ANALYSIS OF SHORT-CIRCUIT EFFECT TO MAGNETIC FIELD DISTRIBUTION OF ELECTRICAL MACHINES

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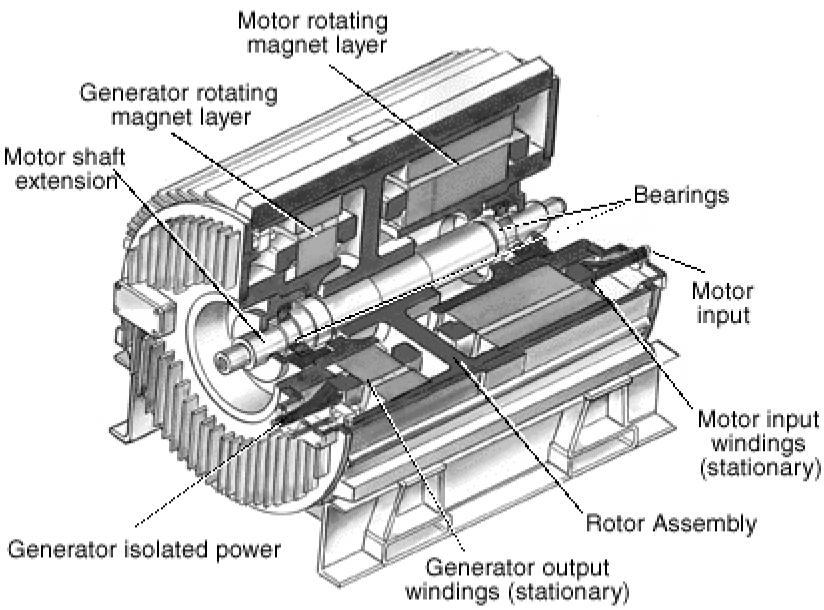
ABSTRACT

This article deals with analysis of short-circuit current effect to magnetic circuit of synchronous machine include magnetic field distribution by finite element in ANSYS. In this article are examined a symmetrical short-circuit problems with a maximal DC component value in one phase. In remaining phases have a half of maximal DC component value with opposite polarity.

1. INTRODUCTION

Near short-circuit, an electrical circuit impedance with voltage are declining and to the short-circuit place creeps short-circuit current of all power sources. The short-circuit current mirrored an electrically conductive phases connection or connection of one phase with ground. In case of 3-phase short-circuit we talk about a symmetrical short-circuit.



Generator parameters of examine problem:

Symbol	Value	Unit	Symbol	Value	Unit
S_G	1255	kVA	x_d”	0,12	-
U_G	725	V	I_{B0}	16,7	A
$\cos\varphi_G$	0,9	-	I_{BN}	45	A

1.1. SHORT-CIRCUIT CURRENT CALCULATION

Subtransient reactance

$$X_d'' = x_d'' \frac{U_G^2}{S_G} = 0{,}12 \cdot \frac{0{,}725^2}{1{,}255} = 0{,}05026\Omega \tag{1}$$

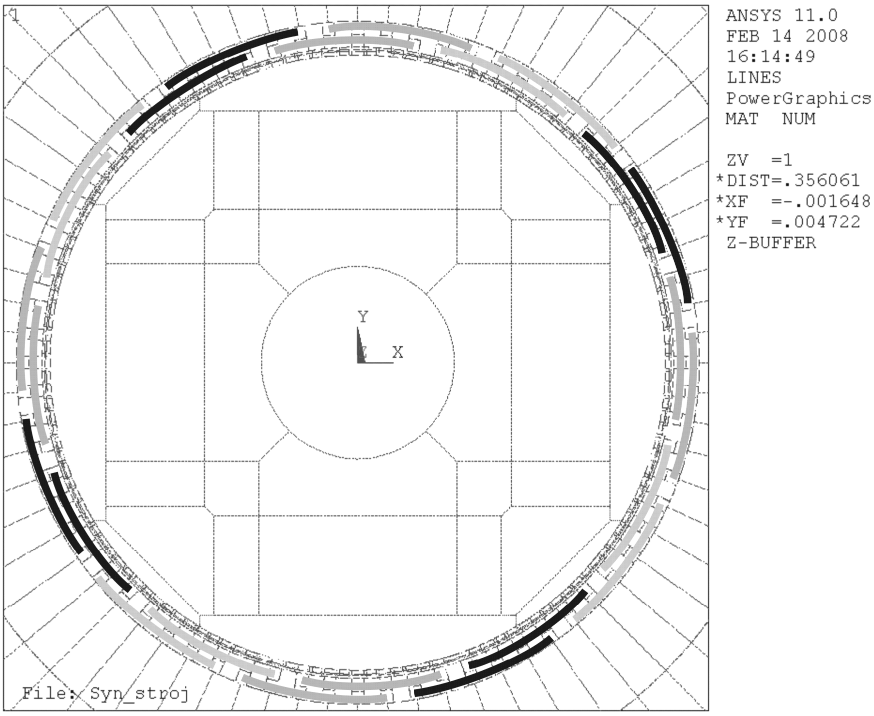
Coefficient KG

$$K_G = \frac{U}{U_G} \frac{c_{\max}}{\left(1 + x_d'' \cdot \sin\varphi_G\right)} = \frac{0{,}69}{0{,}725} \frac{1{,}1}{\left(1 + 0{,}12 \cdot 0{,}4359\right)} = 0{,}99485 \tag{2}$$

Short-circuit current

$$I_k'' = \frac{c_{\max} \cdot U}{\sqrt{3} \cdot X_d'' \cdot K_G} = \frac{1{,}1 \cdot 0{,}69}{\sqrt{3} \cdot 0{,}05026 \cdot 0{,}99485} = 8764{,}4A \tag{3}$$

1.2. WINDING DISTRIBUTION INTO SLOTS



2. MAGNETIC FIELD DISTRIBUTION IN SHORT-CIRCUIT

The analysis of magnetic field distribution in short-circuit was provided for no-load and short-circuit conditions with rated excitation.

2.1. NO-LOAD CONDITIONS

The Fig.1 shows a magnetic field distribution at no-load condition of synchronous machine, the value of exciting current is 16.7A applied as current density 940845A/m^2.

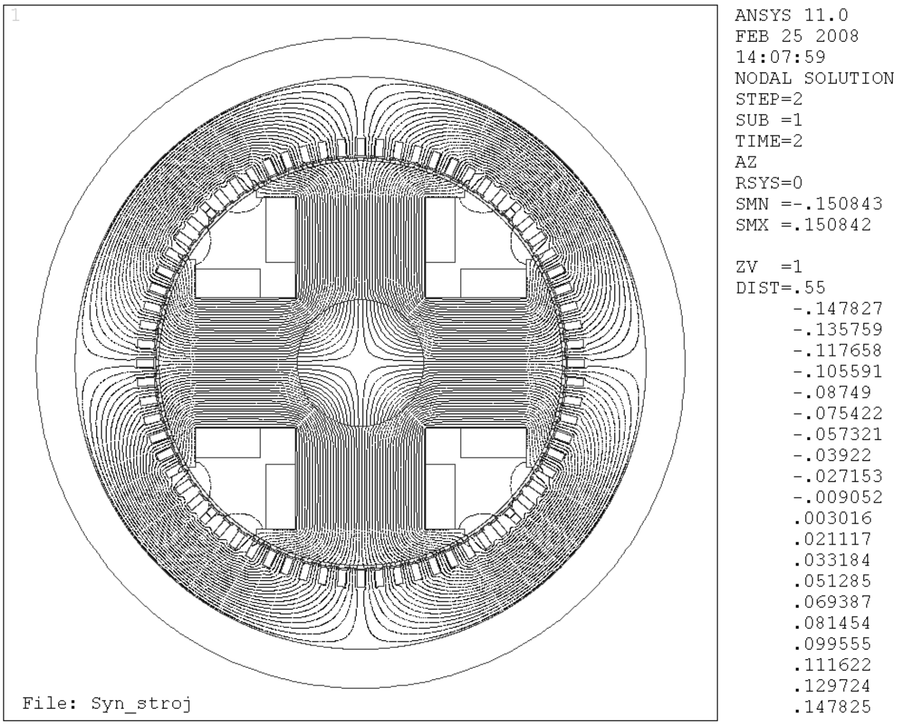


Fig 1: No-load condition magnetic field distribution.

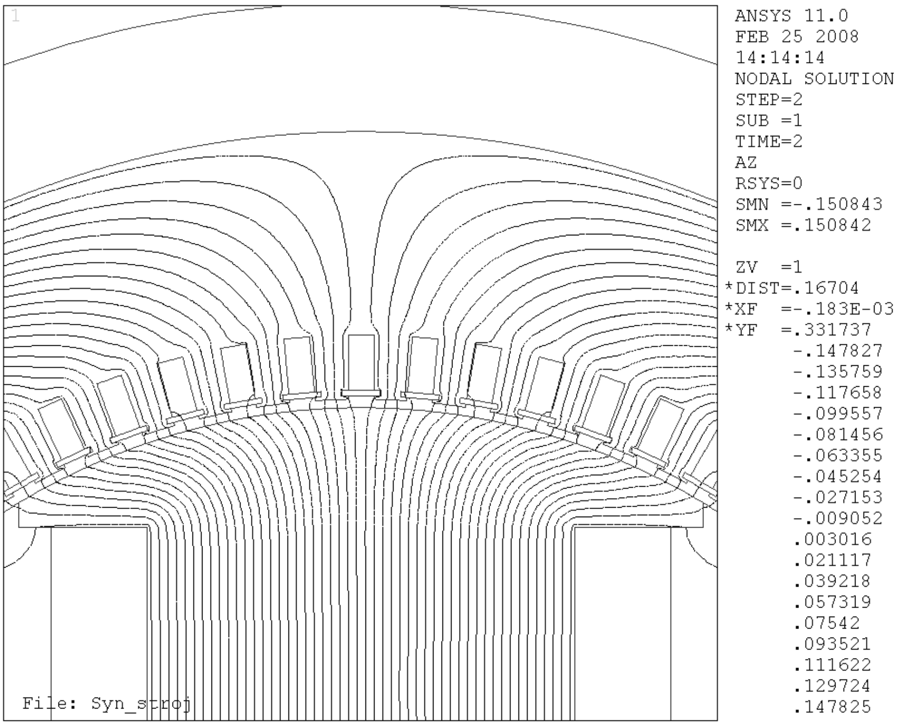


Fig 2: Pole detail at no-load condition.

2.2. SHORT-CIRCUIT CONDITIONS

The Fig.3 shows magnetic field distribution of synchronous machine in short-circuits. The value of exciting current is 45A and the value of short-circuit current is 8764,4A.

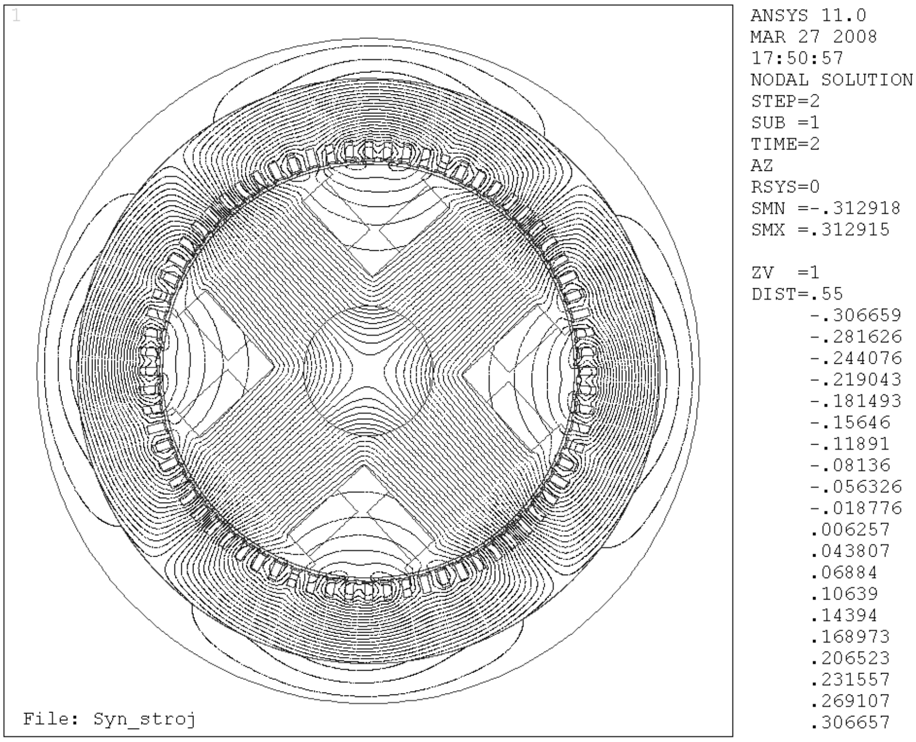


Fig 3: Short-circuit magnetic field distribution.

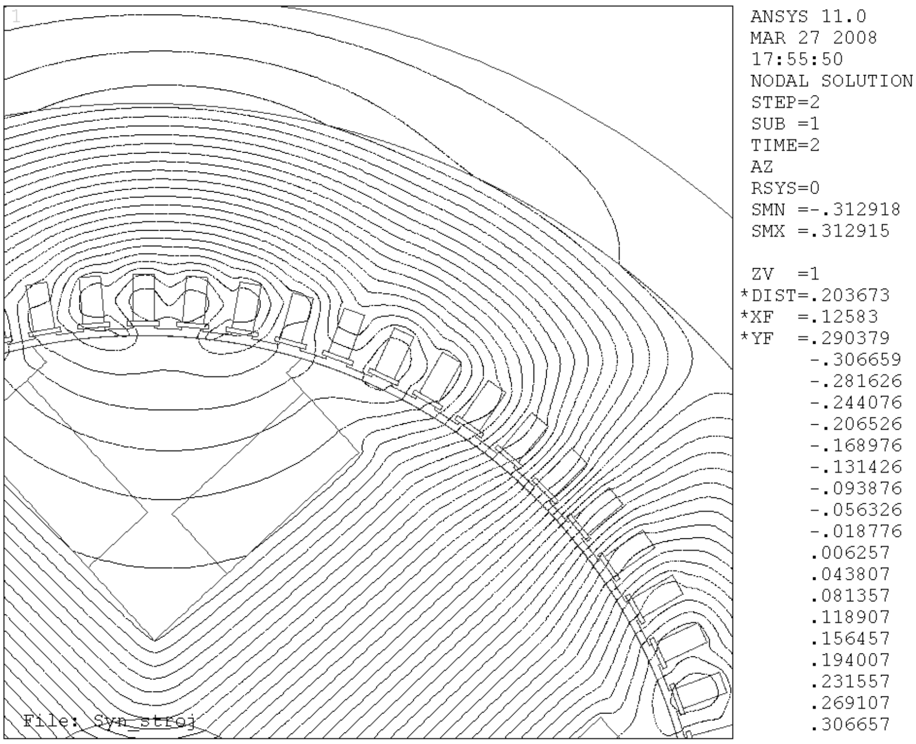


Fig 4: Pole detail at short-circuit condition.

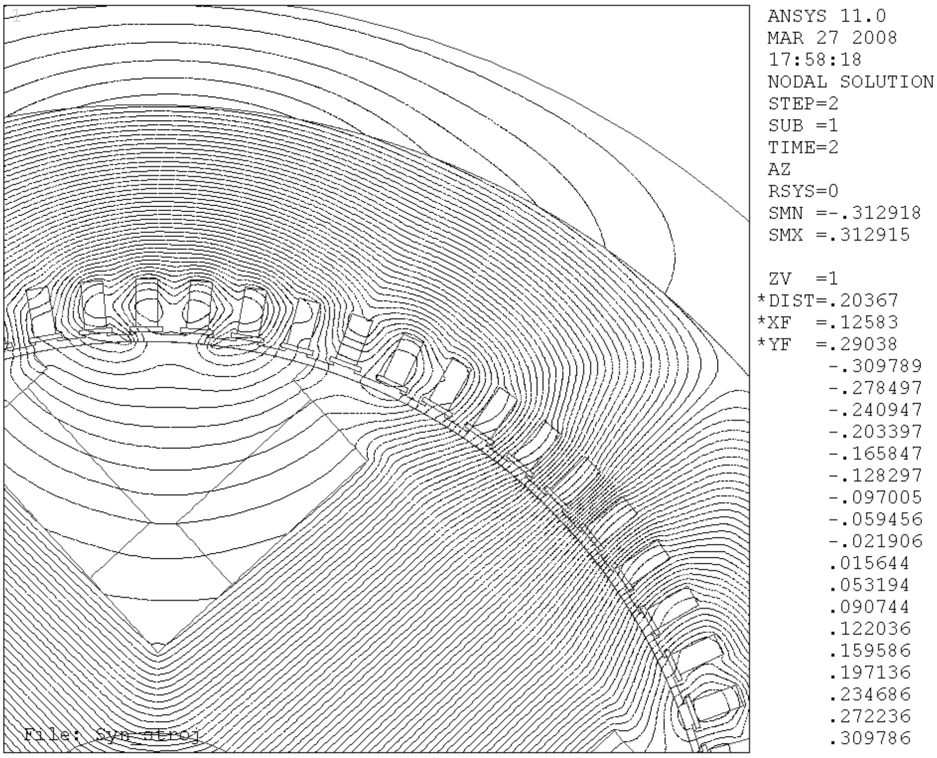


Fig 5: Pole detail at short-circuit condition (bigger flux lines density).

3. CONCLUSION

In case of no-load condition of synchronous machine (Fig.1.) there is a creation of magnetic field only due to exciting current then this field is symmetrical. For better comparison there are a detail views to magnetic flux lines for different condition in one pole.

In case of short-circuit (Fig.3.) the magnetic field is deformed due to winding distributions to slots and due to short-circuit current. Some of the magnetic flux lines are closing through the poles and magnetic circuit of generator and the other flux lines are closed through the air, but their closing ways are not the same as like as no-load condition. In detail (Fig.5) is shown, which kind of way the magnetic flux lines are closed, this figure shows the same detail with bigger flux lines density.

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