3 Computational work

3.4 MassMotion

The idea was to import the SketchUp model in MassMotion, but the model was still not on the right level of detail to be useful. Therefore, to get a feeling for traffic area dimensions a rough Rhino model was imported in MassMotion. The information gathered from this model and its accompanying simulations were used as input to design the traffic areas. When the SketchUp model was updated it was imported in MassMotion, this interaction between MassMotion and SketchUp was repeated several times.

Data for the amount of people was derived from data used for the lift design. This data showed the maximum capacity for each function. This was translated to an overview of the journeys the agents were going to follow in MassMotion, this table can be found in appendix 5.6.1 Flow of people data. Each journey went from one portal to another. Except for a different colour, all agents look the same. However, two different types of agents were used, agents which represents a single person or a family with children.

Initially the lifts were oversimplified in MassMotion, they were merely destination portals were agents would go to and finish their journey. Therefore, they did not accumulate in front of the lift door due to the wait time of the lift. Eventually the software was better understood and it was possible to add lifts and double deck lifts. Although these lifts were also simplified, since they could only go from one floor to another, it gave a much more realistic result. The agents now needed to wait before the lift would arrive and any jams due to this crowd could be seen.

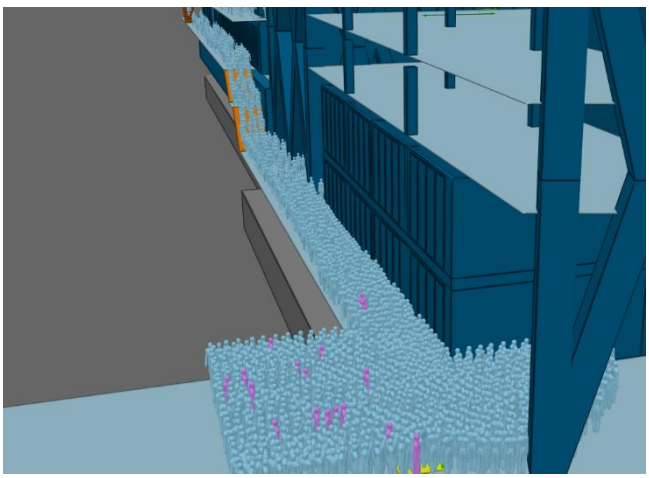


Figure 43: Flow of people with only one building entrance

Design changes

Before the design changes were made a different solution was considered. Since the simulation ran at a maximum building capacity, the question arose: how often will this happen in real life? And: if it happens can it be contained by certain crowd control measurements? A situation like this probably won't happen often, but it can happen. For example also during an evacuation. So it was decided to deliver a functional and safe building instead of requiring odd measures to coop with the crowd.

Due to the simulations in MassMotion a number of design changes were made, for example: changing the sizes of the traffic areas; moving the lifts from the inside of the atrium to just outside the atrium to ensure a clear, open atrium where people can move through while the lifts still have a direct connection with the atrium; rearranging the stairs in the walkway and the atrium.

One of the most clear and influencing changes was adding extra entrances. Initially there was one large main entrance at the south east corner. The whole traffic area got clogged up when all 2800 people (as can be seen in appendix 5.6.1 Flow of people data) wanted to enter the conference rooms. The result of this crowd movement can be seen in Figure 43 and the heat map in Figure 44. In appendix 5.6.2 and 5.6.3 bigger versions of both images can be found.

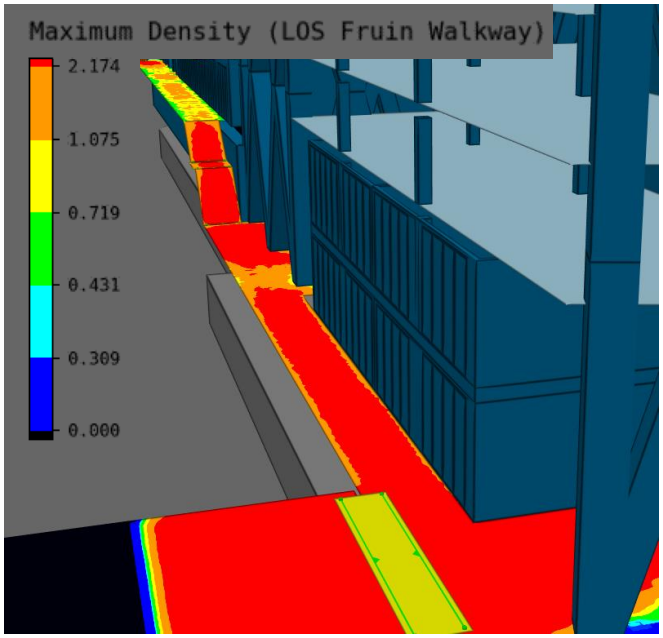


Figure 44: Heat map of the crowd with only one entrance

Final simulation

There are two heat maps shown from the final simulation on which the maximum density is visualised. Heat map 1 assumes the selected area is a walkway, in MassMotion the maximum density of a walkway is set to 2,174 people per m². Which is correct according to (Still, 2018a), he writes: *"until critical density is reached (2-3 people per square metre). This critical density can be different for different events/crowds."*

Heat map 1 in *Figure 46* is an image of the left atrium. The red zones show the density is too high in front of the lifts. However, this area can be considered as a waiting platform for people to enter the lift. The maximum density of a waiting platform is much higher since people do not need to walk. This standard setting of a waiting platform in MassMotion is 5,263 people per m². It is a bit higher than what Still (2018b) states: *"5 people per square metre (this should be the UPPER limit for standing/viewing spaces)."*. The waiting area is not a standing/viewing space, but merely a place to wait. Although it is not preferred, it makes sense the maximum density can be a bit higher. Heat map 2 can be seen in *Figure 47* which shows the same location as heat map 1. But the area is now considered as a waiting platform, in which the maximum crowd density can be higher and therefore there are no red zones. In other words, the area is not too crowded. Images of the final simulation can be found in appendix 5.6.4 MassMotion final simulation. Scan the QR-code below to see a one minute video of the simulation on YouTube.

Figure 45: QR-code to YouTube video of the simulation

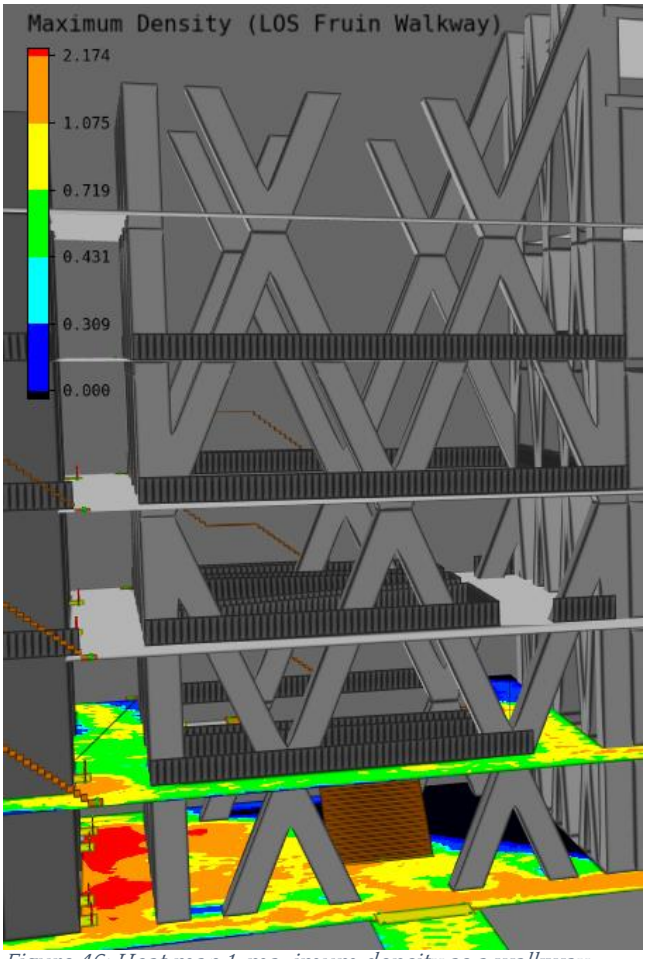


Figure 46: Heat map 1, maximum density as a walkway

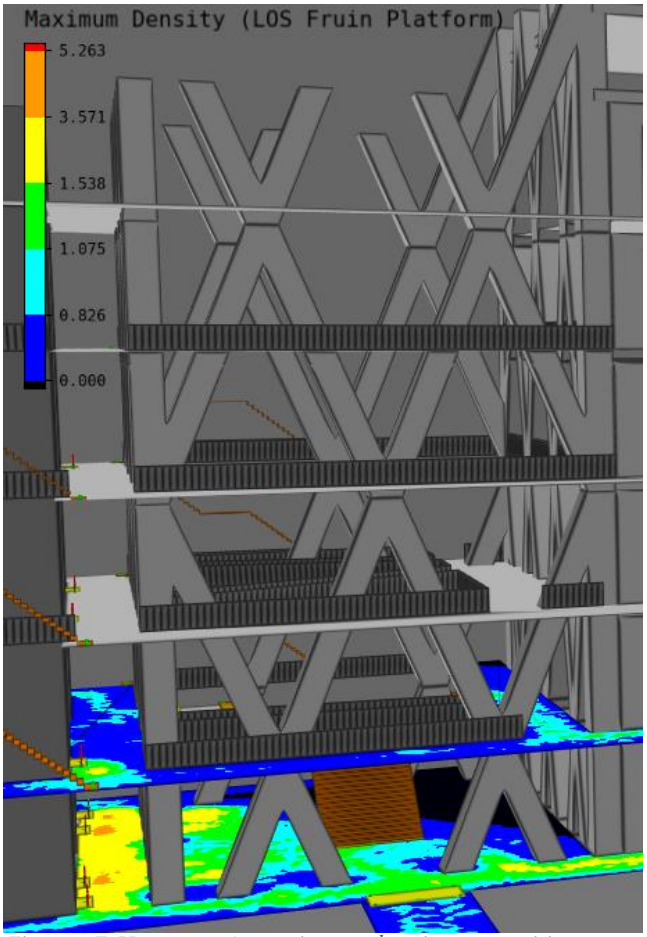


Figure 47: Heat map 2, maximum density as a waiting platform

5 Appendix

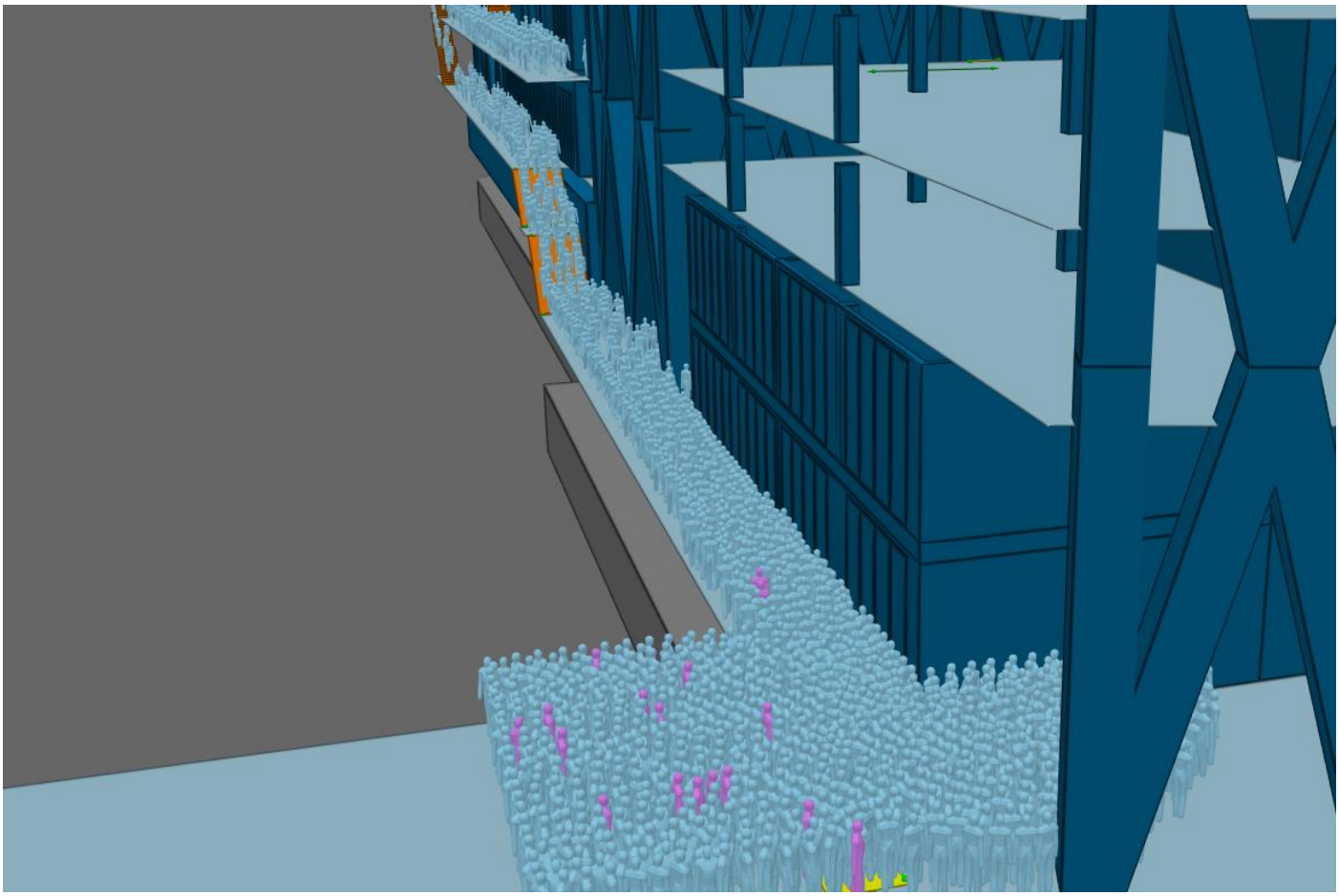
5.6 MassMotion

5.6.1 Flow of people data

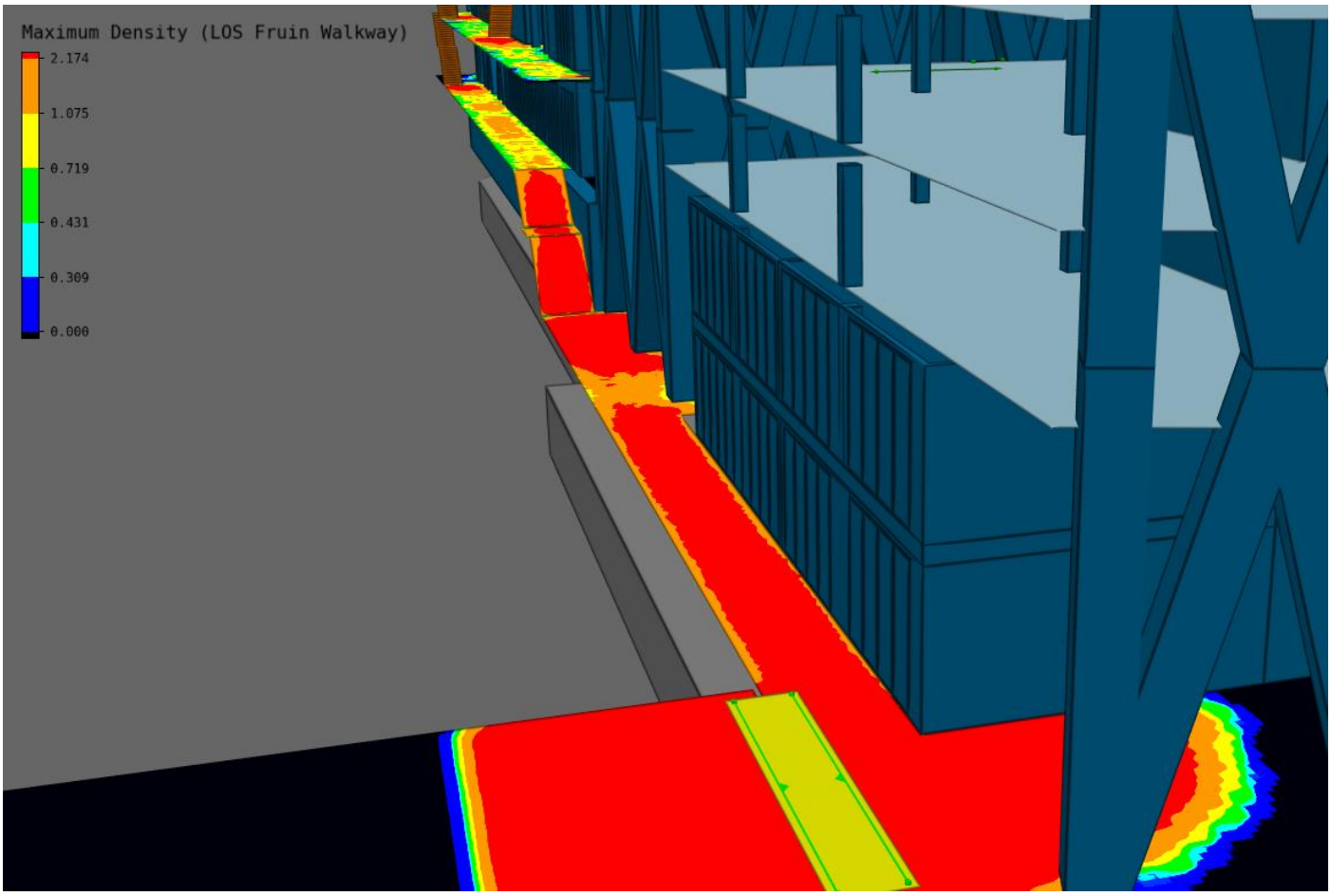
The colour at the function in the table is similar to the colour of the agents in the simulation.

Journey start portal	Journey end portal	%	People	Start time	End time
Hotel max capacity, people leaving:		100%	392	07:00	11:00
Hotel	Entrance main	35%	137		
Hotel	Entrance bus/metro	15%	59		
Hotel	Entrance train	25%	98		
Hotel	Entrance parking	8%	31		
Hotel (family)	Entrance main	7%	27		
Hotel (family)	Entrance bus/metro	3%	12		
Hotel (family)	Entrance train	5%	20		
Hotel (family)	Entrance parking	2%	8		
Conference max capacity, people entering:		100%	2800	08:30	09:00
Entrance main	Conference rooms	28%	784		
Entrance bus/metro	Conference rooms	28%	784		
Entrance train	Conference rooms	20%	560		
Entrance parking	Conference rooms	20%	560		
Offices	Conference rooms	2%	56		
Hotel	Conference rooms	2%	56		
Offices max capacity, people entering:		100%	1450	07:30	09:30
Entrance main	Offices	34%	493		
Entrance bus/metro	Offices	25%	363		
Entrance train	Offices	25%	363		
Entrance parking	Offices	15%	218		
Hotel	Offices	1%	15		
Residential max capacity, people leaving:		100%	488	06:00	10:00
Resident lifts	Entrance residents	30%	145		
Resident lifts	Entrance main	1%	5		
Resident lifts	Entrance bus/metro	20%	98		
Resident lifts	Entrance train	16%	78		
Resident lifts	Entrance parking	8%	39		
Resident lifts (family)	Entrance residents	10%	49		
Resident lifts (family)	Entrance main	1%	5		
Resident lifts (family)	Entrance bus/metro	10%	49		
Resident lifts (family)	Entrance train	1%	5		
Resident lifts (family)	Entrance parking	3%	15		

5.6.2 Only one main entrance overview

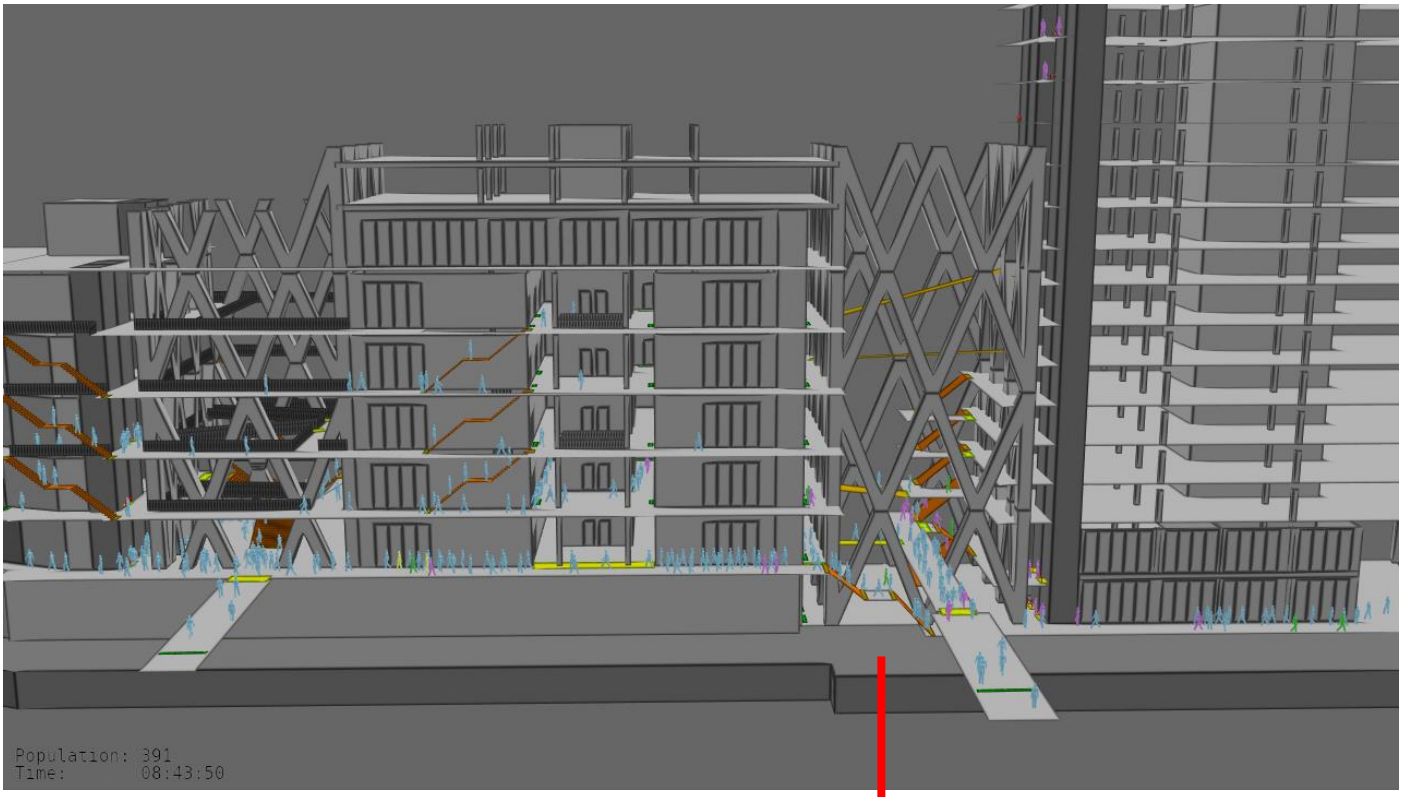


5.6.3 Only one main entrance heat map

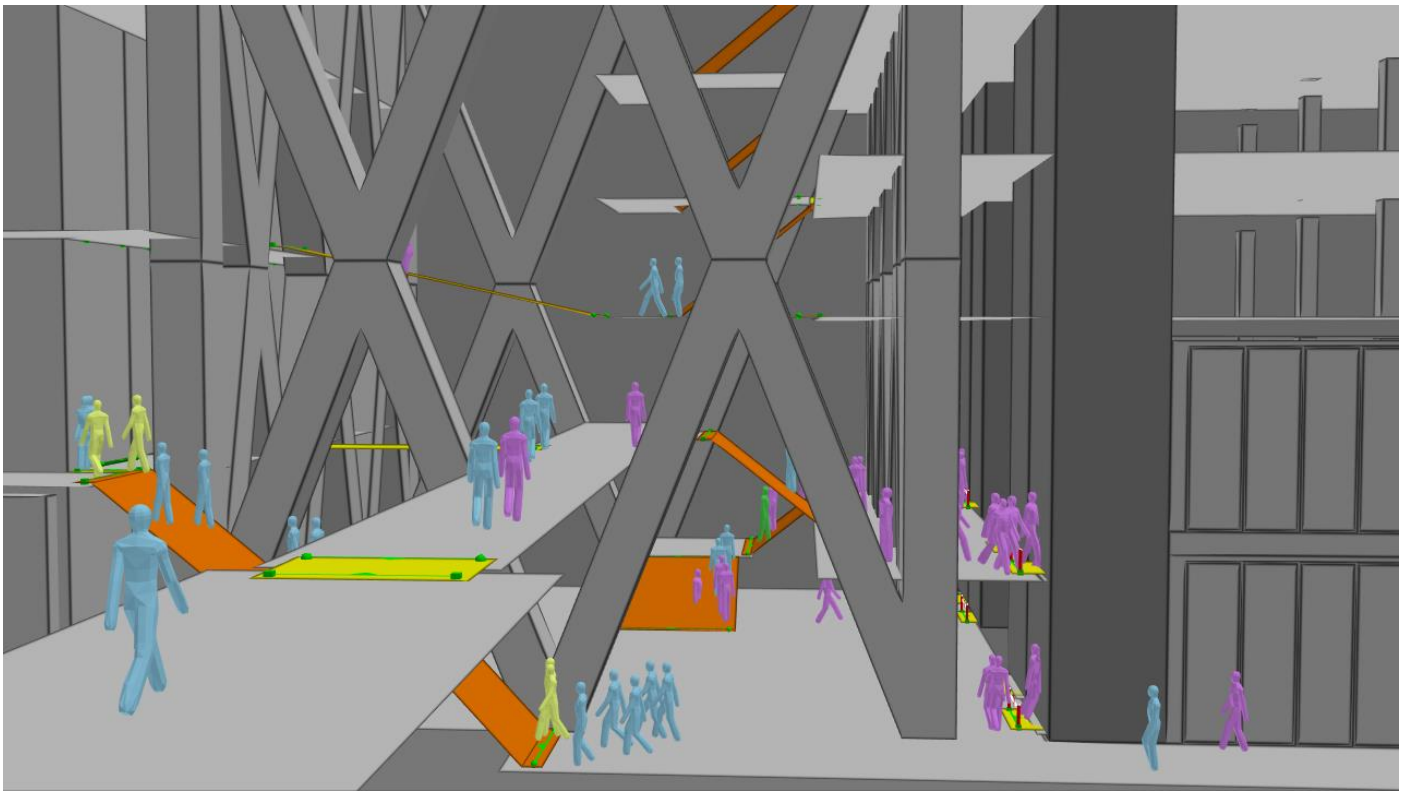


5.6.4 MassMotion final simulation

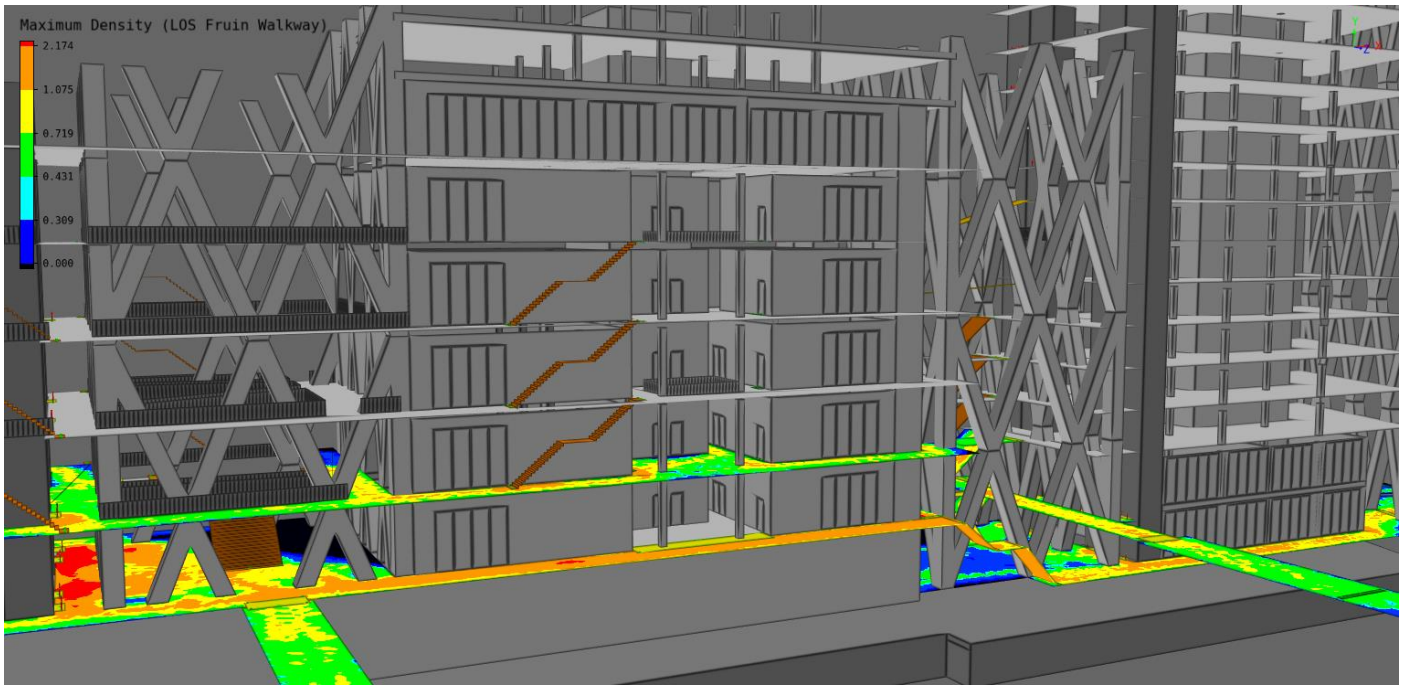
Overview



Close up of the main atrium



Maximum density, based on a walkway



Maximum density, based on a waiting platform