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Appendix B - Sizing and Calculation Methods

Revit MEP automatically calculates sizing information and selects ductwork, piping and wire sizes for the systems created in a project. The following topics provide tables and methods used for calculating size requirements and selecting wire, ducts, and pipe for systems.

Duct Sizing

In Revit MEP, air density, air viscosity, and air flow are used to calculate duct sizing.The values for air density and viscosity values are specified as Duct Settingsin the Mechanical Settings dialog.

Air flow is specified for each duct system component by editing the component family and specifying its HVAC connector's Flow Configuration parameter as either System, Preset, or Calculated. For diffusers, the default Flow Configuration is specified as Preset, and for air handling equipment, the Flow Configuration is specified as Calculated. As a result, the flow for the air handling equipment is calculated as the aggregate air flow of the flow for downstream components (diffusers) connected in the system. When Flow Configuration is set to Preset, an absolute value is specified for flow. When Flow Configuration is set to System, a percentage of the system air flow is allocated to each of the downstream components, according to the Flow Factor parameter. The Flow Factor parameter is specified as a value between 0 and 1, with the total for all downstream components equal to 1.

When sizing duct, you can apply constraints to branch ductwork to limit the maximum height and width for the sections being sized. Both height and width apply to the diameter of round ductwork. When the sizing is incapable of matching both the size constraints and the flow constraints, the size constraints take priority, and an alert is displayed indicating that not all of the sizing parameter could be satisfied.

Duct Sizing Methods

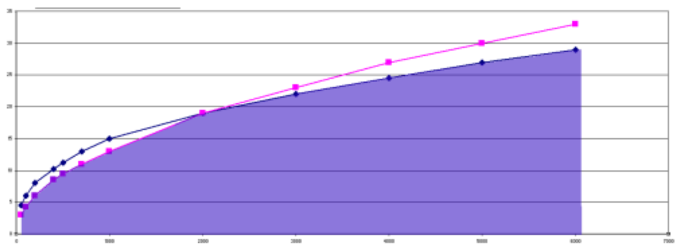
Revit MEP provides 4 standard sizing methods for sizing duct:

- Friction
- Velocity
- Equal Friction
- Static Regain

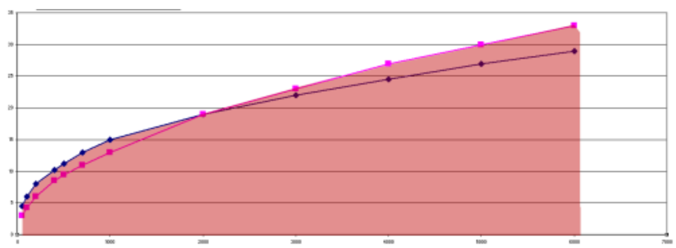
Friction and Velocity Methods

When the friction or velocity sizing method is selected, sizing can be based on Only the selected method, or a logical combination of friction and/or velocity methods. When And is selected, the size of the duct must comply with both the friction and velocity values. When Or is selected, the size of the duct is allowed to break either the friction or velocity rule, but must pass one rule. The following curves (based on 1000 FPM and 0.08") show the difference between Or and And sizing methods:

Friction ( ) And Velocity ( ) Duct Sizing Method



Friction ( ) Or Velocity ( ) Duct Sizing Method



Equal Friction and Static Regain Methods

The Equal Friction method creates an initial estimate for duct sizing based on the constant pressure loss per unit of duct length specified (default is 0.10 in-wg/100 ft. or 25 Pa/30 m). The Equal Friction and Static Regain methods used in Revit MEP use the ASHRAE Duct Fitting Database, which contains information about losses for various duct fittings. The following table shows the mapping for fitting and accessory types to the ASHRAE category used to determine loss calculations.

Fitting/Accessory Type	ASHRAE Category
End Cap	Obstruction
Intersection	Junction
Elbow	Elbow
Offset	Elbow
Tap (Adjustable)	Junction
Tap (Perpendicular)	Junction
Tee	Junction
Transition	Transition
Union	Transition
Wye	Junction

Fitting/Accessory Type	ASHRAE Category
Lateral Tee	Junction
Lateral Cross	Junction
Pants	Obstruction
Damper	Damper
Accessories with BreaksInto behavior	Obstruction
Accessories with AttachesTo behavior	Obstruction

Pressure Drop Calculation

Revit MEP computes pressure losses in ductwork based on the geometry and roughness of the ductwork, air density, and air viscosity. Values for Air Density and Air Viscosity are specified as Mechanical Settings. Roughness is specified in the type properties for duct/duct fitting component families.

The following example shows how Revit MEP calculates the pressure drop for a 100 foot segment of 36' x 24" duct carrying air flow of 12,000 CFM.

- Air Density - 0.0751 lbs/cu ft.
- Air Viscosity - 0.53 cP (Revit stores this as 1.61544x10^-4 ft.^2/s., which is equivalent to standard atmospheric air at 66 degrees F.
- Roughness - 0.0003' (medium smooth galvanized steel duct as defined by 2005 ASHRAE Handbook: Fundamentals, page 35.7).

Pressure drop is defined as:

$$\Delta pf = \frac{12fL}{Dh}\rho\left(\frac{V}{1097}\right)^2$$

Δpf = firction losses in terms of total pressure, in. of water
f = friction factor, dimensionless
L = duct length, ft
Dh = hydraulic diameter, in
V = velocity, fpm
ρ = density, lb_m/ft^3

Hydraulic diameter is defined as:

$$Dh = \frac{2*h*w}{h+w} = \frac{2*24*36}{24+36} = 28.8 = 28\ 205/256"$$

h=height, in
w=width, in

This values checks with the Hydraulic Diameter parameter shown in the Properties of the Duct in Revit:

The velocity is based on the cross sectional area:

V = velocity, fpm
A = duct cross sectional area, sq ft
F = flow, cfm

$$V = \frac{F}{A} = \frac{12000cfm}{3' x\ 2'} = 2000\ FPM$$

Finding *f* is a bit more involved. First, we need to compute the unitless Reynolds number (Re).

$$Re = \frac{DhV}{720v} = \frac{28.8in * 2000FPM}{720 * 1.61544\text{x}10^{-4}\text{ft}^2/s} = 495221.116228$$

Apply the Altshul-Tsal friction factor equation to find f'

$$f' = 0.11\left(\frac{12E}{Dh} + \frac{68}{Re}\right)^{0.25} = 0.11\left(\frac{12 * 0.0003'}{28.8"} + \frac{68}{495221.116228}\right)^{0.25} = 0.0139990$$

if(f' >= 0.018) f=f'
if(f' < 0.018) f = 0.85 * f' + 0.0028

$$f = 0.85 * f' + 0.0028 = 0.85 * 0.0139990 + 0.0028 = 0.014699$$

After determining the friction factor, the pressure drop can be calculated:

$$\Delta pf = \frac{12fL}{Dh}\rho\left(\frac{V}{1097}\right)^2 = \frac{12 * 0.014699 * 100}{28.8} 0.0751 \left(\frac{2000}{1097}\right)^2 = 0.1528$$

The value for the calculated pressure drop matches the value found in the duct's properties in Revit MEP.

Duct Sizing Examples

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