Lifts Group

CIBSE Lifts Group – Lift (US: Elevator)
Traffic Analysis & Simulation Open Forum
Monday, 14 May 2007, 13.00 – 17.00 & Tuesday, 15 May 2007, 09.00 – 17.00
Institute of Physics, 76 Portland Place, London

Reported by Dr Richard Peters

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PRESENT
Dr Eur Ing Gina C Barney
Dr Marja-Liisa Siikonen
Dr Richard Peters
Dr Bruce Powell
Mr Rory Smith
Dr Lukas Finschi
Mr Steve Hobson
Mr Chang Meng
Herr Joerg Mueller
Mr Keith England
Mrs Elizabeth Evans
Mr Adam Scott

DISTRIBUTION
Those present plus:

Mr K Butcher, *(CIBSE)*
Ms Samantha McDonough, *(CIBSE – Director of policy and groups)*

The purpose of this open forum was to bring together experienced practitioners in lift (US: elevator) traffic analysis and simulation from around the world for discussion and debate on topics of mutual interest.

The Chairman of the CIBSE Lifts Group, Mr Adam Scott, opened the meeting. As always with CIBSE meetings the opinions and views expressed by the speakers did not necessarily agree with their organisations or CIBSE.

Relationship between calculation and simulation

Dr Barney reviewed the equations available today to analyse the uppeak traffic condition to deal with basements, double deck and hall call allocation systems. Specifically she showed a correction to the equations based on Schroeder's work for hall call allocation. A look ahead factor (k) should be used instead of the number of cars in the formula for S.

Referring to work carried out over 30 years ago she graphically showed the relative performance of legacy and modern traffic control systems under the four main traffic conditions. These results

had been obtained using many hundreds of simulations to produce scatter diagrams. From these diagrams, equations were developed for Round Trip Time, Handling Capacity and Passenger Average Waiting Time for the four traffic conditions. Dr Barney was very concerned that many conclusions made by designers today are often based a single example. Citing three examples she warned against this “Bad Science”.

Dr Barney was also worried about the over reliance on simulation *vis-à-vis* traffic calculations. She considered that designers should understand their art properly. This understanding is best approached by carrying out a few simple calculations. She did agree, however, that the final results should always be confirmed by simulation as calculations are precisely mathematically derived and often bear no resemblance to a simulation.

Definition of mixed traffic

Dr Peters introduced a discussion about the definition of mixed traffic. There was consensus that traffic could be classified in terms of incoming, outgoing and interfloor traffic. For example, there could be a demand for 13% of the building population to be transported in five minutes, with the traffic divided into three components, say 40% incoming, 40% outgoing and 20% interfloor. In scenarios where there are multiple entrance floors, we can define an entrance bias to indicate the relative attraction of different entrance floors to incoming and outgoing traffic. Interfloor traffic with multiple entrance floors is more complex and there may be interfloor traffic between the entrance floors. Dr Peters proposed a way of calculating this, which was discussed. This needs further consideration; Dr Peters will prepare a paper for review and publication. Other factors such as floors with restaurants were considered too complex to include in a mixed traffic definition. It was noted that smoking breaks, and the tendency of people to use coffee shops increases traffic. Interfloor traffic is less in mixed tenancy buildings. The use of stairs varies according to region; sometimes there is no stair usage at all.

Using simulation for design

Mr Smith discussed design procedures for simulation. First he reviewed up peak round trip time calculations and why, with conventional systems, providing sufficient up handling capacity ensures other peaks in the day can be managed. Round Trip Time calculations are fast, and should be used to determine approximate needs. With simulation we can study designs in more details, and also taking into account up peak boosters, dispatching algorithms and real world traffic. Simulation results are not easy to line up with round trip time calculations. It would be useful to agree simulation design procedures. Mr Smith proposed the use of a step profile, which involves starting the simulation at a low intensity of traffic, and gradually increasing the traffic in steps until the system saturates. Observing car loading, queue lengths and waiting time, it is possibly to identify the level of demand at which the system saturates. It was noted that this approach gives the designer a graphs of performance (e.g. waiting time, time to destination) plotted against traffic intensity (demand or handling capacity). Dr Siikonen explained that they also used a step profile with a single, longer 30-60 minutes simulation for each step. This way they determine whether or not the system can transport traffic continuously at each step level of traffic intensity. (A shorter step with multiple simulations is a less demanding because the system "passes" the test corresponding to each step by managing the traffic intensity for just a 5 minute period rather than

continuously.) Dr Finschi explained that they used a ramp (single simulation with a constantly increasing intensity rather than steps). There was general agreement that the use of a step or ramped profile could be part of a standard design procedure. Dr Barney will research this further. Dr Peters will compare results of the alternative step/ramp approaches using Elevate.

Discussion on Interval

Both Dr Finschi and Dr Peters introduced discussions on Interval.

Dr Peters discussed the measurement of Interval in simulation. In round trip time calculations, ever car is assumed to return to the main terminal floor. In simulation, the car may reverse before it reaches the main terminal floor. If there are multiple entrances, the main floor may be bypassed. In both these instances, the use of interval as an indicator of waiting time ceases to be meaningful. It was also noted that interval is not an indicator of waiting time for destination control (hall call allocation) systems.

Alternative definitions and approaches to calculating interval were discussed. For example, round trip time could be defined as the time between two reversals, not necessarily at the main terminal floor. The majority view was that changing the definition of interval would cause confusion and unnecessary complexity; it would be better to educate designers to apply waiting time criteria in instances were interval ceased to be a good indicator.

Dr Finschi discussed the definition of interval and the correlation between interval and waiting time. Furthermore, he demonstrated that interval and waiting time are only loosely correlated, by this making interval a doubtful measure for quality of service. Waiting time is a more powerful and flexible measure for quality of service, but we need simulation to calculate it reliably.

Traffic Analysis for Residential Buildings

Dr Powell further highlighted the limitations of interval when calculated for residential buildings. He gave an example of a hypothetical building (based on many real jobs) where the interval measured in simulation was 136 seconds, but the average waiting time was 18.3 seconds. He illustrated that in residential buildings with car-parking floors, the elevator often bypasses the main terminal floor, as there are no calls to stop for. Furthermore, even during peak residential traffic, a lift might be idle for a significant period. Thus the time between departures from the main terminal floor is often high, which is reflected in a high interval. Dr Powell suggested that interval could even be eliminated from the discussion for residential buildings. It was agreed that average waiting time and time to destination are better measures of performance for residential buildings. Dr Powell also questioned whether a residential building needed to be able to sustain a peak demand, say 8% for any significant period. It was suggested that the requirement for peak traffic to be transported in residential buildings was primarily a criteria applied to calculate an appropriated number of lifts, rather than a reflection of actual traffic in buildings. As we move to simulation, this peak demand criteria should be reviewed. Dr Powell will be taking some site measurements. Dr Barney said that she could add waiting time criteria to the tables in CIBSE Guide D.

Planning criteria for lifts using destination control

Dr Siikonen explained why current equations for up-peak round trip are not valid for the destination control, agreeing with previous speakers that interval calculated from the round trip time does not correlate with passenger waiting times in the same way as it does with conventional control. Simulation with stepwise or linerly increasing handling capacity can be used to determine waiting time and time to destination at at different traffic intensities.

Currently used criteria for up-peak interval and handling capacity implicitly assume that up-peak is the worst traffic situation. With destination control, up-peak handling capacity is increased. The up-peak and down-peak handling capacities are comparable, but during mixed lunch hour traffic handling capacity is the lowest. Dr Siikonen considered that if up-peak traffic is used in selecting elevators with destination control, the handling capacity criteria should be revised to ensure that there will be enough handling capacity in mixed lunch hour traffic.

In simulation of, for instance office buildings, up-peak and a two-hour lunch hour traffic pattern can be used. Then waiting times and time to destination can be compared at required handling capacity with conventional and destination control.

Planning criteria with destination control need to be revised to include handling capacity, average waiting time and time to destination. Dr Siikonen tabled some example templates of traffic demand for a range of buidlings based on control system measurements. It was noted that with destination control, more data was becoming available. Further survey work and analysis is required to improve criteria.

Destination Control

The range of names applied to destination based dispatching was noted. It was agreed, almost unanimously, that Destination Control should be adopted as the generic term for destination based dispatching. Dr Barney prefers the term Hall Call Allocation having used it for nearly 40 years.