A QUADRUPLE M. V. TRANSMISSION LINE WITH INSULATED CONDUCTORS

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1. INTRODUCTION

The construction of new overhead lines or the widening of the route around the already built lines is being confronted with continuously more severe requirements concerning the limits on land occupation along line constructions, their aesthetic impacts, the reduction of disturbing influences on the nature in their environment and the protection of animals, especially of birds. These are the reasons of the increasing efforts to apply new technologies enabling to reduce the dimensions of overhead lines and thus to install multiple lines into existing routes.

2. REQUIREMENTS ON LINES AND ON CONDUCTOR CONFIGURATIONS

The basic requirement is that four lines might be installed into a route for a single-circuit 22 kV line with bare conductors. When preserving initial dimensions it means to use insulated conductors instead of bare ones and longer steel poles instead of conventional concrete ones. The increased length of poles also resulted in greater lengths of line spans (naturally depending on terrain conditions) attaining up to a double length compared with lines built on concrete poles.
There exist several variants of conductor configurations for installing four 22 kV lines on one and the same pole. Only the variants shown in Fig. 1 have been considered for the evaluation. Main dimensions of the variants described below are given in Table 1.

Table 1. Main dimensions of lines [m]

Parameter	Variant		
	a	b	c
Pole length above earth	16,5	15,5	14,6
Fixing of lower conductor above earth	14,0	14,0	14,0
Fixing of upper conductor above earth	16,6	16,0	15,0
Horizontal distance of outer conductors	1,3	1,9	2,9

2.1. Variant A

On a steel pole the individual lines are dislocated by twos from each side and pair above pair. The dislocation of the line is logical and the danger of interchanging the lines during revisions or repairs is minimal. However, higher poles must be used for lines to be installed one above another which reflects in a higher price of the pole. On the contrary, this configuration requires the smallest width of the route.

2.2. Variant B

The lines are installed on three brackets. Individual phases are placed one above another again but always by twos from both sides of the pole. From the point of view of revisions and repairs this variant is less advantageous because the inner lines are hard accessible. The pole is lower than in Variant A but to the detriment of route width.

2.3. Variant C

In this variant the lines are also installed by twos from both sides of the pole but individual phases are configurated horizontally which is - regarding the logic of configuration and access to conductors - more advantageous than in Variant B. The price of the steel pole will be the lowest from all the three variants but the necessary width of the route will be the greatest one.

3. EVALUATION OF INDIVIDUAL VARIANTS

It is very important when evaluating individual variants from which point of view each variant is being evaluated and to which extent the standpoints of line operators, land-owners and other organizations making decisions on issuing the building licence are being given priority.
As, in the meantime, the problem of a quadruple 22 kV line is dealt with in this paper just as a technical and economical intention only, we have not yet treated precise price data according to which the individual variants could be evaluated from the point of view of investment and operational costs as is usually done in technical practice.
For the sake of orientation we may compare the technical and economical parameters of the following ways of electricity supply:

a) Four single-circuit lines with bare conductors:
The costs of this way of electricity supply, i. e. the costs of concrete poles, bare conductors, insulators and foundations will be taken to be 100 % for the purpose of comparing with other ways. Of course, the width of the necessary route is equally significant and it will also be taken for 100 %.

b) Two double-circuit lines with bare conductors:
The costs of lattice towers, bare conductors, insulators and foundations make 90 % and the costs of route width make 65 % compared with those of four single-circuit lines.

c) One quadruple line with insulated conductors:
The costs of a quadruple line with insulated conductors make 110 % compared with those of four single-circuit lines (point a) but the costs of route width make only 20 % of those given in point a).

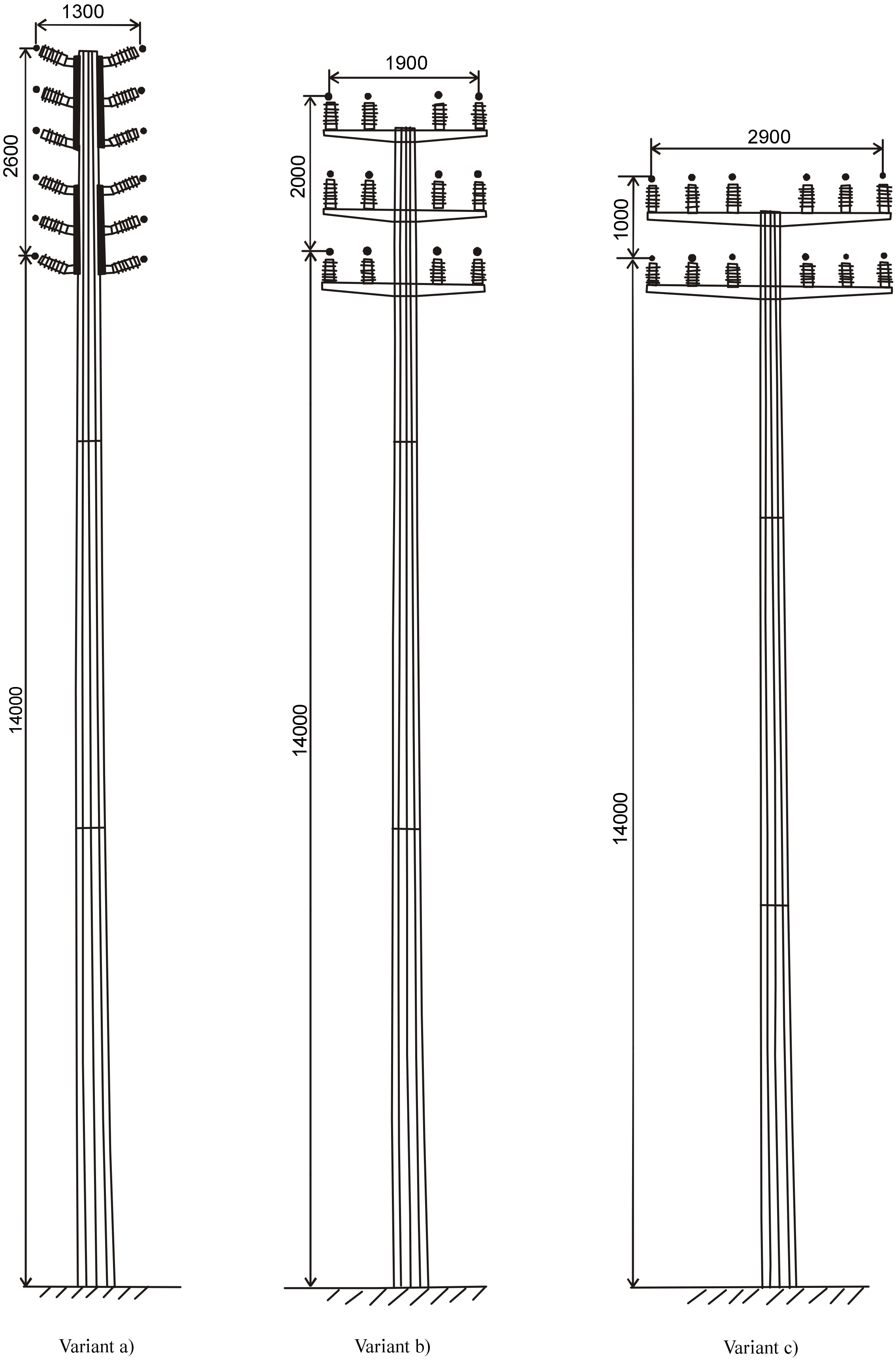

Fig. 1. Variants of the configuration of conductors of a quadruple line

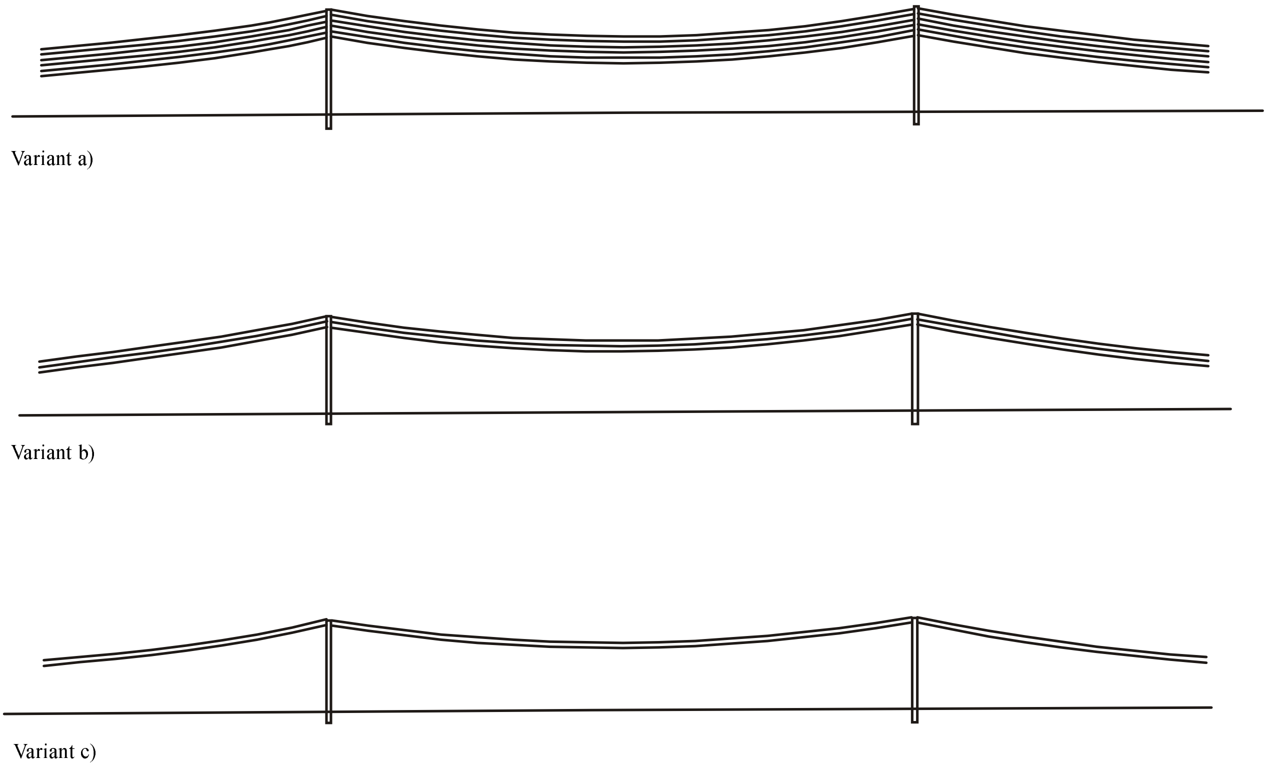

Fig. 2. A quadruple 22 kV line - side view

Table 2. Comparison of costs (percentage)

Way of supply	Poles, conductors, insulators, foundations	Route width
Four single-circuit lines with bare conductors	100	100
Two double-circuit lines with bare conductors	90	65
One quadruple line with insulated conductors	110	20

We may also compare - by estimate at least - the requirements of individual variants on pole length (Table 1) and dimensions of brackets for mounting conductors. It may be seen that the differences of investment costs connected with individual variants will not be decisive for their choice.

Consequently, a priority seems to be the appearance of individual variants and their general negative perception in the landscape.

Fig. 2 shows (schematically the shape and appearance as viewed from the side when the levels of conductors of the variants being compared become most evident.

Coefficients evaluating individual facts or degrees of difficulties have been used for a preliminary evaluation of variants under consideration.

This relative and subjective evaluation is demonstrated in Table 3 by means of differently dark areas: the lighter is the area the more advantageous is the particular variant. According to line operators and environmental organizations, the configuration of conductors as per Variant c) received the best evaluation.

Table 3. Evaluation of variants of individual line configurations

Fact being examined		Variant a	Variant b	Variant c
Height of pole		▓	░	
Time nesessary for mounting			▓	░
Land occupation			░	▓
Laboriousness of mounting			░	░
Quantity of material			░	░
Simplicity in production			░	░
Maintenance	simple access		▓	░
	logical configuration	░	▓	
	need for mechanization	▓	░	
Regular revisions of the line			░	░
Laboriousness of repairs of the line			▓	░
Standpoint of ecologists		▓	░	
Standpoint of land-owners		▓	░	
Standpoint of other public organizations		▓	░	

4. SCOPE OF APPLICATION

The proposed technical solution of a quadruple overhead line with insulated conductors should be understood as one of the possibilities of using the existing line routes, especially in the vicinity of 110 kV/220 kV substations or in locations where lines are running in parallel at a longer distance and where there is not sufficient space for building another line. The disadvantage of this solution consists in a decreased reliability of supply because a mechanical damage or breakdown of a pole results in the outage of all lines.

5. CONCLUSION

The utilization of insulated conductors together with using steel poles enables to build up compact multiple lines in locations with lack of space or as a substitution of existing lines when their transmission capability needs to be increased.

6. REFFERENCES

[1] Standard ČSN 33 3301 „Construction of overhead electric lines with rated voltage up to 52 kV„ ČNI Prague, 8 - 1997.