



A Comparative Study of Active Chilled Beam and Fan Coil Unit Energy Consumption

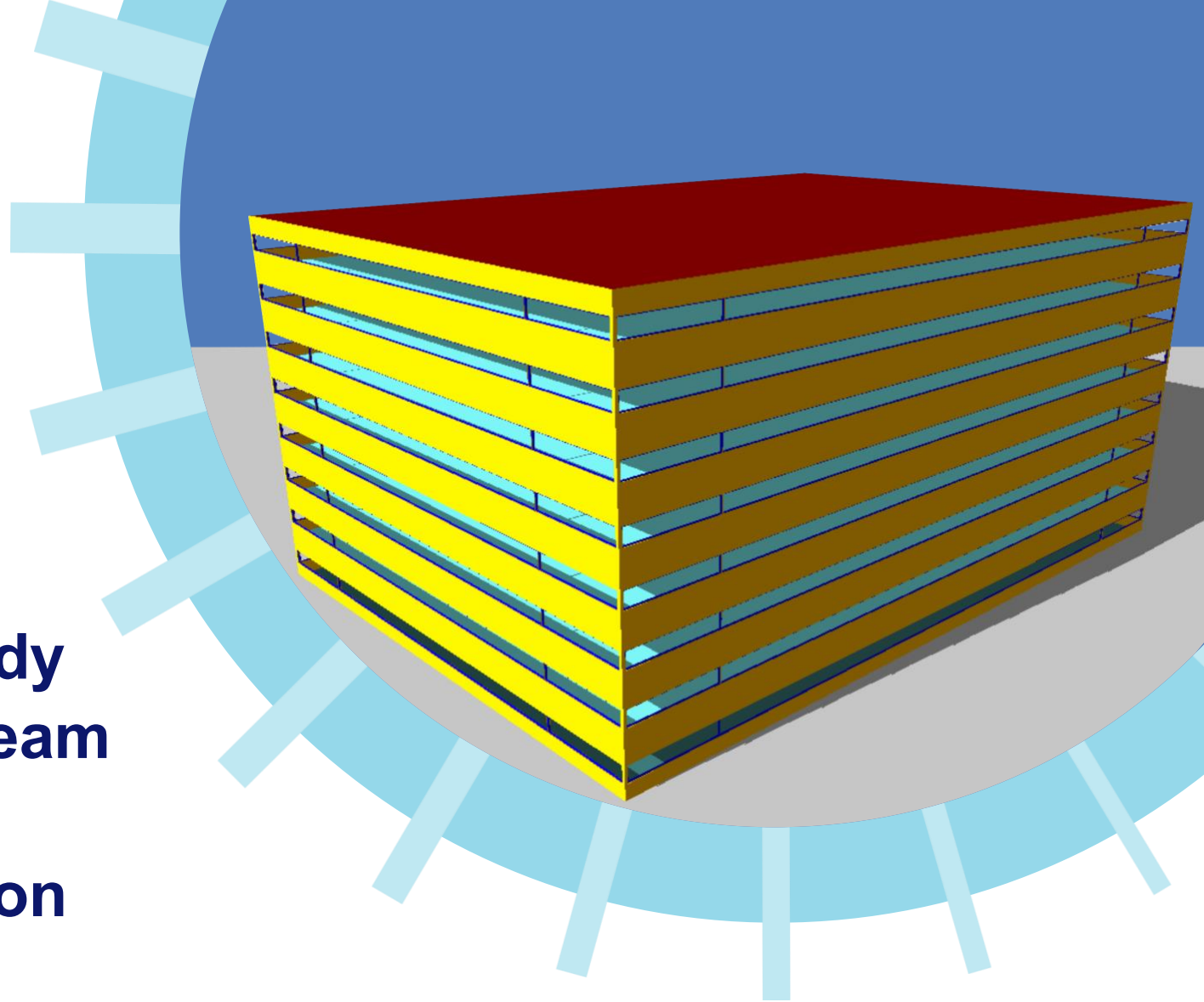
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Software Used: Tas v9.3.1

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1.0 INTRODUCTION

Following a previous study commissioned by the CBCA [1], where fan-coil units (FCU) and active chilled beams (ACB) were compared under different operating conditions, the HEVAC Fan Coil Unit Group commissioned this work to compare their relative energy consumption under the same operating conditions.

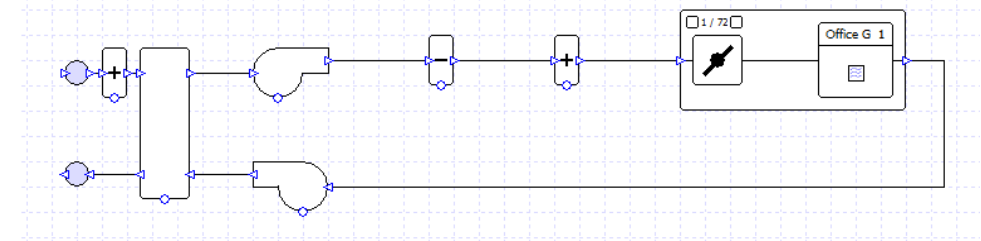
A typical office building has been modelled to give realistic hourly heating and cooling loads. Two HVAC systems have then been created to calculate the FCU and ACB energy consumptions, which are then compared. The following sections describe the building and HVAC model assumptions, followed by the results of the simulations.

The Tas models used in this study (and a copy this report) can be found here <http://www.edsl.myzen.co.uk/downloads/FETA.zip> and are freely available for download.

2.0 THE BUILDING MODEL

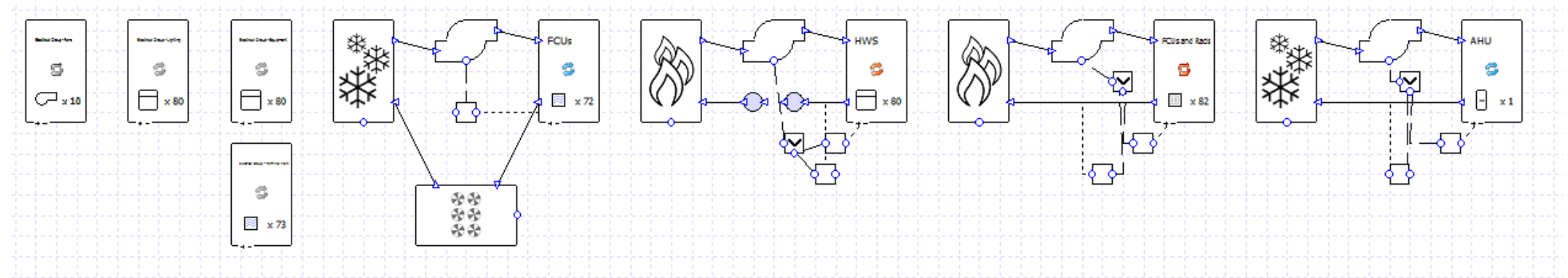
A typical 8 storey office building with a rectangular foot print of 35m x 50m and 2.8m ceiling height, was created. The CIBSE London TRY weather data was used. The office areas were assumed to be open plan, but with an internal, 8m x 4m, core area for lifts, stairs and WCs, in the centre. The building was assigned Part L2 Notional constructions and glazing percentages. The building was zoned in accordance with the NCM Modelling Guide [2] and incorporates 6m wide perimeter zones to enable the differing façade solar gains to be analysed. The standard NCM office internal conditions were also applied, effectively giving this building the energy consumption of the current NCM 2013 Part L2 target.

3.0 AIR-SIDE SYSTEMS



The fresh air supply system is identical in both FCU and ACB models, supplying 12 l/s/person during occupied hours. The supply fresh air was controlled to 16C throughout the year. A heat recovery system with 70% efficiency was included, again, an NCM Notional requirement. No de-humidification of the incoming fresh air was needed, there was no space latent removal in either model. There was no humidification of the supply air included in the model. An SFP of 1.8 W/l/s was used for the supply fan in the FCU model, while an SFP of 1.9 W/l/s was used for the ACB model, to account for the higher supply pressure needed to induce flow in the room. No additional distribution loss was included in the ACB system due to higher duct pressures. Both models used an SFP of 0.3 W/l/s for the return fan. The part load efficiency of the terminal fan, in the FCU model, was assumed to follow the 'square law' curve. A fixed induction rate of 4.5x fresh air supply flow rate was used in the ACB model. The FCU model allowed the terminal fan to turn down to 50% of design flow rate at 'off peak' conditions. The terminal fan 'pick up' was assumed to be 100%. No chilled beam or coil performance data was needed in either model, the equipment was assumed to be sized correctly to deliver the peak heating and cooling demands. Both systems have a parasitic power consumption of 1.8 kW overnight, rising to 2.4 kW during system operation in the day.

4.0 PLANTROOM SYSTEMS



The plant room model was identical for both systems. Lochinvar Crest condensing boiler performance data was entered for each boiler. Efficiency varied with return water temperature as well as outside wet bulb temperature (correctly accounting for actual condensing performance). Chiller performance was based on the Carrier 30XA series, with efficiency varying with part load and outside dry bulb temperature. The design supply and return temperatures for the chilled water loop were 14C and 17C respectively. The valves controlling flow to both the FCUs and ACBs were assumed to be tuned to optimise free cooling with the following part load control of the return water temperature for the ACB model.

Part load	Return temperature
100%	17C
75%	18.8C
50%	20.8C
25%	22C

The FCU model used the following return water temperature control, which is slightly less advantageous in terms of free cooling.

Part load	Return temperature
100%	17C
75%	18C
50%	18.8C
25%	20C

Free cooling was implemented via a dry air cooler (DAC). The performance of the DAC was taken from the Alfa Laval Fincoil Solar Max data. Fan SFP was 0.0333 W/l/s and overall exchanger efficiency was set at 0.67. NCM distribution efficiencies were entered as follows; 80% for cooling, 90% for heating and 95% for HWS.

5.0 RESULTS

Four hourly annual energy analyses have been run. One for the ACB, and three for the FCU. The three FCU runs were with varying terminal fan SFPs of, 0.3, 0.2 and 0.15 W/l/s, 0.2 W/l/s being typical good practice.

5.1 Results for the ACB Model

	Heating kWh	Cooling kWh	Auxiliary kWh	Total kWh
Annual Demand	152382.3	479420.9	159929.8	791733
Annual Consumption	161461.8	108463.5	159929.8	429855.1

5.2 Results for the FCU with terminal fan SFP = 0.3 W/l/s

	Heating kWh	Cooling kWh	Auxiliary kWh	Total kWh
Annual Demand	149526.1	496035.5	171271.6	816833.2
Annual Consumption	158457.5	112482.2	171271.6	442211.3

5.3 Results for the FCU with terminal fan SFP = 0.2 W/l/s

	Heating kWh	Cooling kWh	Auxiliary kWh	Total kWh
Annual Demand	150477.6	492109.9	165361.5	807949
Annual Consumption	159458.4	111586.1	165361.5	436406

5.4 Results for the FCU with terminal fan SFP = 0.15 W/l/s

	Heating kWh	Cooling kWh	Auxiliary kWh	Total kWh
Annual Demand	150954.9	490143.1	162403.5	803501.5
Annual Consumption	159960.4	111137.1	162403.5	433501

6.0 CONCLUSIONS

The following table summarises the relative total annual energy consumption for the various systems.

Terminal Fan SFP	% above ACB
0.3	2.87
0.2	1.52
0.15	0.85

7.0 REFERENCES

- [1] A Comparison of Chilled Beam and Fan Coil Units for CBCA, EDSL, April 2013.
- [2] National Calculation Methodology (NCM) modelling guide, BRE, April 2014. Can be downloaded from <http://www.ncm.bre.co.uk>.

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