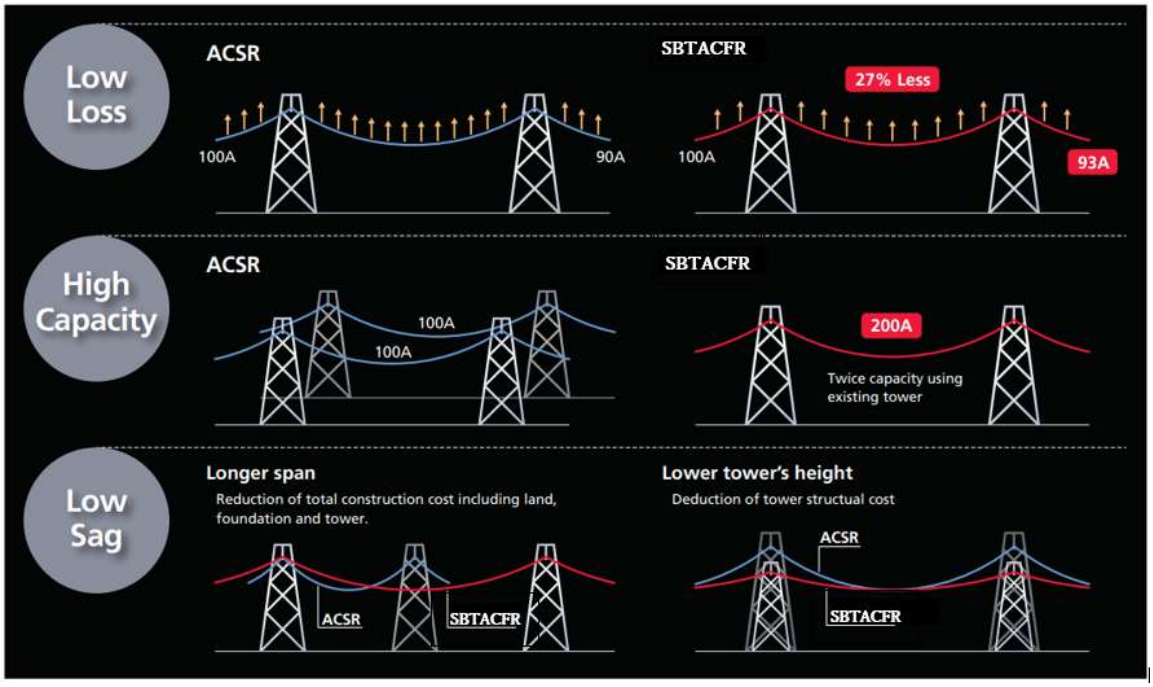

Fig. 1 Characteristics of SBTACFR

Fig. 2 Comparison of sag at completion of one side line during replacement of ACSR 410 mm^2 single conductor to ACFR 315 mm^2 2 conductor (left side line is ACFR, right side ACSR)

2. In case of building new transmission line : SBTACFR vs ACSR

Although the cost for conductor and fitting price of ACFR will be higher than that of ACSR, the use of lighter (or smaller) SBTACFR allows utlities to downsize the height of the structure and/or reduce the number of structures by taking advantages of lighter weight and lower sag characteristic of SBTACFR, allowing the conductor to be installed at equivalent tension or sag with longer span or shorter installed height which can result in siginificantly lower construction cost and shorter construction period while maintaining required transmission capacity and sag.

Table 1 Advantages and disadvantages of installing SBTACFR when new transmission lines are constructed

Advantages	・Reduction of the number of towers or downsizing the towers which can result in: ・Lower structure costs ・Lower ROW acquisition costs ・Shorter construction period
Disadvantages	・Increase in conductor and fitting prices

3. In case of reconductoring SBTACFR on existing transmission lines :

In case of reconductoring of SBTACFR using existing structures, utilities need to verify the limitation of tension on the existing structures to determine whether it is necessary to improve the strength of the structures. In general, lighter SBTACFR can be installed higher at the same tension which allows utility to increase the current carrying capacity or reduce transmission loss without improvement of structures while maintaining the required sag clearance. In case that bigger size SBTACFR is required, necessary improvements of the structure needs to be taken into consideration when the tension of the SBTACFR exceeds the existing conditions .

Fig.3 Replacement of ACSR410 mm^2 single conductor to ACFR mm^2 2 conductor (left line is ACFR with tensioned work completed)

(1) Using existing structures without improvement (reinforcement)

Installing SBTACFR on existing structures at equal or less tension than existing conductor does not require any improvement of the structures while cross sectional area of aluminum of the conductor is increased and the sag is lowered.

Table 2 Advantages and disadvantages without tower reinforcement

Advantages	・Increase current carrying capacity ;or reduce transmission loss (depending on operation temperature.) ・Lower sag / increased clearance. ・Construction period is minimum.
Disadvantages	・Increase in conductor and fitting prices

(2) Using existing structures with improvement (reinforcement) of the structures

In case that bigger sized SBTACFR is required for further increased transmission capacity, tower improvement design needs to be developped. Although the additional cost for the improvement will increase the total construction cost and its preparation period it can be significantly lower than constructiung entirely new parallell line to achieve the same current carrying capacity of the line.

Table 3 Advantages and disadvantages with additional tower reinforcement

Advantages	・Transmission capacity can be further increased without constructing a entirely new parallel line.
Disadvantages	・Additional cost for tower reinforcement (development of design of structural members, tower loading test, installtion of reinforcing members) ・Higher conductor and fitting prices

4. Conclusion

Advantages of SBTACFR are lighter weight, increased aluminum, high temperature operatability and its resistancy to thermal energy. There are various ways and combinations of cost-impacting factors to turn SBTACFR's advantages into financial benefits. Utilities may conduct project specific CBA to find the most beneficial scenarios to operate the line efficiently.