Analysis IV: HVAC Re-routing due to Structural Instability

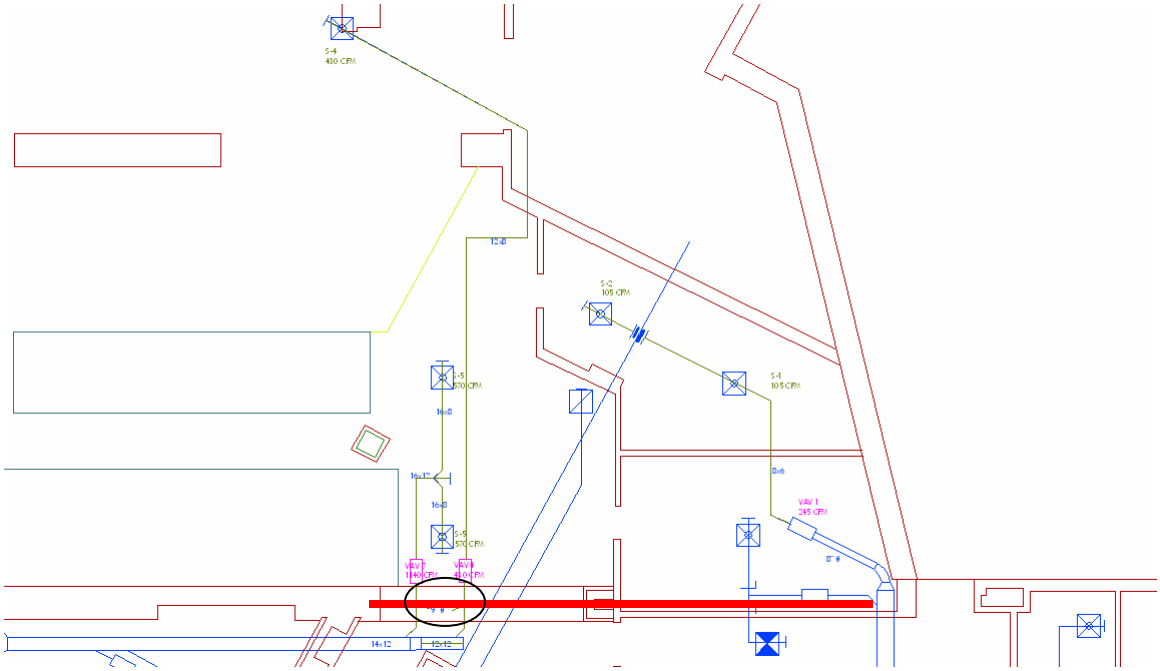
Introduction

After calculating the possibilities of the points where ducts could punch through there is more to analyze on top of all of that. Will making the duct go through the proposed section of the beam be cost effective? Or will it add to other complications from the other trades in the above ceiling plan?

There are three main diffusers that will need to be taken into account when analyzing the issue at stake. These diffusers are in open areas and will be supplying conditioned air to circulation areas and open areas. The need to supply an appropriate amount of conditioned air is important, but not critical. The areas that are being conditioned are open circulation areas and a hallway. The one diffuser is supplying the edge of the baggage claim circulation area which is a vast open area. The other two diffusers are supplying a hallway underneath the escalators. This hallway leads mainly to the security section of the airport.

The main idea is to remove three of the diffusers off of one roof top unit to another roof top unit. The reason to move the branches is due to the beam that blocking the route of the ducts which ultimately lowered the opening of the lintel in the building.

Load Transfer Analysis

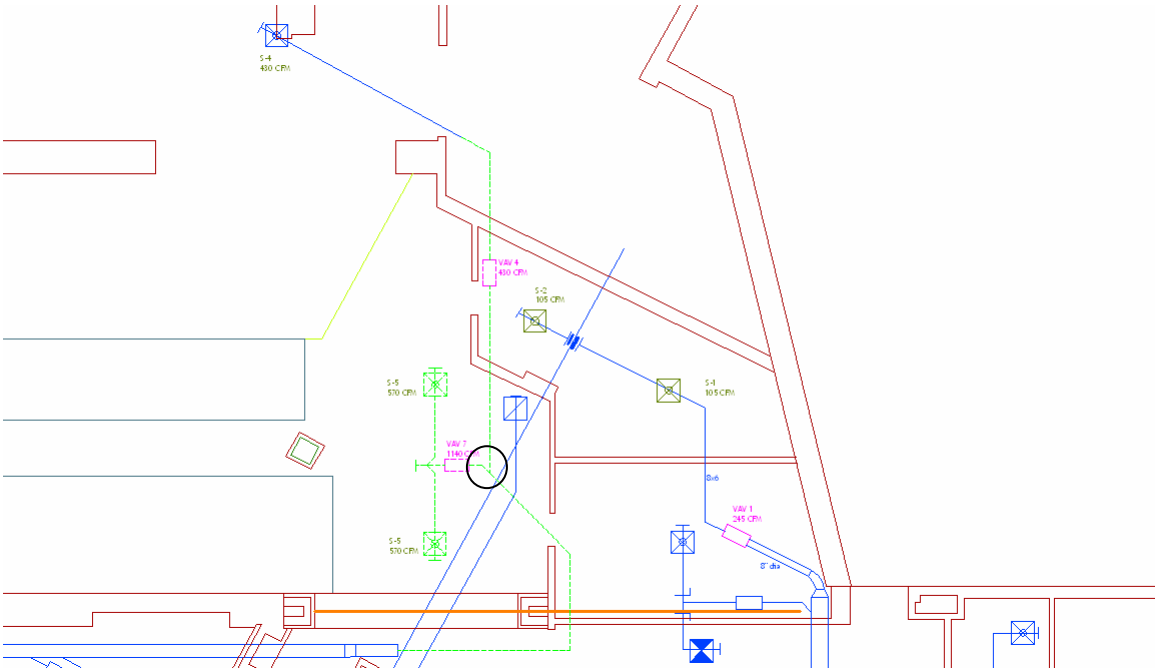


The mechanical plan above shows the area in which this analysis is taking place. The thick red line at the bottom of the plan is the W33x118 and on the left side of the beam is the two ducts that bend around the beam. The conflict is indicated by the oval. The two ducts that are in conflict are supplied by Roof Top Unit 5. This rooftop unit is a Trane SFHFC20 and has a total output of 6000 CFM being processed by this unit. There are 2 compressors inside that are rated at 10 tons per compressor. This is the tonnage for conditioning and not the actual weight. The duct main that supplies the two branches is the 14x12 duct that is in the lower left hand corner of the plan. Larger plans can be reviewed in the appendices.

There are three diffusers that will be affected by any change of the duct layout. These diffusers are diffusers S-4 and S-5. Each branch is regulated by a VAV box and these boxes are VAV 7 and VAV4. Each VAV box has been designed to regulate the flow of air to the areas by amount of CFM. VAV box 7 has been set to regulate 1140 CFMs. The two diffusers on the same line as VAV 7 will have 570 CFMs diffuse out of each. The far diffuser on the branch that has VAV 4 will put out 430 CFMs and that VAV box 4 will be set to have 430 CFMs flow through it. The static pressure found with in the duct pre VAV box must be less than 6000 CFMs but each VAV box has been rated to control the flow from the main. The total amount of CFMs that are being distributed equal up to 1570 CFMs.

After the beam analysis found that the section of the web where the shear was equal to 0 was found to be 22’-5” from the left end of the beam in plan view. The duct would have to continue from where it initially branched off and continue along the beam to the point where a punch can be cut through the center of the web. The plan is to cut a hole in the web that can let a 9” diameter duct pas through the web. The hold will have to be cut an extra 1.5” to allow for insulation as well as expansion and contraction of the duct as well as the beam to prevent any unnecessary forces that could damage the duct.

Duct Layout 1

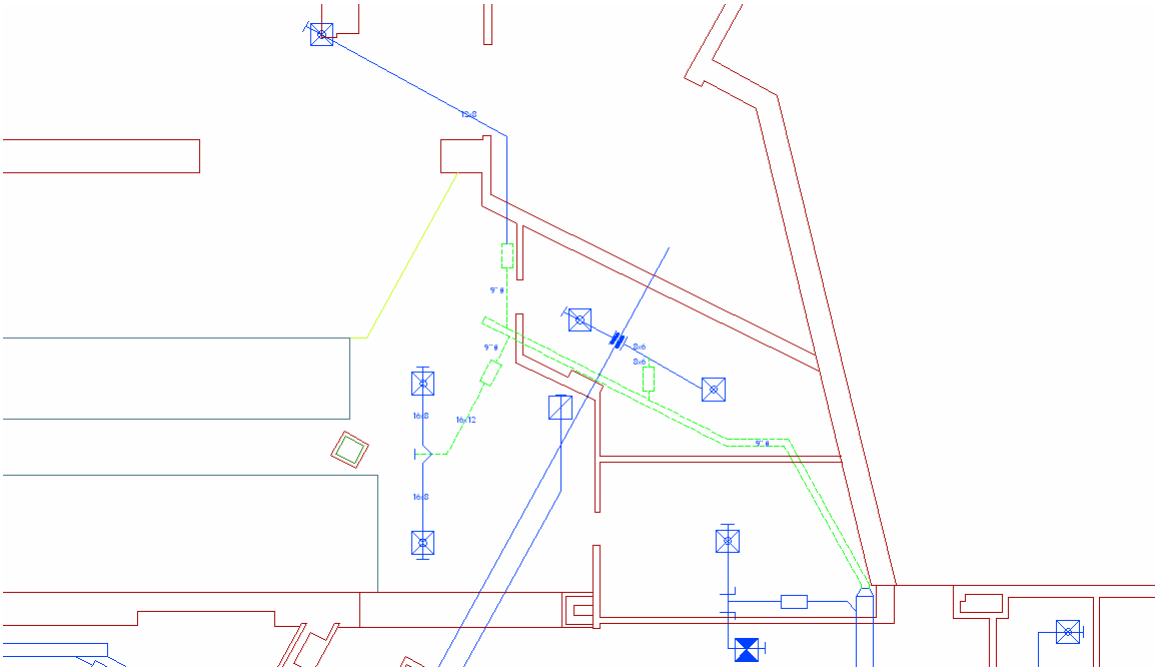


The plan above shows the new plan of the duct to punch through the beam at the point where the shear is zero. The reason the punch has to occur in a location where the beam is equal to zero is because of the redistribution the beam will have to do when a deduction in the structural support of the web is missing. From the beam analysis only a load of about 500 pounds will have to be redistributed around the hole in the web. This is much easier for the beam to do rather than the 25,000 pounds that would have to be redistributed around the two holes in the left end of the beam.

The new plan can be seen by the light green dotted line. All affect ducted paths are colored in this manner. The new plan has a 9" diameter duct run up to the beam where it can pass through, and continue up to a "Y" intersection indicated by a circle on

the plan. The VAV boxes will have the 9” duct connect to them and will switch to the original duct that was planned to connect to the diffusers.

Duct Layout 2



The second proposed duct layout actually moves the loads from Rooftop Unit 5 and adds onto the load of Rooftop Unit 7. The main that was in area two can be removed because it is no longer needed to run the length it did up to the original point. The duct that was originally in place was an 8” diameter duct that supplied two diffusers in a smoking lounge. The new duct will now have to supply 5 diffusers instead of the original two. The duct will increase in diameter as well as gauge to handle the additional pressure that will be within the duct. The two diffusers in the smoking lounge run off the same VAV box. The plan is to have the VAV boxes right off of the main line and have the original sized ducts used for after the VAV boxes. The above ceiling coordination shows

that there is plenty of space to place a duct along the proposed path. The path of the new duct is also shown in a green dotted line. The lines that are still blue indicate that there was no change in the duct layout and size.

The additional load that will be required from Rooftop unit 7 is an additional 17 percent more than what the rooftop is producing now. According to the specifications of rooftop unit 7 the maximum output load of this particular rooftop maxes out at 11700. This rooftop will suffice for the needed load to supply the additional load on to the branch the rooftop is 1130 CFM in excess what is needed. The choice to move the new branches onto Rooftop unit will work and save plenty of money.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Conclusion

The practical application of each new duct layout will theoretically work best in each scenario. The issue that is driving the plans is the costs behind it. The major costs are that of cutting the hole in the web of the beam and the costs of the duct with the labor included.

As it turns out, the original duct layout would cost approximately $7,100. This is including the labor to install the duct. The value was found by summing the weight of the duct. Using a basic sum of two sides and gauge of duct a n approximate weight of the total duct being installed came to 1163 pounds of galvanized steel. The costs to have two holes cut into the beam would cost approximately $3.17 per linear foot for steel cut. The steel cut would be 5.76 feet. With the equipment feel of Oxygen-Acetylene torch, regulator, and goggles of $200 the total costs of cutting would be $218.25 (Getaquote.com) The over all costs would equal up to $7,315.

The costs of installing the duct to punch through the middle of the beam are actually more expensive than expected. With the beam will only have one hole punching through the center the costs of cutting that would be $209 for one 11” hole. The additional duct to stretch from the original point actually adds 95 pounds of galvanized steel to the total. That brings the total cost of duct up to $7,680, with the cutting fee its $7,889. This is an additional $500 on to the total, this is small change in the overall building costs.

The final option to re route the duct off of a new rooftop proves itself much more cost effective in terms of duct and labor. The amount of duct to install comes to 1055

pounds of galvanized steel. This comes to a total of $6,435.81. There is no need to cut any holes in a beam either which makes this a possible solution. Fortunately the rooftop unit that will be supplying the additional load is 1130 CFM over the required CFM to run efficiently with the added load. Moving the loads off of Rooftop 5 and onto rooftop 7 will save $880.