DoSA

(Designer of Solenoid & Actuator)

Version 0.9.6

User's Manual

2017.12

Open Actuator Project

(http://www.OpenActuator.org)

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1. DoSA Introduction

가) DoSA

DoSA is an acronym for **D**esigner **o**f **S**olenoid and **A**ctuator and is development software for Actuator and Solenoid developers. It has been developed by including Actuator's development Know-how. It also provides accurate experimental environment and design of the program.

DoSA's goal is to allow test (predict performance) developers design, with no concerns on CAE, by providing similar experimental environment with product development. For this, DoSA internally manages CAE related programs automatically.

DoSA's main functions can be divided into two.

Developer Work

- Entering component Specification value required for design

- Entering experiment condition value

DoSA Automatic Work

- Pre-Process input value extraction for design specification and experiment condition values.

- Analysis SW, Computer analysis execution

- Securing Actuator experiment result value using Post-Process function.

Thus, through the steps above, if the developer inputs the values required for experiments or designs, DoSA automatically conducts the experiment, providing with final result report for the user.

나) Applied Fields

DoSA allows performance prediction for several Actuator products listed below.

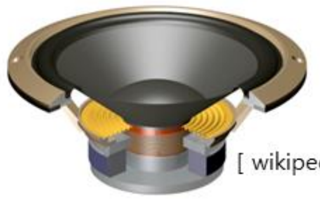
① Solenoid Actuator

- ✓ Car Solenoid
- ✓ Domestic electronics Solenoid
- ✓ Industrial Solenoid
- ✓ …

[wikimedia]

② Voice Coil Actuator

- ✓ Optical AutoFocus Actuator
- ✓ Linear Vibration Motor
- ✓ Industrial Voice Coil Actuator
- ✓ Speaker Drive Unit
- ✓ Ear Phone Drive Unit
- ✓ …



[wikipedia]

③ Other Actuators

- ✓ Circuit Breaker
- ✓ Linear Vibration Pump
- ✓ Solenoid Impactor
- ✓ …

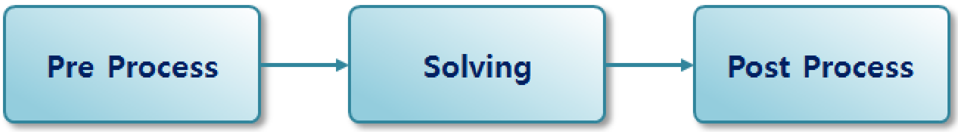
다) Development Background

Electromagnetic field analysis software(SW), such as FEMM, has reached a sufficient level of technology, therefore CAE technology is used in many electronics. However, Analysis SW required CAE majored experts limiting the utilization only to big-sized firms' CAE professionals that possess analysis organizations.

CAE technology, that is used for electronics development, predicts the product's basic performance and improves the performance of the development. Therefore electronic development firms are putting effort on educating developers on Analysis SW and encouraging usage to fully utilize CAE technology. However, as mentioned above, CAE Experts are required in Analysis SW. Therefore the analysis done is limited in only primary levels and the advanced analysis relies on CAE experts.

To solve such problem, Common-Use(Everyday) analysis SW firms strive for developing an easier Analysis SW; however, this also is an Analysis SW which requires CAE education for the developers. It may attract more developers into CAE development environments; however, limitations seem inevitable.

Most Analysis SW is a software based on CAE Solver and can solve all problems of relevant physical fields. Therefore, the operation follows the steps shown in Picture 1.3.1.



1.3.1 Analysis SW's operation steps

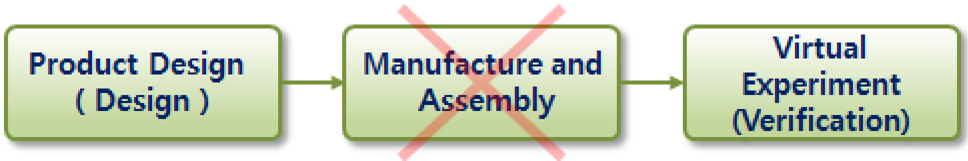
Picture 1.3.1 may seem familiar to CAE majored experts; however, for developers, who are used to product development, this is the very first step that has to be learned in CAE.

Then, would there be a way for developers to utilize CAE technology without any CAE education?

As a solution, we now want to now introduce a paradigm shift: Not an easy Analysis SW but a new concept of Development SW. If Analysis SW is a program that solves all problems of relevant physical field and is a program that is developed for CAE human-resources, Development SW is a program that is developed in the tall of the eyes of developers' and that develops products for specific product family.

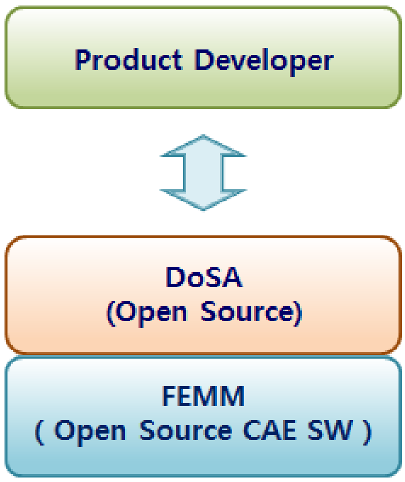
The developer processes the development through the product development procedure. The product development procedure is divided into three main steps: Product Design, Sample Manufacture and Assembly and finally Verification of examination. Therefore the Development SW's operation procedure doesn't follow Picture 1.3.1's computational analysis steps but follows product development procedures.

Picture 1.3.2 represents the Development SW's operation procedure. The Development SW is developed targeting specific product family; thus, it can provide familiar product design and verification of examination operations to the developers. Development SW's experiment takes place virtually; thus, designed sample's manufacture and assembly are not required.



Picture 1.3.2 Development SW's operation procedure

Development SW virtual experiment is a procedure that predicts the examination results that is required for specific products and uses Analysis SW for required computational analysis. Development SW is composed to provide virtual experiment results to the developer by controlling the Analysis SW, if the developers input the product design and experiment values. (Shown in Picture 1.3.3). Therefore, Development SW provides similar environment with product development and Analysis SW secures credibility of the predicted results.



Picture 1.3.3 Development SW's procedure

DoSA is an Actuator Development SW, which provides optimal development environment for Actuator or Solenoid developers.

라) Development Goal

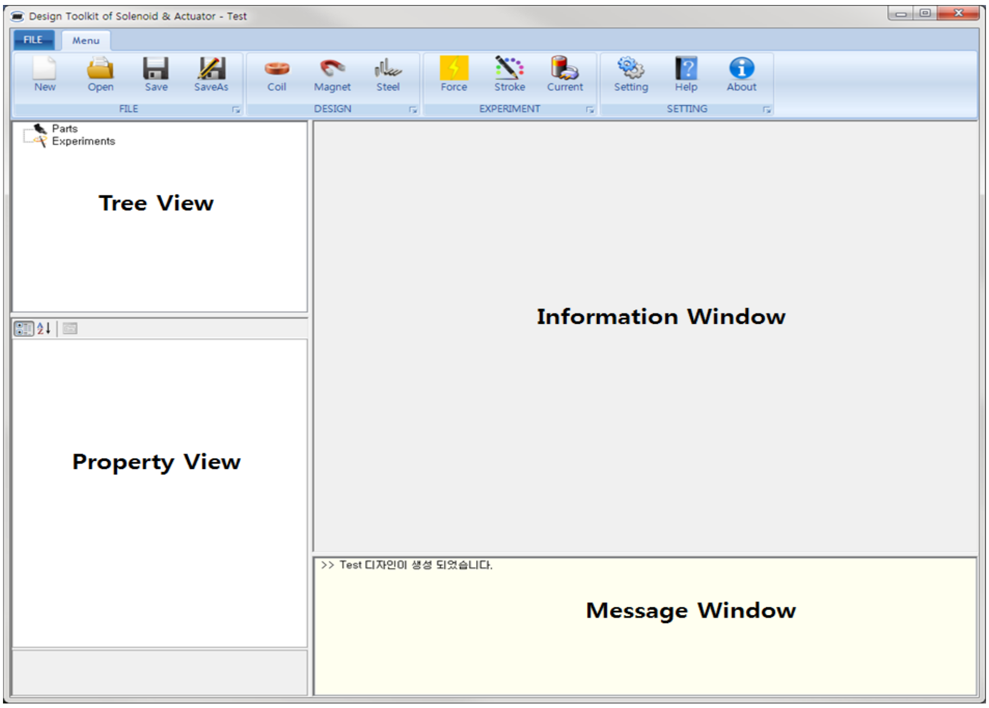
DoSA is a Development SW for developers. DoSA's goal is to provide development environments to CAE Non-majors enabling performance prediction of their own design, without any CAE education. For this, we have developed DoSA's operation environment similar to product development procedures: Not computational analysis but repetitive design and examination. Analysis SW is indeed used internally for virtual experiments; however, CAE related contents are automatically processed internally, allowing developers to utilize DoSA without any concerns on CAE.

DoSA is an Actuator product specialized development SW and contains Actuator's design, experiment technology Know-hows. Especially, DoSA provides a function that can calculate component specification values(which are essential for Actuator development), to instrument design input. It also allows various experiments those are done in actuator design verification, in virtual experiment forms. Furthermore, DoSA automatically creates a report which consists both components design specification value and virtual experiment results and admins design, experiment test data, allowing great reduction in document work time.

2. DoSA Components

DoSA's basic screen composition is shown in Picture 2.1.1 and each function are explained below.

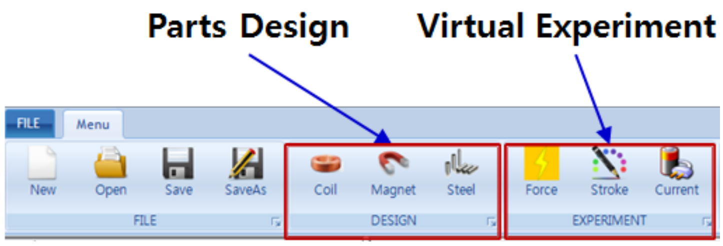
- ✓ Upper Menu Toolbar : Work Management, Component Design, Virtual Experiment, Settings
- ✓ Tree View : Tree View of components and virtual experiments.
- ✓ Property View : Property View of components and virtual experiments
- ✓ Information Window : Window that informs design and experiment results
- ✓ Message Window : Window that shows procedure progress



Picture 2.1.1 DoSA Screen composition

가) Menu Toolbar

DoSA's upper menu toolbar is shown in Picture 2.1.2. It is composed of product design and virtual experiment to provide similar work environment with product development.



Picture 2.1.2 Upper Menu Toolbar

① Work Management

DoSA's basic operation step is design. Save and New design work functions are explained below.

- ✓ New : New operation
- ✓ Open : Opens saved DoSA design file. (Extension name: *.dsa)
- ✓ Save : Saves design
- ✓ SaveAs : Saves design in a different name (Does not copy analysis results)

② Component Deisgn

Actuator product design means component part's design. Therefore design Toolbar is composed of three different component buttons that determines Actuator's performance design. Each button functions are explained below.

- ✓ Coil : Add new Coil and plan specifications
- ✓ Magnet : Add magnet and plan specifications
- ✓ Steel : Add steel and plan specifications

If we sort the often used components based on each Actuator methods, Coil and Steel are often used for Solenoids. Voice Coil Motor method (VCM) uses Coil, Steel and Magnet often.

③ Virtual Experiments

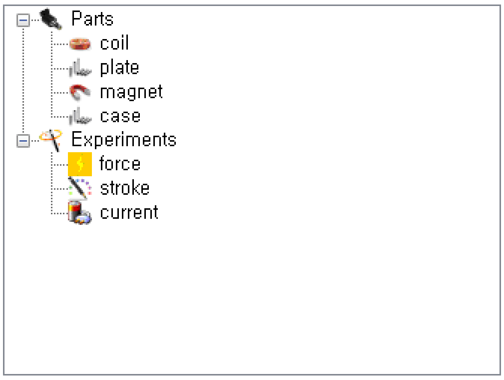
Examinations that are done when developing Actuators are supported with virtual experiments shown below.

- ✓ Force Measurement : Driving Part magnetic force Measurement
- ✓ Stroke Measurement : Different displacement Magnetic Force Measurement
- ✓ Current Measurement : Different current Magnetic Force Measurement

DoSA provides examination results, required for Actuator product development, as virtual examinations.

나) Tree View

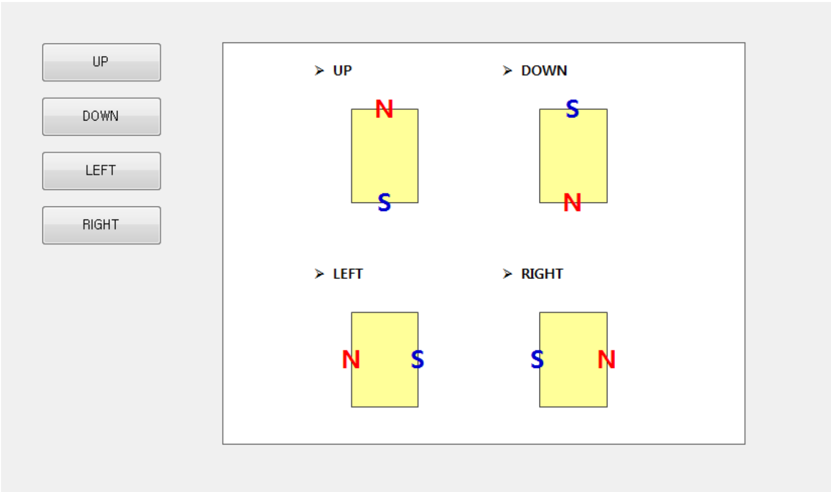
Tree View shows and allows selection of design components and virtual experiments. Picture 2.2.1 represents the Actuator operation's Tree View Picture. Components and Virtual experiments are added which are required for Actuator analysis.



Picture 2.2.1 Actuator Operation Tree View

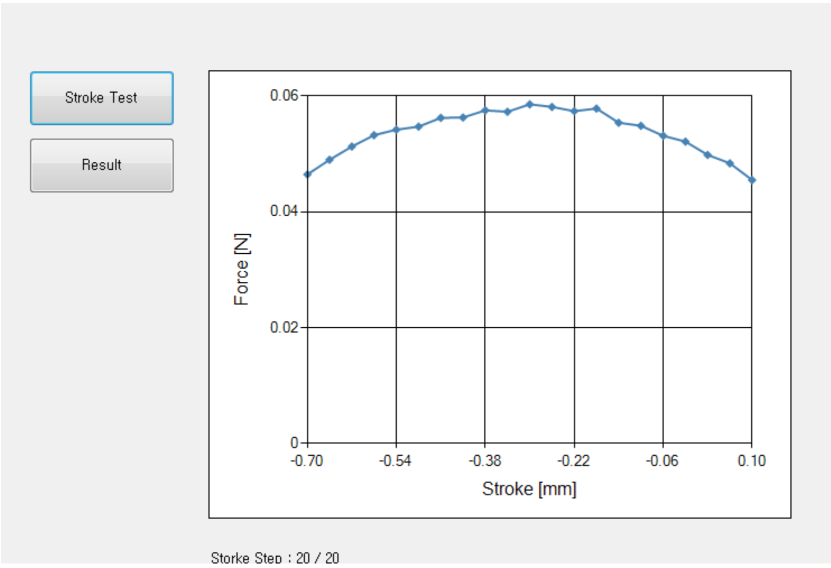
Information Window provides pictures to help developer's understandings when designing components or inputting virtual experiment conditions. Furthermore, it is used to show the results of the experiment.

다) Information Window



Picture 2.3.1 Magnet characteristics setting explanation

Picture 2.3.1 is a picture which shows magnets characteristics setting information through Information Window. Furthermore, DoSA provides Coil formula calculation design function. The information required for component formula design, are provided through the Information Window.



Picture 2.3.2 VCM Stroke Magnetic Force results

Picture 2.3.2 shows the results of VCM Actuator's Magnetic Force for each stroke. DoSA provides not only components' design explanation but also results after the virtual experiment through the information window.

라) Property View

Property View is a window for inputting component specifications and virtual experiment conditions.

Picture 2.4.1 is Coil Property View image. Property View's optional category is not the information used directly in virtual experiment but is a component design input value for automatic calculation of component specifications for virtual examinations.

Common Fields	
Node Name	coil
Specification Fields	
Part Material	Copper
Curent Direction	OUT
Moving Parts	FIXED
Calculated Fields	
Coil Turns	126
Coil Resistance [Ω]	15.74769
Coil Layers	6
Turns of One Layer	21
Design Fields (optional)	
Coil Wire Grade	Bonded_IEC_Grade_1B
Inner Diameter [mm]	3
Outer Diameter [mm]	3.73
Coil Height [mm]	1.18
Copper Diameter [mm]	0.045
Wire Diameter [mm]	0.04953
Coil Temperature [℃]	20
Horizontal Coefficient	0.95
Vertical Coefficient	1.13
Resistance Coefficient	1.1

Picture 2.4.1 Coil Related Property View

3. Function Explanation

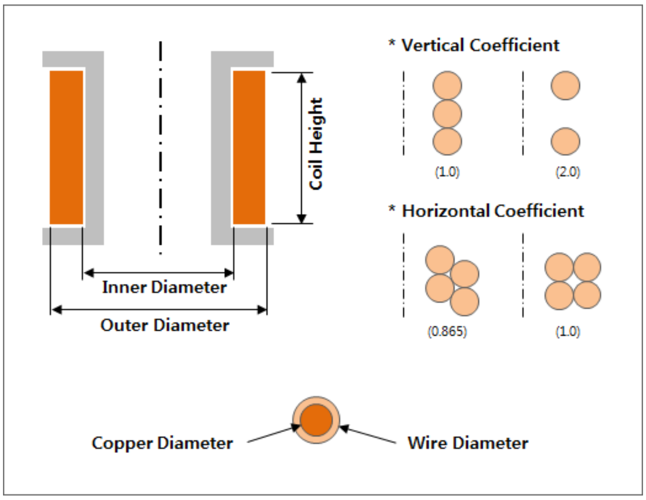
가) Component Design

Actuator's performance is realized with performance component's mix. Therefore, Actuator Product Design can be said as a process that designs components. After inputting Actuator performance component's specification value or calculating design procedure, DoSA automatically extracts every input values, required in Analysis SW's Pre-Process, from performance component's specification values. It then automatically executes Analysis SW.

Each component design procedure will be explained.

① Coil

Coil related information required for Analysis SW, is Turns and resistance. However, Coil's property values(Turns and resistance) can be obtained after coil production. Therefore, the developer must predict the values with the production design values before the coil production. To assist developers' coil design, DoSA provides a function that calculates Coil's Turns and resistance using the Coil production design values.



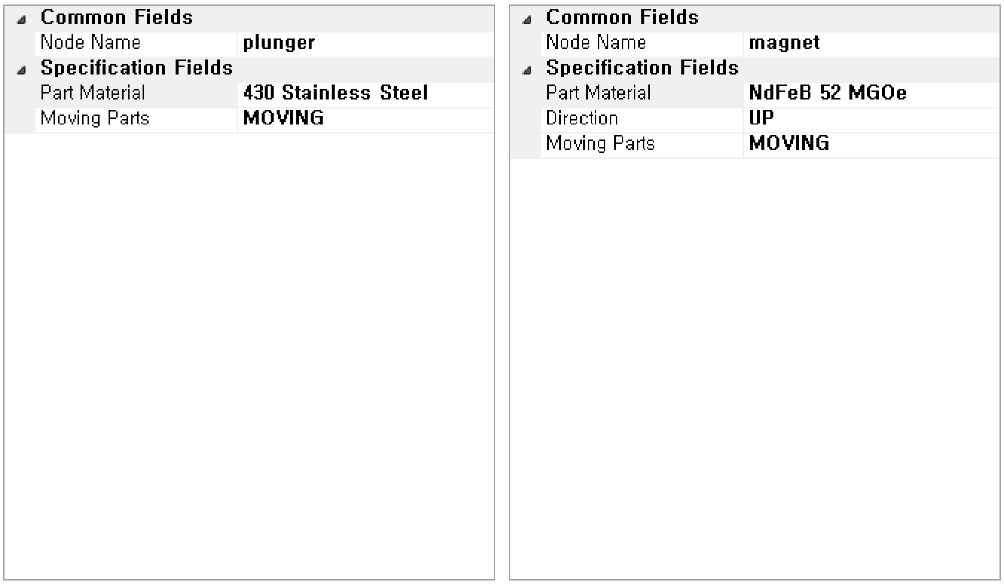
Common Fields	
Node Name	coil
Specification Fields	
Part Material	Copper
Curent Direction	OUT
Moving Parts	FIXED
Calculated Fields	
Coil Turns	126
Coil Resistance [Ω]	15.74769
Coil Layers	6
Turns of One Layer	21
Design Fields (optional)	
Coil Wire Grade	Bonded_IEC_Grade_1B
Inner Diameter [mm]	3
Outer Diameter [mm]	3.73
Coil Height [mm]	1.18
Copper Diameter [mm]	0.045
Wire Diameter [mm]	0.04953
Coil Temperature [℃]	20
Horizontal Coefficient	0.95
Vertical Coefficient	1.13
Resistance Coefficient	1.1

Picture 3.1.1 Coil Design

- ✓ Part Material : Enameled Wire Property (copper, aluminum)
- ✓ Current Direction : Coil Current Direction
- ✓ Moving Parts : Decision of Fixed parts and Non-Fixed part
- ✓ Coil Turns : Coil Turns (Can input manually or can be calculated automatically)
- ✓ Coil Resistance : Coil Resistance (Can input manually or can be calculated automatically)
- ✓ Coil Layers : Number of Coil layers (Calculated Automatically)
- ✓ Turns of One Layer : Number of turns in on layer (Calculated Automatically)
- ✓ Coil Wire Grade : Coil Enameled Wire grade (Covering Depth differs from grade to grade)
- ✓ Inner Diameter, Outer Diameter, Coil Height, Copper Diameter : Coil Shape design info.
- ✓ Wire Diameter : Enameled Wire diameter (Calculated automatically considering enameled wire grad)
- ✓ Coil Temperature : Coil Movement Temperature (Used for resistance calculation)
- ✓ Horizontal Coefficient : Horizontal Coefficient of one layer (Determines with Turns of One Layer)
- ✓ Vertical Coefficient : Vertical Coefficient of one layer (Determines with Coil Layers)
- ✓ Resistance Coefficient : Coil resistance coefficient (Determines with Coil Resistance)

② Soft Magnetic Material and Permanent Magnets

Picture 3.1.2 is an input window for Permanent Magnet and Soft Magnetic Material component properties. Permanent Magnets require material quality and magnetization direction settings, Soft magnetic Materials requires careful material property selection considering material's magnetic characteristics (BH curve). Soft magnetic Materials and Permanent Magnets' form input work must be done manually in DoSA by the developer.



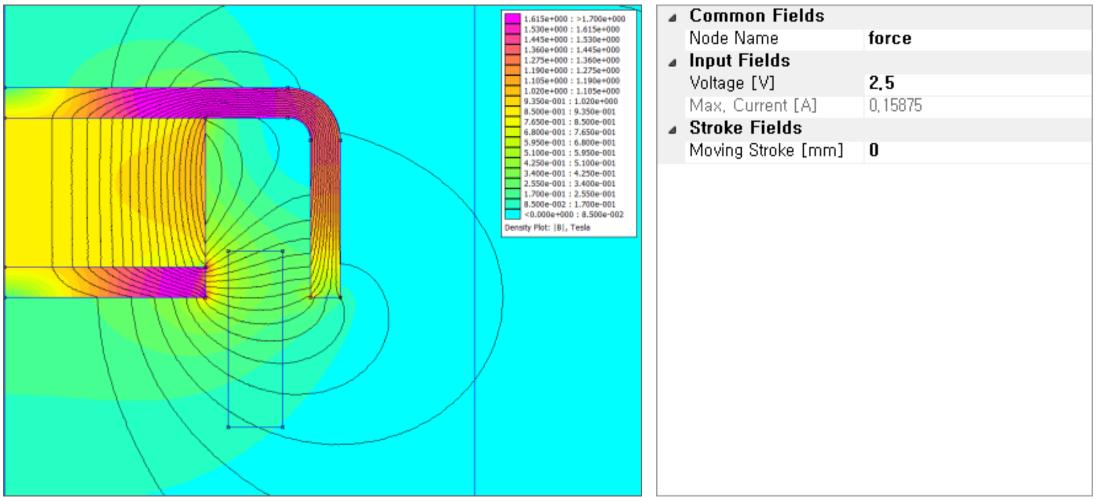
Picture 3.1.2 Soft magnetic Materials 와 Permanent Magnets

- ✓ Part Material : Soft magnetic Materials or Permanent Magnets material property (Can use user's properties)
- ✓ Moving Parts : Selection of moving parts or fixed parts
- ✓ Direction : Setting Permanent Magnets' magnetization direction (UP, DOWN, LEFT, RIGHT)

나) Virtual Examination

① Magnetic Force Virtual Examination

Magnetic Force examination examines the Magnetic Force by allowing current through while the moving parts are stationary. DoSA also allows Virtual Magnetic Force examination, which calculates magnetic flux patterns and Magnetic forces when specific voltages are inputted.

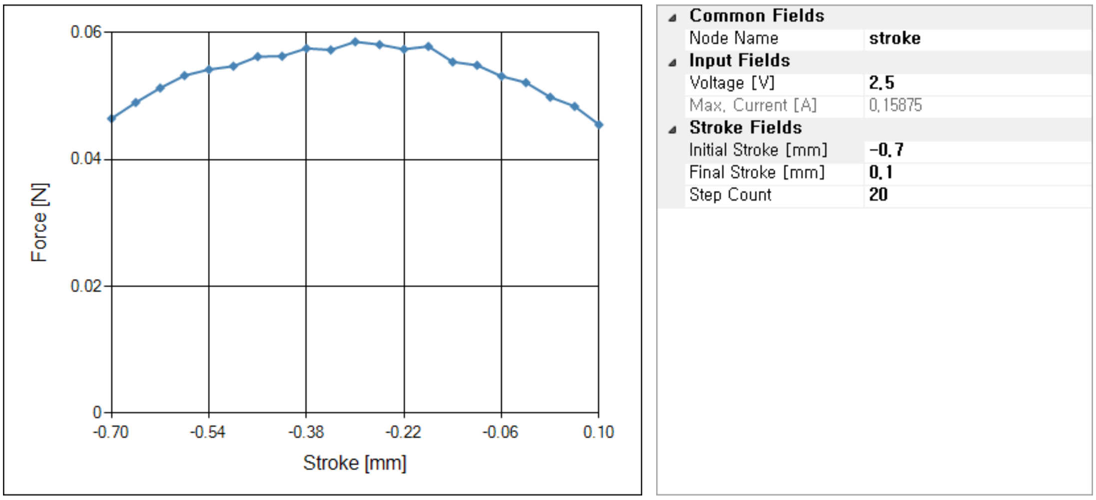


Picture 3.2.1 Virtual Magnetic Force Examination

- ✓ Node Name : Name of the Node
- ✓ Max. Current : Permitted maximum current in Coil(Automatic Calculation)
- ✓ Voltage : Permitted Coil Voltage 전압
- ✓ Moving Stroke : Driver Location

② Stroke Virtual Examination

Stroke examination examines Magnetic Force that occurs when the moving part changes stroke in a fixed current and voltage permission conditions. DoSA also allows Virtual Stroke examination, that predicts the Magnetic Force, by moving the moving parts in a uniformed interval.

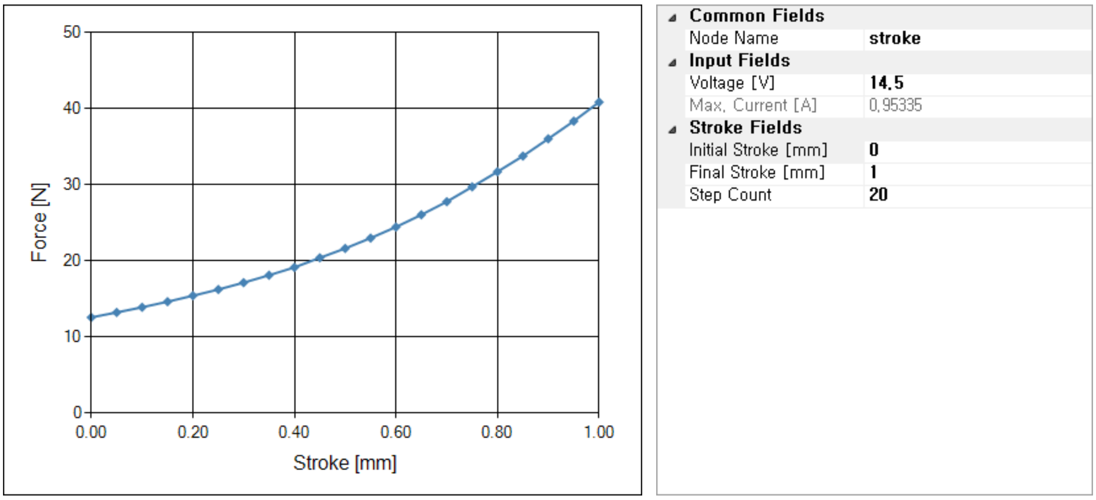


Picture 3.2.2 Virtual Stroke Examination

- ✓ Voltage : Permitted Coil Voltage
- ✓ Current : Permitted Maximum Coil Current Automatic Calculation
- ✓ Initial Stroke : Minimum Stroke within Stroke Section
- ✓ Final Stroke : Maximum Stroke within Stroke Section
- ✓ Step Count : Step Count within Stroke Section

③ Current Virtual Examination

Current Examination examines Magnetic Force which is created while changing the moving part's current at a fixed permission condition. DoSA also allows Current Examination and predicts Magnetic Force by moving the moving parts in a fixed interval.



Picture 3.2.3 Virtual Current Examination

- ✓ Initial Current : Current Section's minimum Current

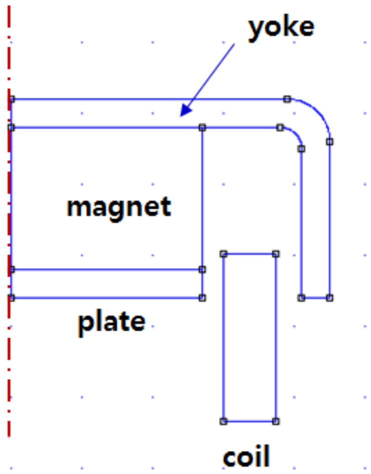
- ✓ Final Stroke : Current section's maximum Current
- ✓ Step Count : Current Section's Step Count
- ✓ Moving Stroke : Driver movement location

4. Copying Each Actuator

가) Linear Vibration Motor (VCM method, Axial-Symmetry 2D Analysis)

① Model Explanation

As a VCM Actuator's work example, the Cross Section's Linear Vibrator, shown in Picture 4.1.1, is used. Axial-Symmetry 2D Analysis formation work must work on only the right-side form based on the axis.



Picture 4.1.1 Linear Vibrator Cross Section

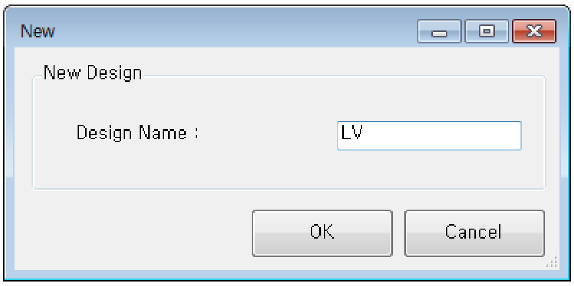
Example Linear Vibration motor's specifications are shown below

- ✓ Coil Specifications
  - → Coil Turns : 126 turns
  - → Coil Resistance : 15.75 Ohm
- ✓ Permanent Magnets
  - → Material : NdFeB 52
  - → Magnetization Direction : 90 (UP)
- ✓ Power Waveform
  - → Voltage : 2.5 V

② Design Creation

- ✓ Click New button on Toolbar 

✓ Set Design Name as “LV”. (Shown in Picture 4.1.2)



Picture 4.1.2 New Design Window

③ Coil addition

✓ Click Coil button on Toolbar. 

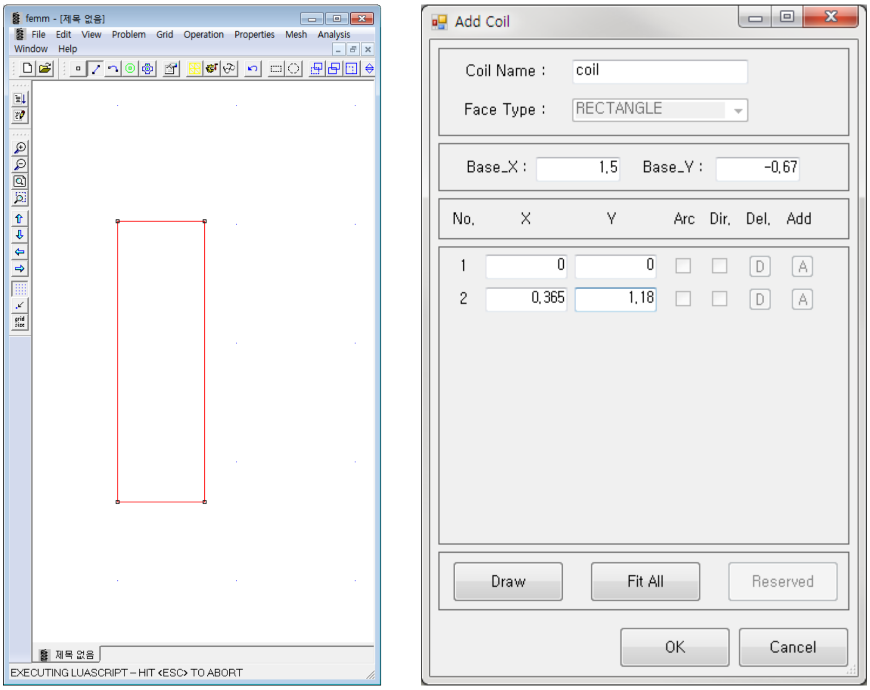
✓ Set Coil Name as “coil” and input Coil form values in the window (shown in Picture 4.1.3)

→ Coil Location : Base_X = 1.5, Base_Y = -0.67

→ Down Left Point : X = 0, Y = 0 (Relative Coordinates)

→ Upper Right point: X = 0.365, Y = 1.18 (Relative Coordinates)

✓ Adjust Screen with Fit All button, and confirm form through FEMM window



Picture 4.1.3 Coil Creation

✓ Input Coil design values for Coil specification calculation in Property View (shown in Picture 4.1.4). Coil Turns and Resistance are calculated thus they are not inputted.

→ Part Material : Copper Selection

→ Current Direction : OUT Selection (Outer Direction)

→ Moving Parts : FIXED Selection (Fixed Component)

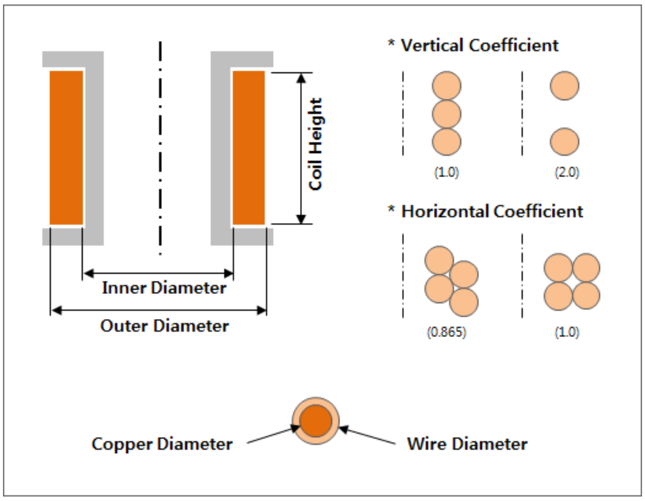
→ Coil Wire Grade : Bonded_IEC_Grade_1B Selection

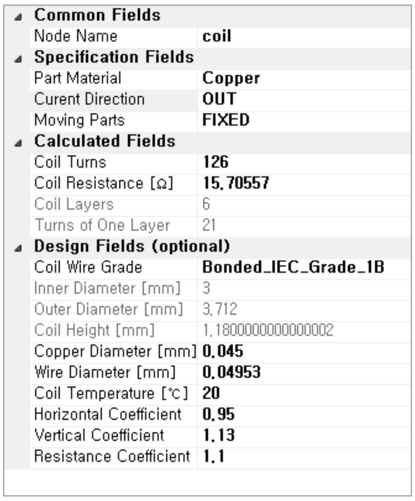
→ Copper Diameter : 0.045 mm Input

→ Horizontal Coefficient : 0.95 Input

→ Vertical Coefficient : 1.13 Input

→ Resistance Coefficient : 1.1 Input





Common Fields	
Node Name	coil
Specification Fields	
Part Material	Copper
Curent Direction	OUT
Moving Parts	FIXED
Calculated Fields	
Coil Turns	126
Coil Resistance [Ω]	15.70557
Coil Layers	6
Turns of One Layer	21
Design Fields (optional)	
Coil Wire Grade	Bonded_IEC_Grade_1B
Inner Diameter [mm]	3
Outer Diameter [mm]	3.712
Coil Height [mm]	1.1800000000000002
Copper Diameter [mm]	0.045
Wire Diameter [mm]	0.04953
Coil Temperature [℃]	20
Horizontal Coefficient	0.95
Vertical Coefficient	1.13
Resistance Coefficient	1.1

Picture 4.1.4 Coil design value name and Coil specification value

✓ After inputting design values, click Design Coil button on Information Window to calculate Coil specification values (Shown in Picture 4.1.4).

④ Adding Permanent Magnets

✓ Click Magnet Button on Toolbar. 

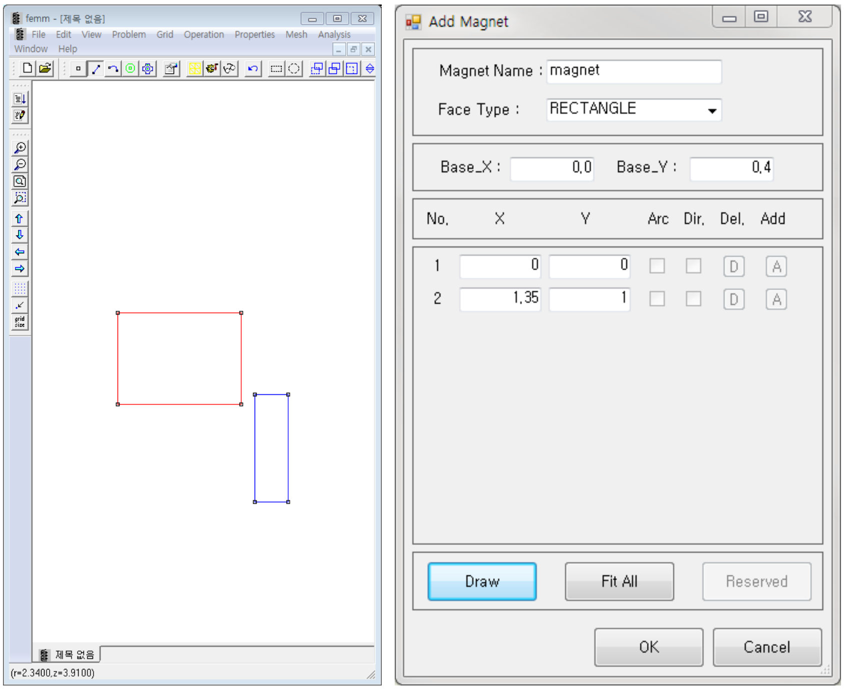
✓ Set Magnet Name as “magnet” and input magnet form in window (shown in Picture 4.1.5)

→ Magnet Location : Base_X = 0, Base_Y = 0.4

→ Down Left Point : X = 0, Y = 0 (Relative Coordinates)

→ Upper Right Point : X = 1.35, Y = 1 (Relative Coordinates)

✓ Adjust screen with Fit All button, and confirm form through FEMM window.



Picture 4.1.5 Permanent Magnets Creation

✓ Input Permanent Magnet specifications in Property View (Shown in Picture 4.1.7)

→ Part Material : NdFeB 52 MGOe Selection

→ Direction : UP

→ Moving Parts : Moving (Moving components)

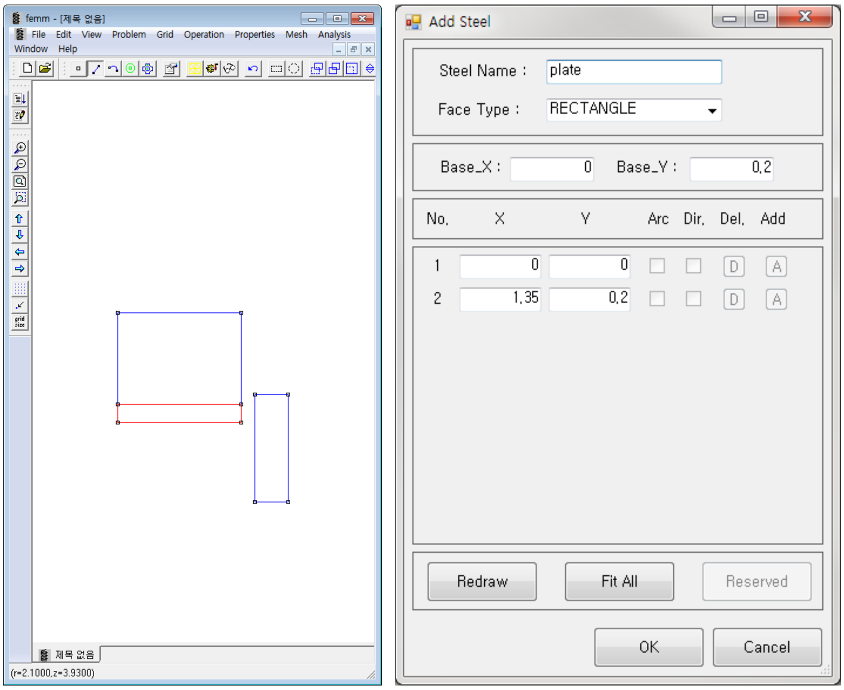
Permanent Magnets are dynamic components thus it must be selected as MOVING (shown in Picture 4.1.6)

Picture 4.1.6 Permanent Magnets Properties values

⑤ Adding Soft magnetic Materials

✓ Click Steel Button on Toolbar. 

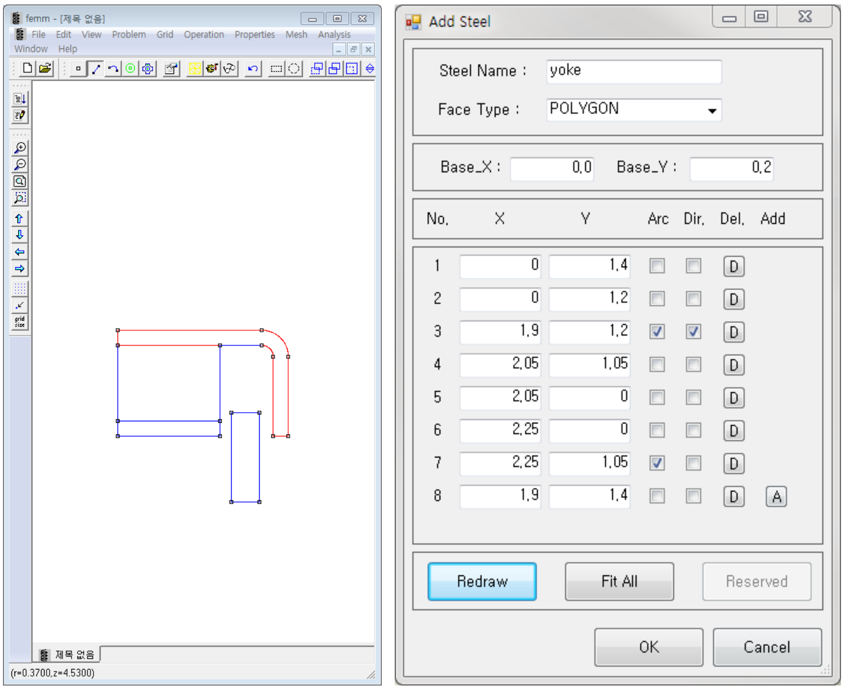
- ✓ Set Steel Name as “plate” and input Steel form values. (Shown in Picture 4.1.7)
  - → Face Type : RECTANGLE
  - → Steel location : Base_X = 0, Base_Y = 0.2
  - → Down Left point : X = 0, Y = 0 (Relative Coordinates)
  - → Upper Right point : X = 1.35, Y = 0.2 (Relative Coordinates)
- ✓ Adjust screen with Fit All button. Confirm form through FEMM window.



Picture 4.1.7 Soft magnetic Materials (plate) Creation

- ✓ Click Steel button on Toolbar. 

- ✓ Set Steel Name as “yoke” from the window (shown in Picture 4.1.8) and input Steel form values.
  - → Yoke Location : Base_X 0, Base_Y 0.2
  - → 1 Point : X 0, Y 1.4
  - → 2 Point : X 0, Y 1.2
  - → 3 Point : X 1.9, Y 1.2 (Arc, Dir Check)
  - → 4 Point : X 2.05, Y 1.05
  - → 5 Point : X 2.05, Y 0
  - → 6 Point : X 2.25, Y 0
  - → 7 Point : X 2.25, Y 1.05 (Arc Check)
  - → 8 Point : X 1.9, Y 1.4
- ✓ Adjust screen with Fit All button and confirm form through FEMM window.



Picture 4.1.8 Soft magnetic Materials (yoke) Creation

✓ Input Coil properties in Property View as shown in Picture 4.1.9.

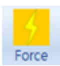
→ Part Material : 430 Stainless Steel Selection

→ Moving Parts : Moving Selection (Moving parts)

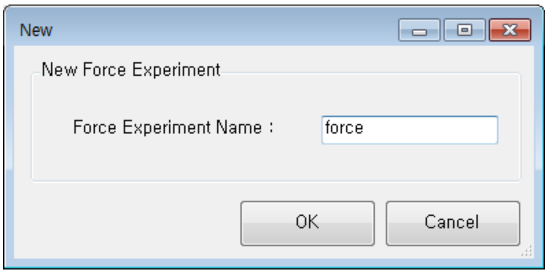
Soft magnetic Materials plate and yoke are dynamic components thus MOVING must be selected for Moving parts as shown in Picture 4.1.9.

Picture 4.1.9 Soft magnetic Materials Property Values

⑥ Magnetic Force Virtual Examination

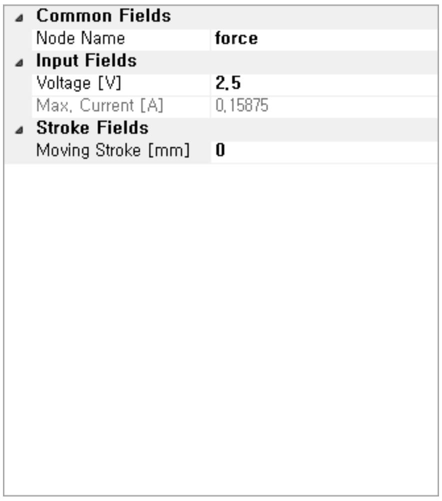
✓ Click Force Button on Toolbar. 

✓ Input Magnetic Force Virtual Examination's name as shown in Picture 4.1.10.



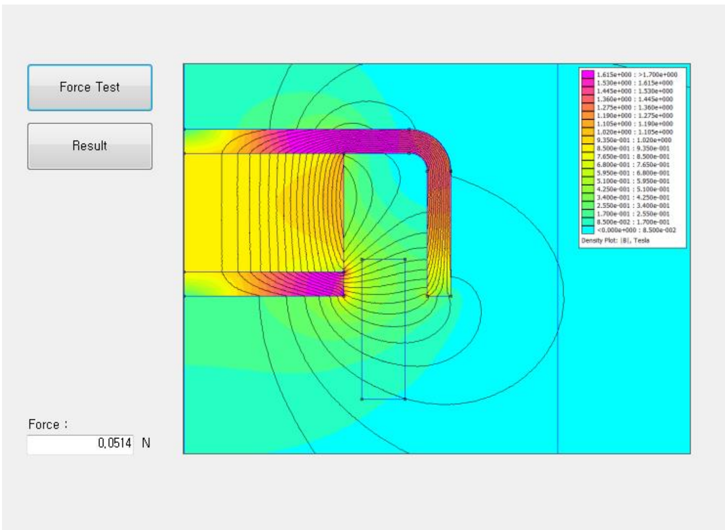
Picture 4.1.10 Magnetic Force Virtual Examination name input

✓ Input voltage in Property View as shown in Picture 4.1.11



Picture 4.1.11 Magnetic Force Virtual Examination conditions

✓ Click Force Test button on Information Window to calculate 0.051N's Magnetic force as shown in Picture 4.1.12

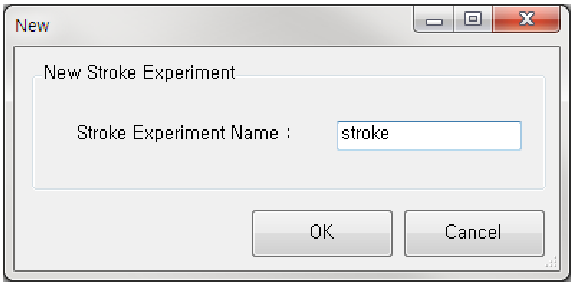


Picture 4.1.12 Magnetic Force Analysis

⑦ Stroke-Magnetic Force Virtual Examination

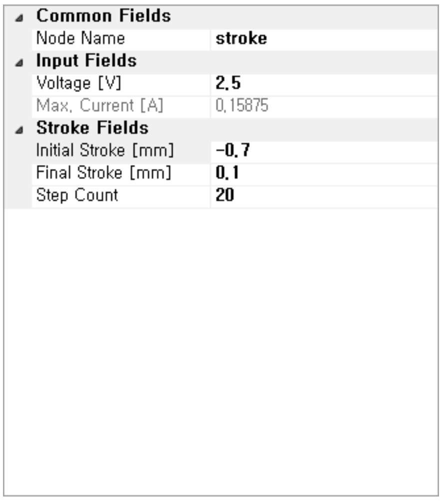
- ✓ Click Stroke button on Toolbar. 

- ✓ Input Stroke-Magnetic Force Virtual Examination name as shown in Picture 4.1.13.



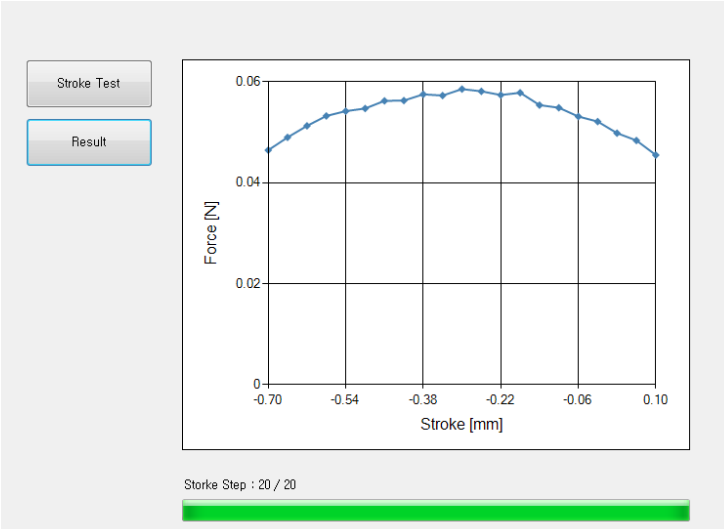
Picture 4.1.13 Stroke-Magnetic Force Virtual Examination Name input

- ✓ Input Stroke-examination conditions in Property View as shown in Picture 4.1.14



Picture 4.1.14 Stroke Virtual Examination condition

- ✓ Click Stroke Test button on Information Window to analyze Magnetic Force for each stroke and the magnetic force for each stroke can be seen in Information Window as shown in Picture 4.1.15.

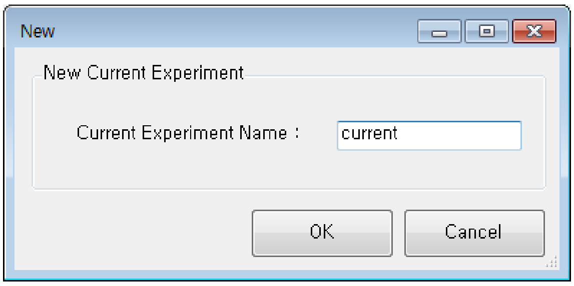


Picture 4.1.15 Stroke-Magnetic Force Virtual Examination Results

⑧ Current-Magnetic Force Virtual Examination

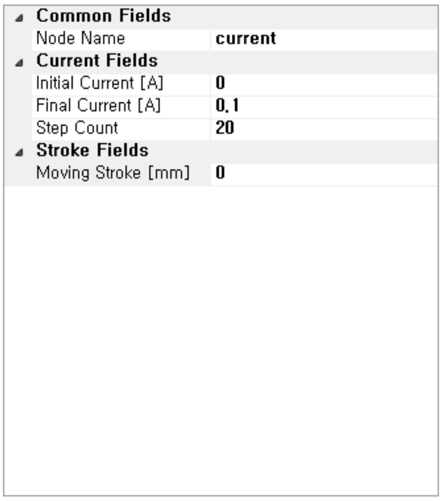
✓ Click Current button on Toolbar. 

✓ Input Current-Magnetic Force Virtual Examination name as shown in Picture 4.1.16



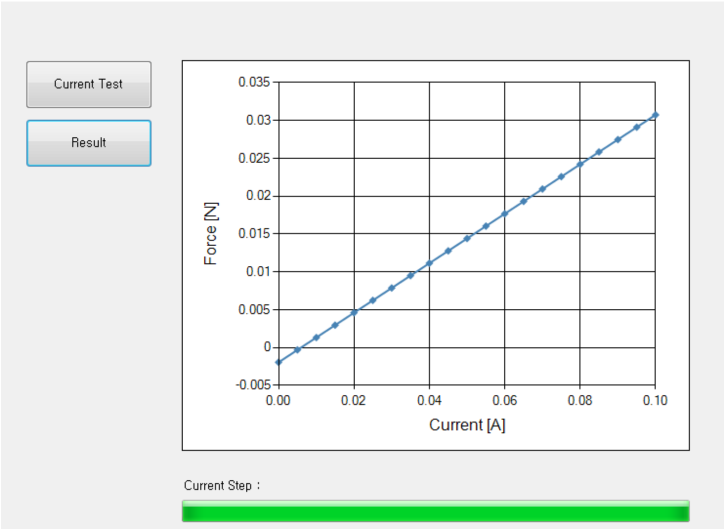
Picture 4.1.16 Current-Magnetic Force Virtual Examination Name input

✓ Input Current-Magnetic Force examination conditions in Property View as shown in Picture 4.1.17.



Picture 4.1.17 Current-Magnetic Force Virtual Examination Settings

- ✓ Click Current Test button on Information Window to analyze Magnetic force for each current. The magnetic force for each current can be seen on the Information Window as shown in Picture 4.1.18.

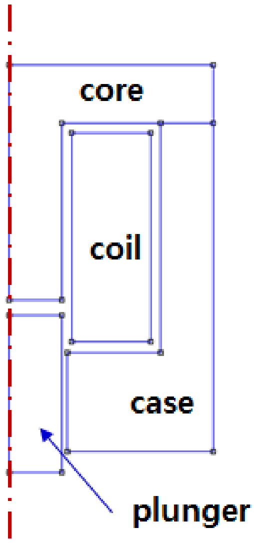


Picture 4.1.18 Current-Magnetic Force Virtual Examination results

나) On/Off Solenoids

① Model Explanation

As a Solenoid actuator operation example, cross sectional On/Off Solenoids are used as shown in Picture 4.2.1.

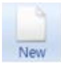


Picture 4.2.1 On/Off Solenoid cross section

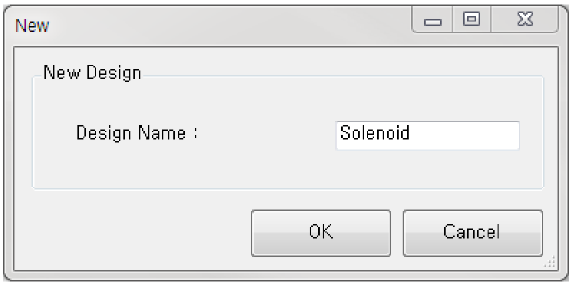
The example solenoid's properties are shown below.

- ✓ Coil Properties
  - → Coil Turns : 1040 turns
  - → Coil Resistance : 15.2 Ohm
- ✓ Power Waveform
  - → Voltage : 14.5 V

② Creating Design

- ✓ Click New button on Toolbar. 

- ✓ Input New Design's name as "Solenoid" as shown in Picture 4.2.2.



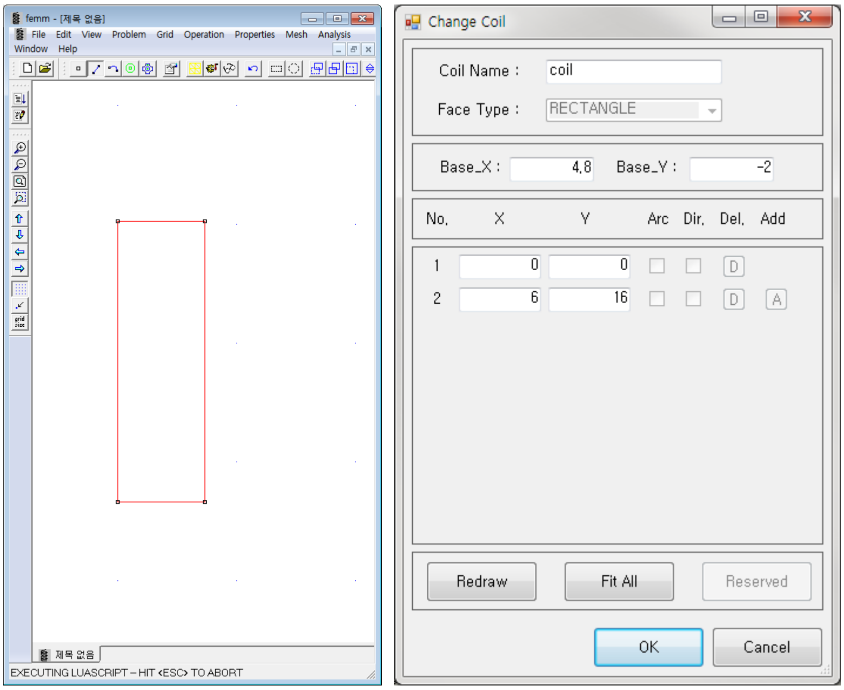
Picture 4.2.2 Design creation window

③ Coil Addition

- ✓ Click Coil button on Toolbar. 

- ✓ Input Coil name on the creation window as "coil" and input Coil form as shown in Picture 4.2.3.
  - → Magnet Location : Base_X = 0, Base_Y = 0.4
  - → Down Left Point : X = 0, Y = 0 (Relative Coordinates)
  - → Upper Right Point : X = 1.35, Y = 1 (Relative Coordinates)

- ✓ Adjust Screen with Fit All and confirm form through FEMM window



Picture 4.2.3 Coil creation

✓ Input Coil design values in Property View for Coil property calculation as shown in Picture 4.2.4. Coil Turns and Coil Resistance are calculated, thus does not have to be inputted.

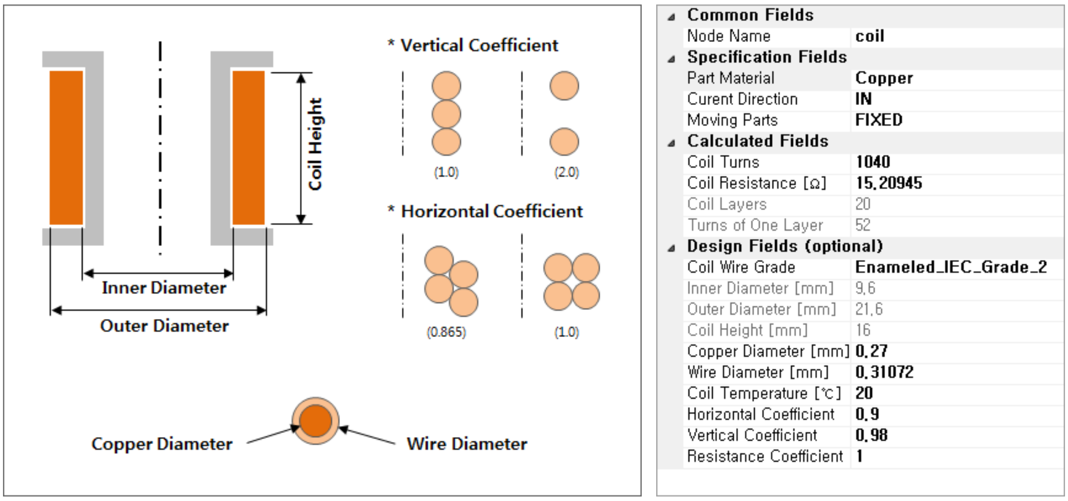
→ Part Material : Copper Selection

→ Current Direction : IN Selection (Inner Direction)

→ Moving Parts : FIXED Selection (Fixed Components)

→ Coil Wire Grade : Enameled_IEC_Grade_2 Selection

→ Copper Diameter : 0.27 mm input



Picture 4.2.4 Coil apparatus design value input

✓ After entering design value, click Design Coil on the Information Window to calculate Coil property values as shown in Picture 4.2.4

④ Soft magnetic Materials addition

✓ Click Steel button on Toolbar. 

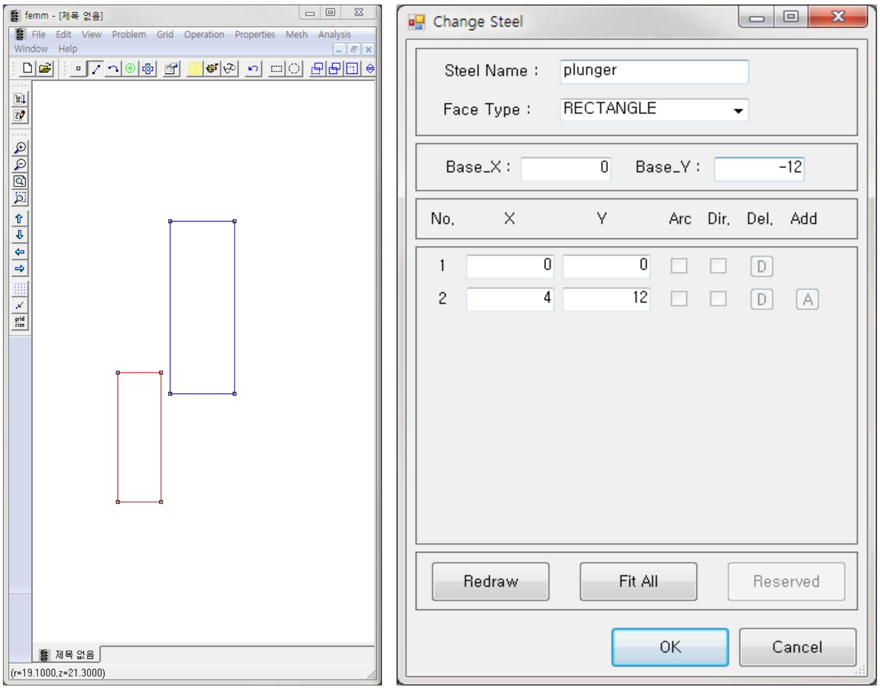
✓ Set Steel Name as "Plunger" in the window and input Steel form as shown in Picture 4.2.5.

→ Face Type : RECTANGLE

→ Plunger Location : Base_X 0, Base_Y -12

→ Down Left Point : X 0, Y 0 (Relative Coordinates)

→ Upper Right Point : X 4, Y 12 (Relative Coordinates)



Picture 4.2.5 Plunger Creation

✓ Property View 에서 Soft magnetic Materials plunger 사양을 Picture 4.2.6 와 같이 입력한다.

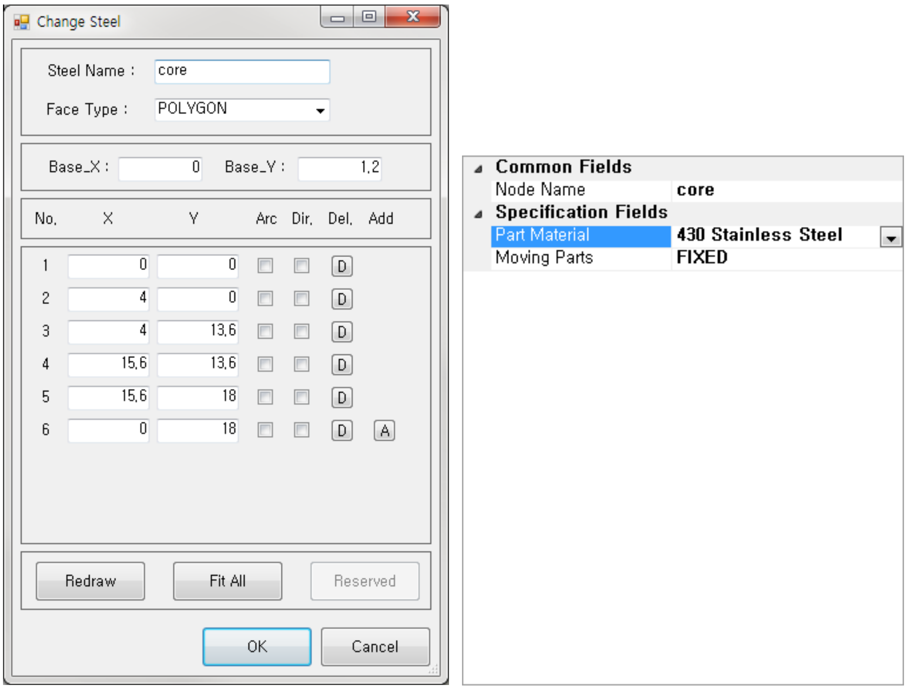
→ Part Material : 430 Stainless Steel Selection

→ Moving Parts : Moving Selection (Moving Components)

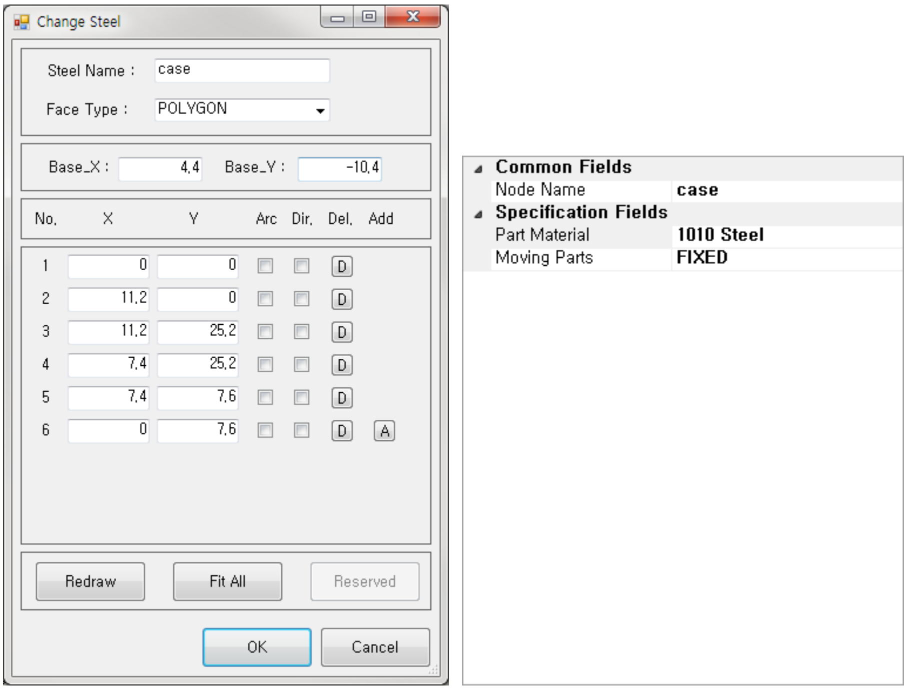
Plunger is a dynamic component thus MOVING must be selected for the Moving parts as shown in Picture 4.2.6

Picture 4.2.6 Soft magnetic Materials(Plunger) Property Values

✓ Repeat the steps above to the remaining Case and Core which are Soft magnetic Materials. Case and Core are fixed components thus FIXED must be selected for Moving parts.

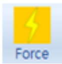


Picture 4.2.7 Soft magnetic Materials(Core) Creation

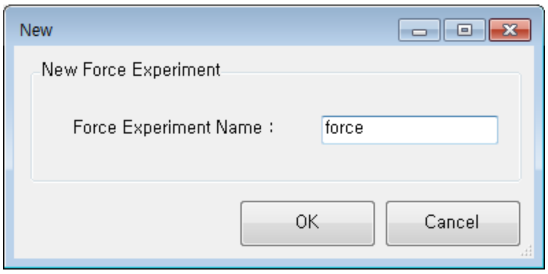


Picture 4.2.8 Soft magnetic Materials (case) Creation

⑤ Magnetic Force Virtual Examination

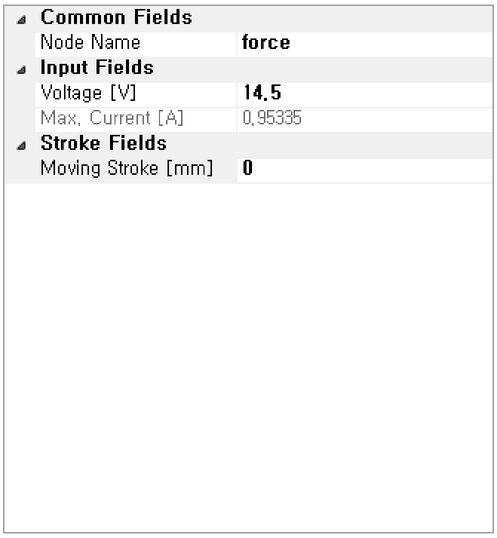
✓ Click Force button on Toolbar. 

✓ Input Magnetic Force Virtual Examination name as shown in Picture 4.2.9.



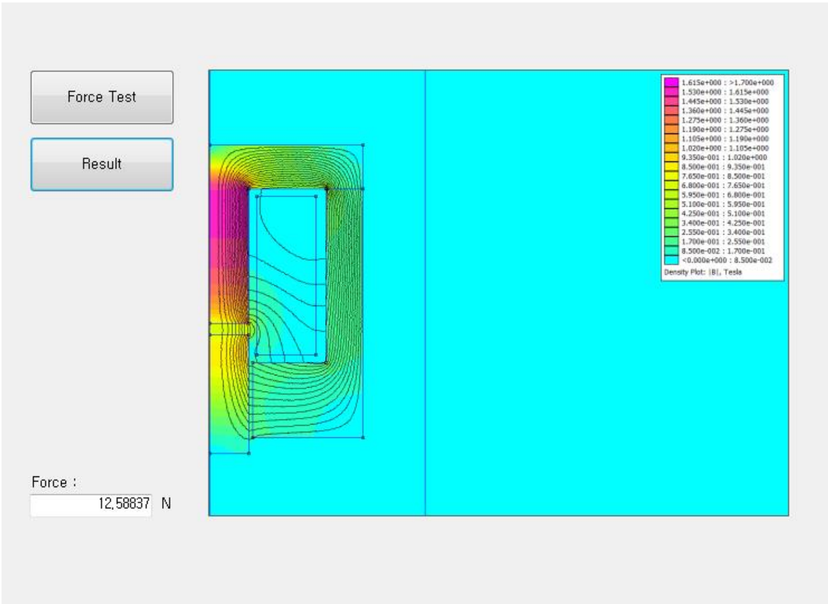
Picture 4.2.9 Magnetic Force Virtual Examination Name input

✓ Enter input voltage in Property View as shown in Picture 4.2.10.



Picture 4.2.10 Magnetic Force Virtual Examination permitted power

✓ Click Force Test button on Information Window to analyze Magnetic force as shown in Picture 4.2.11.

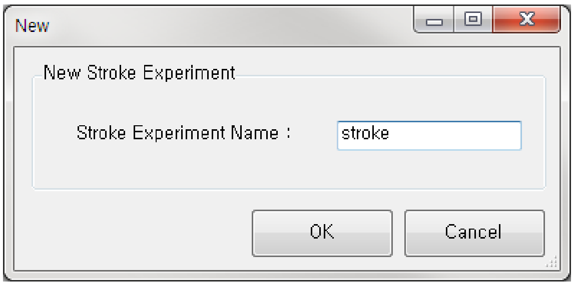


Picture 4.2.11 Magnetic Force Analysis

⑥ Stroke-Magnetic Force Virtual Examination

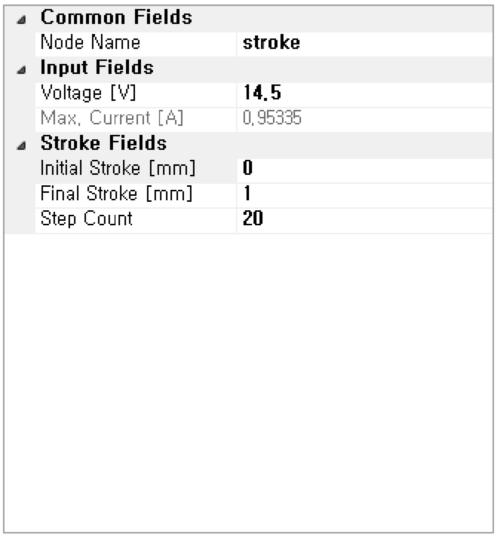
✓ Click Stroke Button on Toolbar. 

✓ Input Magnetic Force Virtual Examination name as shown in Picture 4.2.12



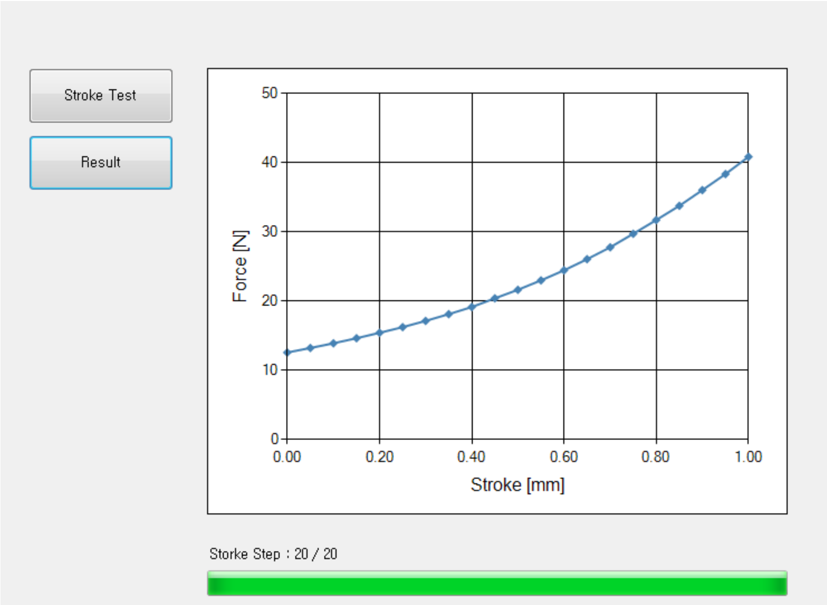
Picture 4.2.12 Stroke-Magnetic Force Virtual Examination Name input

- ✓ Input stroke examination conditions in Property View as shown in Picture 4.2.13.



Picture4.2.13 Stroke-Magnetic Force Virtual Examination Conditions

- ✓ Click Stroke Test on Information Window to initiate Maxwell and analyze Magnetic Force for each stroke. The Magnetic Force for each stroke can be seen on the Information Window as shown in Picture 4.2.14.

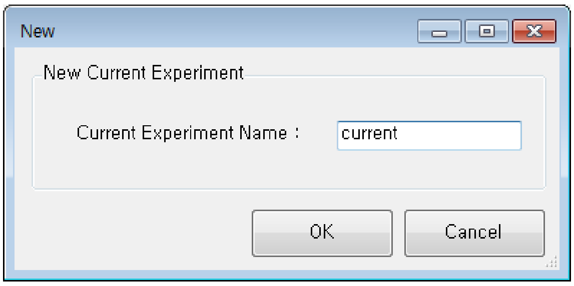


Picture 4.2.14 Stroke-Magnetic Force Virtual Examination Results

⑦ Current-Magnetic Force Virtual Examination

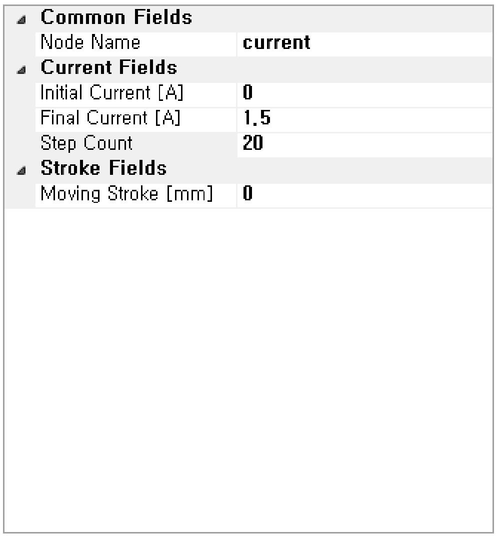
- ✓ Click Current Button on Toolbar. 

- ✓ Enter Current-Magnetic Force Virtual Examination name as shown in Picture 4.2.15.



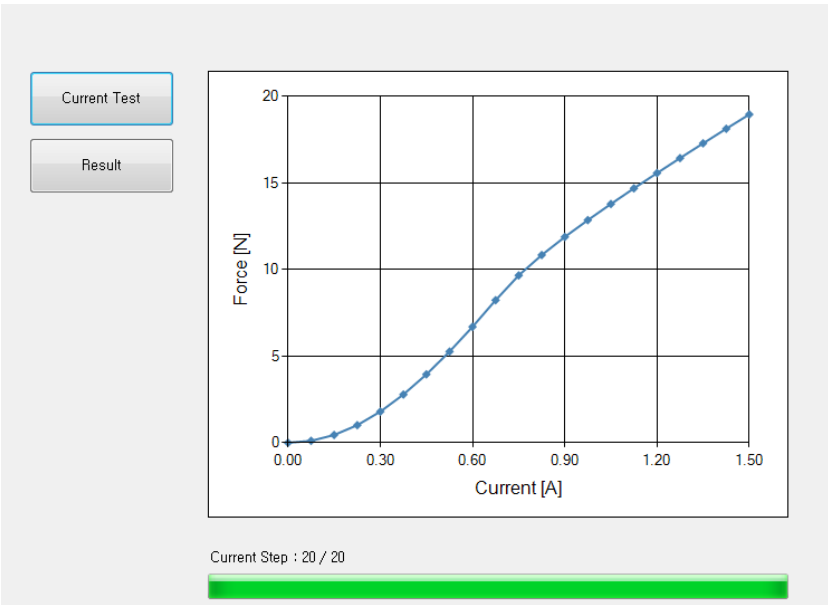
Picture 4.2.15 Current-Force Examination Name input

- ✓ Input Current-Magnetic Force examination conditions in Property View as shown in Picture 4.2.16.



Picture 4.2.16 Current-Magnetic Force Virtual Examination Settings

✓ Click Current Test button to analyze Magnetic force for each current in the Information Window. The Magnetic Force for each current can be viewed in the Information Window as shown in Picture 4.2.17.



Picture 4.2.17 Current-Magnetic Force Virtual Examination Result