Using symmetric conditions in magnetic solvers: AMPERES and FARADAY programs

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When a model has mirror symmetry about a plane, it may possible to apply Symmetry or anti-symmetry condition to reduce the problem size in half. In addition to the existence of the mirror symmetry in the geometry, there should be symmetry or anti-symmetry in the source (excitation) to apply the symmetry or anti-symmetry condition. The possible sources in the magnetic solvers are the Electric current coils, permanent magnets, and the impressed magnetic fields.

In AMPERES and FARADAY programs, the nomenclature **Symmetry Condition** and **Anti-symmetry Condition** are coined keeping the Electric Current excitation in mind. With reference to the vector excitations the Electric current, Magnetization of the permanent magnet, and the Impressed Magnetic field the **Symmetric** and the **Anti-symmetric conditions** are defined below.

For Electric Currents:

When the excitation Electric current vector arrow is having a mirror symmetry about the same plane that also possesses the mirror symmetry in the geometry, then the model has **Symmetric Condition** about that plane **(Fig 1 and 2).**

When the Electric current vector arrow is having a **reverse** of the mirror symmetry about the same plane that possesses the mirror symmetry in the geometry, then the model has **Anti-symmetric Condition** about that plane **(Fig 5 and 6).**

For Permanent magnets and Impressed Fields: It is the reverse of the Electric Current case

When the Magnetization/Impressed Magnetic Field vector arrow is having a **reverse** of the mirror symmetry about the same plane that possesses the mirror symmetry in the geometry, then the model has **Symmetric Condition** about that plane **(Fig 3 and Fig 4).**

When the Magnetization/Impressed Magnetic Field vector arrow is having a mirror symmetry about the same plane that also possesses the mirror symmetry in the geometry, then the model has **Anti-symmetric Condition** about that plane **(Fig 7 and Fig 8).**

It is important to note that we can define **Symmetry/Anti-Symmetry Conditions** in AMPERES and FARADAY about the Principle Planes **X=0**, **Y=0**, **Z=0**. Also, the portion of the model geometry should only be on the positive side of the Principle Planes. If a **Symmetry/Anti-symmetry Condition** is defined about X=0 plane, then the half portion of the model geometry that exists in the region X≥0 which is referred to as **Object** in this document. The half portion of the model geometry that should not be created is referred to as **Image**. In some models there can be symmetry/anti-symmetry about any two or about all three Principle Planes. It is also very common to have symmetry condition about one Principle Plane and anti-symmetry conditions about other Principle Plane(s) and vice versa.

When permanent magnets and current coils exist in a model, we must be careful in assigning symmetry/anti-symmetry condition. Both permanent magnets and current coils should have same type of condition about the Principle Plane(s) to assign the appropriate condition. The type of the condition with reference to the **Objects** and **Images** of an electric current element and a permanent magnet is shown in the given figures below.

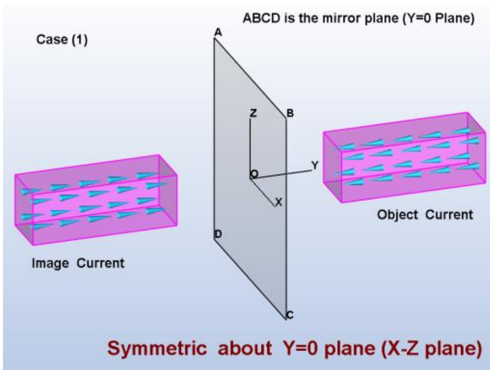

Fig 1

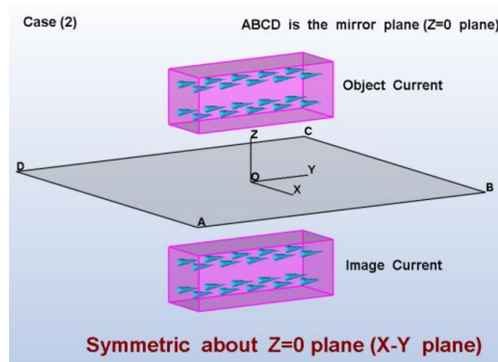

Fig 2

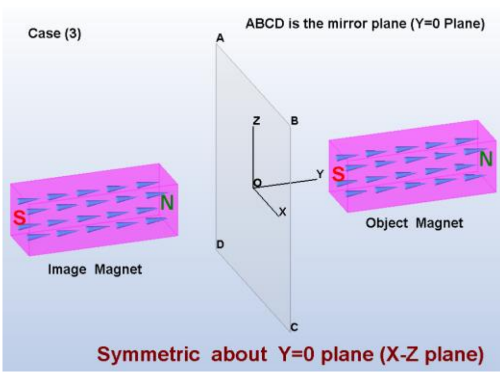

Fig 3

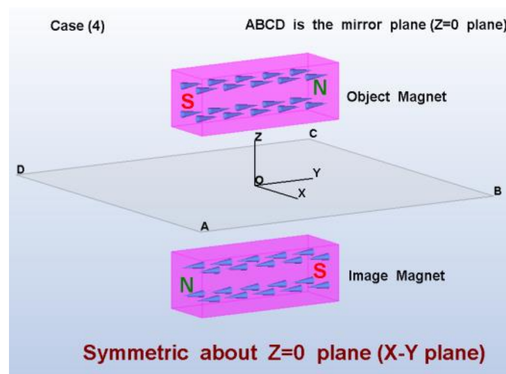

Fig 4

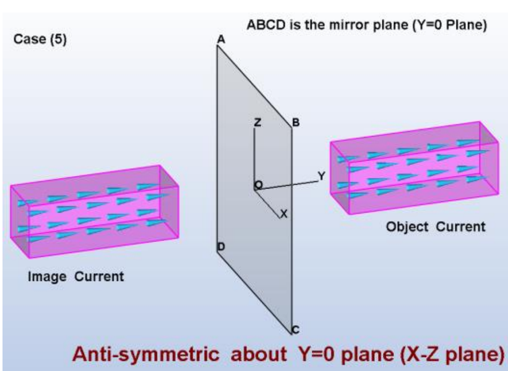

Fig 5

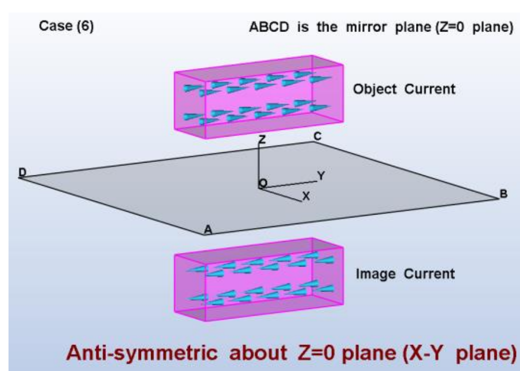

Fig 6

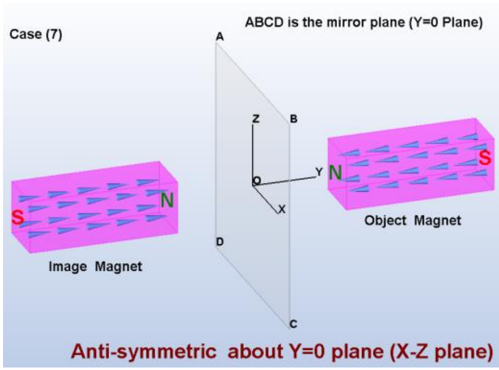
Case (7)
ABCD is the mirror plane (Y=0 Plane)
A
B
C
D
Z
Y
X
O
S
N
N
S
Image Magnet
Object Magnet
Anti-symmetric about Y=0 plane (X-Z plane)

Fig 7

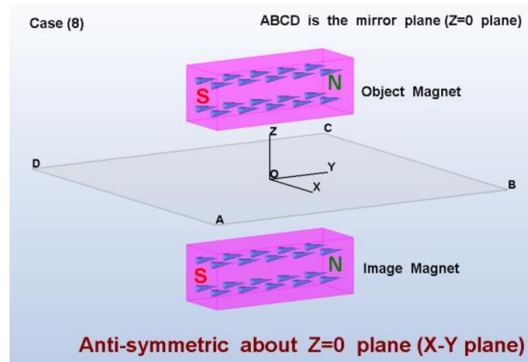
Case (8)
ABCD is the mirror plane (Z=0 plane)
S
N
Object Magnet
Z
C
D
Y
O
X
B
A
S
N
Image Magnet
Anti-symmetric about Z=0 plane (X-Y plane)

Fig 8