

Design of toilet facilities for public buildings

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Abstract

The regulations for public buildings, at least in Germany, do not contain sufficient information concerning design and equipment of toilet facilities, which have to vary in number according to the type of building and the nature of the events held there. In order to determine the necessary number of toilet facilities in different kinds of buildings, investigations and measurements were made in stadiums and other places where numerous people can gather. Additionally, the water consumption in an arena-type stadium was measured and the user behaviour examined. The results and findings served to draw up new guidelines and design new stadiums for the 2006 FIFA World Cup Germany. Part of those results and recommendations of the guideline will be presented.

Keywords

Number of toilet fixtures, user behaviour, water consumption, public buildings, stadiums

1. Introduction

Our project was started in 1997 and is still being continued. Our goal was and is to determine figures regarding the number of sanitary fixtures needed at assembly places and in particular at stadiums. On the one hand there should not be too many sanitary facilities being unused, but on the other hand waiting times in front of toilets should not be long during events.

In 1998 Schwacke [1] started a series of examinations at 8 open-air stadiums of the German federal state of North-Rhine/Westphalia and 2 stadiums in the Netherlands: Amsterdam ArenA and Gelredome Arnhem. These were regarded to be the first multi-functional stadiums of the Arena-type in Europe. Demiriz turned all these experiences combined with the results of his examinations at universities [2,3] into a new guideline, VDI 6000-3 [4]. In 2001 the most modern multi-functional football/soccer arena of that time was opened in Gelsenkirchen. Terlau carried out the first statistical examination of all the sanitary facilities of this stadium during various events [5]. For the purpose of keeping a careful record students were placed in front of each toilet area. In addition to the number of users they recorded waiting times as well as the times the users stayed in the toilet rooms. In the same year Kircheim designed and installed a data-recording system for a ladies' and gents' toilet [6]. Recordings and the first analyses carried out by Brauckhoff brought new data which could be utilized [7]. During all events flow measurements were carried out at the main supply pipe.

2 Experimental

For data recording the InterBUS Inline System was used. For the implementation the ladies' toilet (room No 3031) and the gents' toilet (room No 3029) were chosen as they are located in the "North Bend" (Figure 1), the stand of the Schalke-fans, which, as experience has shown, are the most frequented ones. Four cubicles and two washstands in the ladies' toilet and two cubicles, two washstands and ten urinals in the gents' toilet were fitted with measuring equipment.

The sensor technology comprised the following components:

- **Ladies' toilet**
 - 6 pulse flow meters (2 washstands, 4 flush tanks)
 - 8 Reed-contacts (4 cubicle doors, 4 flush activations)
 - 4 infra-red detectors (inner room of 4 cubicles)
 - 1 pressure detector (water supply pipe)
- **Gents' toilet**
 - 4 pulse flow meters (2 washstands, 2 flush tanks)
 - 4 Reed-contacts (2 cubicle doors, 2 flush activations)
 - 2 infra-red detectors (inner room of 2 cubicles)
 - 1 pressure detector (water supply pipe)
 - 10 urinal controls (use and flushing)



Figure 1 – Location of the reference toilets

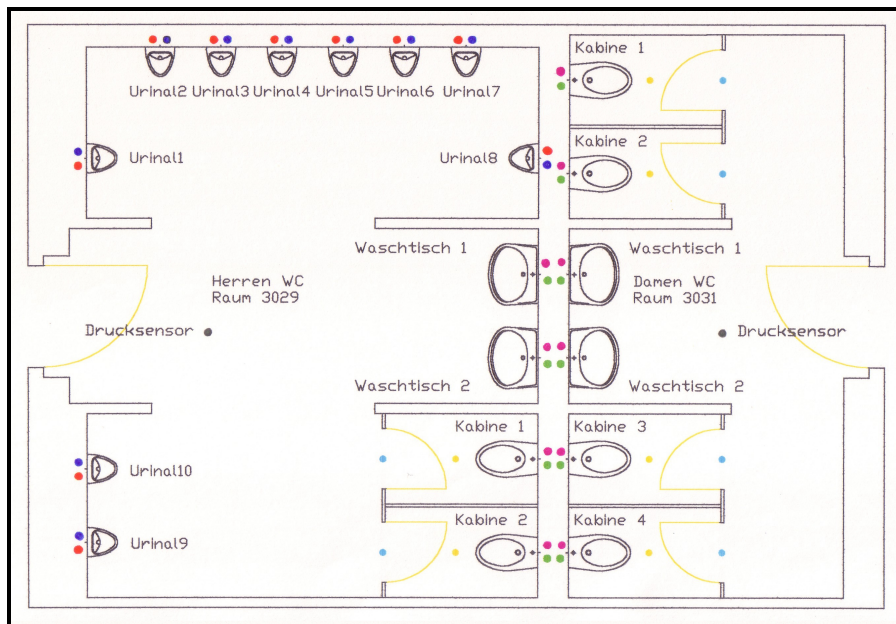


Figure 2 – Location and art of sensors

- Urinal Flush ● Urinal use ● Flow meter ● Push detector
- Door sensor ● Movement detector

An ultrasound flow meter of the type Panametrics was used for the flow measurements at the main supply pipe.

The following data and rates could be analyzed:

- Water consumption at the washstands
- Number of users and duration of use at the washstands tischen
- Number of users and number of flushings at the urinals
- Frequency of cubicle use without locking the door
- Frequency of cubicle use with locking the door
- Activation of flushing
- Intervals in use, frequency of use and simultaneity at all sanitary fixtures
- Total water consumption and peak flow

3 Result

Schwacke [1] calculated a simple rule for the number of sanitary fixtures in football (soccer) stadiums (Table 1). His methods comprised surveys, observations and counts in ten stadiums which in most cases were merely used for football/soccer.

	Urinal	WC	Wash basin
Men	10	3	3
Women		6	3

**Table 1 – Number of sanitary fixtures for each 1000 spectators
In football stadions according Schwacke[1]**

Demiriz created a general table for public houses (=pubs) buildings and areas as a part of the guideline VDI 6000-3 [4] and integrated Schwacke’s numbers in a slightly changed manner in this table (Table 2). Hereby more equality between men and women and the fact that the next generation of stadiums would be multi-functional was taken into consideration. In the year 2000 it was somewhat revolutionary to equalize the number of urinals for men to the number of WCs for women.

For stadiums the numbers given in the line for 1000 people in the part “medium level of simultaneous use” should be projected to the maximum number of spectators. This was the recommendation in the first announcement of the guideline VDI 6000-3. But DFB (German Football Association) contradicted to this method with the argument that it would make too many sanitary fixtures necessary in stadiums. That is why in the final version of the guideline [4] the numbers given in the line for 2000 people in the part “medium level of simultaneous use” were recommended to be taken into consideration. This was the state of the guideline at the end of 2001 for planning the football arenas for the 2006 FIFA World Cup in Germany.

Ten years later, the latest issue of the guideline shows a total equality of the sexes. Both have the same numbers of washbasins and the total number of the urinals and men’s toilets is equal to the number of ladies’ toilets (Table 2).

Number of People	Women		Men			Barrier-free WC cubicle
	WC	WB	UR	WC	WB	
low level of simultaneous use						
25	1	1	1	1	1	1W 1M
50	2	2	2	1	1	
100	2	2	2	1	2	
300	4	2	4	2	2	
500	4	3	4	2	3	
700	5	4	5	3	4	
1000	6	4	6	4	5	
1500	8	6	8	5	6	2W 2M
2000	9	7	9	6	8	
3000	12	10	12	8	10	
4000	14	12	14	10	12	3W 3M
5000	16	14	16	12	14	
6000	18	16	18	14	16	
medium level of simultaneous use						
Number of People	Women		Men			Barrier-free WC cubicle
	WC	WB	UR	WC	WB	
25	1	1	1	1	1	1W 2M
50	2	2	2	1	1	
100	3	3	3	1	2	
300	5	3	5	2	3	
500	6	4	6	3	4	
700	7	5	7	4	5	
1000	9	6	9	5	7	
1500	11	8	11	7	9	2W 2M
2000	13	10	13	9	11	
3000	17	14	17	12	14	
4000	21	18	21	15	18	3W 3M
5000	24	21	24	18	21	
6000	26	23	26	20	23	
high level of simultaneous use						
Number of People	Women		Men			Barrier-free WC cubicle
	WC	WB	UR	WC	WB	
25	2	2	2	2	2	1W 1M
50	3	3	3	2	2	
100	5	4	5	2	3	
300	8	5	8	3	5	
500	9	6	9	5	6	
700	11	8	11	6	8	
1000	14	9	14	8	11	
1500	17	12	17	11	14	2W 2M
2000	20	15	20	14	17	
3000	26	21	26	18	21	
4000	32	27	32	23	27	3W 3M
5000	36	32	36	27	32	
6000	39	35	39	30	35	

Table 2 – Figures of requirements for public buildings 2001[4]

Number of People	Women		Man			Barrier-free WC cubicle
	WC	WB	UR	WC	WB	
low level of simultaneous use						
25	2	1	1	1	1	1
50	2	1	1	1	1	
100	3	2	2	2	2	
300	4	2	2	2	2	2
500	6	3	4	2	3	
700	7	3	4	3	3	
1000	9	4	6	3	4	3
1500	11	5	7	4	5	
2000	14	7	9	5	7	
3000	16	8	10	6	8	4
4000	20	10	13	7	10	
5000	25	12	16	9	12	
6000	30	15	20	10	15	
medium level of simultaneous use						
Number of People	Women		Man			Barrier-free WC cubicle
	WC	WB	UR	WC	WB	
25	2	1	1	1	1	1
50	3	2	2	1	2	
100	4	2	2	2	2	
300	5	3	3	2	2	2
500	8	4	5	3	4	
700	10	5	6	4	5	
1000	12	6	8	4	6	4
1500	15	7	10	5	7	
2000	18	9	12	6	9	
3000	22	11	14	8	11	6
4000	27	13	18	9	13	
5000	35	17	23	12	17	
6000	40	20	26	14	20	
high level of simultaneous use						
Number of People	Women		Man			Barrier-free WC cubicle
	WC	WB	UR	WC	WB	
25	3	1	1	2	1	1
50	4	2	2	2	2	
100	6	3	4	2	3	
300	8	4	5	3	4	2
500	11	5	7	4	5	
700	14	7	9	5	7	
1000	18	9	12	6	9	4
1500	22	11	15	7	11	
2000	27	13	18	9	13	
3000	32	16	21	11	16	6
4000	40	20	26	14	20	
5000	50	25	33	17	25	
6000	60	30	40	20	30	

Table 3 – Figures of requirements for public buildings 2011[8]

The equal status for women was an explicit demand of a number of female architects who lent weight to their wish by means of a collection of signatures. The new table is based on the assumption that half the number of people visiting events are women and half the number are men. It may be true that women shy away from using public toilets, which would decrease the need for ladies' toilets, but the time it takes them to use the cubicles for urinating is three to four times longer than it takes the men. [7]. On average women also stay longer at the washstands than men. They use the washstand to put on make-up. Therefore, it is advisable to fit out the room with additional places for make-up equipped with mirrors, light and a place to put their things.

According to the new guideline [8] the number of sanitary fixtures in stadiums should be calculated according to the high level of simultaneous use shown in table 3.

The total water flow measurement does not only show that the maximum flow was at 32 litre/sec. It also shows the tension of the match:

The match started at 03:30 p.m. There were 68,000 visitors in the stadium. In the last 15 minutes before the start of the match all of them took their seats. The consumption went down to a minimum and varied on a low level. 15 minutes after kickoff, Schalke was leading 2:0, the fans began to celebrate, the situation was less tense, which gave them the chance and time to go the toilet. At about 04:20 p.m. Agali was shown the red card, the match got exciting. This led to a clearly visible low. At half-time the flow reached its maximum. In the second half the score rose to 2:2, the match remained exciting, the consumption varied on a low level. There was a fight between the wish not to miss anything and the full bladder. Schalke was not granted a goal because of offside. The match remained exciting up to the end. After the final whistle a lot of spectators had to go to the toilet. The water consumption went up to 30 litres/sec.

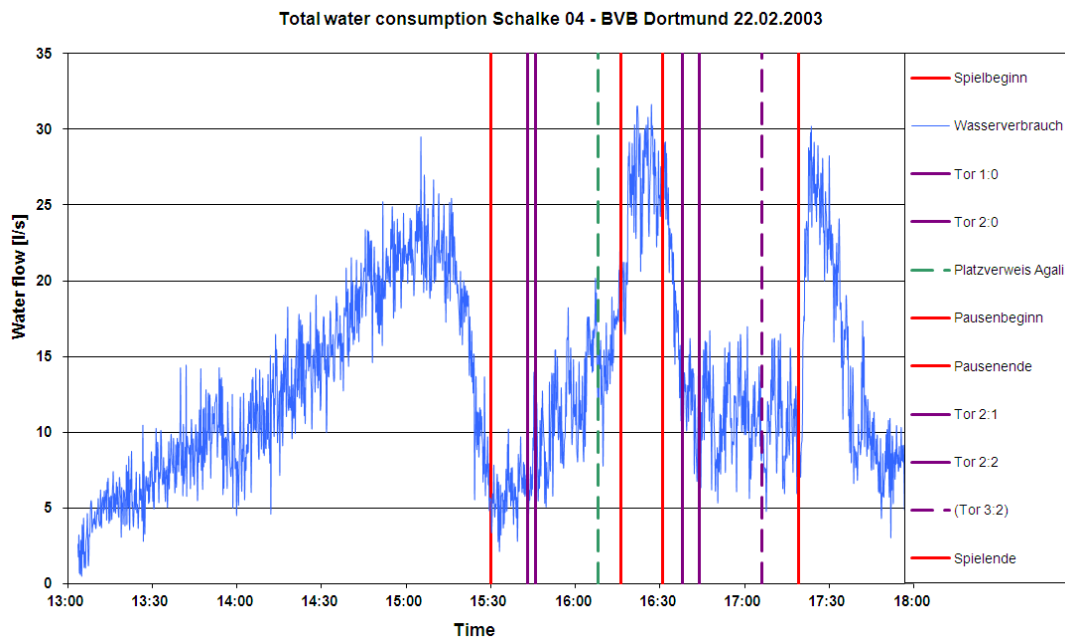


Figure 4 – Water consumption during a football match

4 Conclusion

By means of observations and measurements in football/soccer stadiums and assembly places tables were drawn up to help calculate the appropriate number of sanitary facilities and fixtures. Attention was also directed to the equality of the sexes.

Shortly before the match, at half-time and shortly after the match the water consumption reached a maximum.

5 References

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