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A Study on the Comfort Comparison based on Thermal Characteristics of the Floor Materials - Steel, Urethane Rubber, Pine Tree, Clay at the Seating Life Style

*   **   ***   ***

Song, Gook-Sup   Jeon, Bong-Ku   Kim, Ki-Hoon   Jeon, Sung-Won

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Abstract

The thermal characteristics of the materials for a floor structure are very important factors on the thermal comfort because Koreans are used to be seated or lay down on the floor. In this study, experimental chambers were constructed to evaluate the thermal sensitivity difference between floor materials, steel and urethane rubber, pine tree, clay. At the first experiments, the clay floor and pine tree floor were experimented and the second experiments, the steel floor and urethane rubber floor were experimented. In each case, the floor surface temperature and air temperature were varied from 12 to 36 by 3 step and the number of guinea pigs participated in each step temperature were 30 peoples. The results of this experiment are as follows. (1) In the clay floor, the comfortable floor surface temperature is 25 32 at the seated or lay down posture. (2) In the pine tree material, the comfortable floor surface temperature is 18 30 . (3) In the steel floor, the optimum floor surface temperature is 28 31 at the posture of lay down or seated on the floor. (4) In the urethane rubber floor, the optimum floor surface temperature is 18 23 at the posture of lay down or seated on the floor.

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Keywords : Thermal Comfort, Floor Material, Ondol, Seating Life Style

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                                                           27   23   31
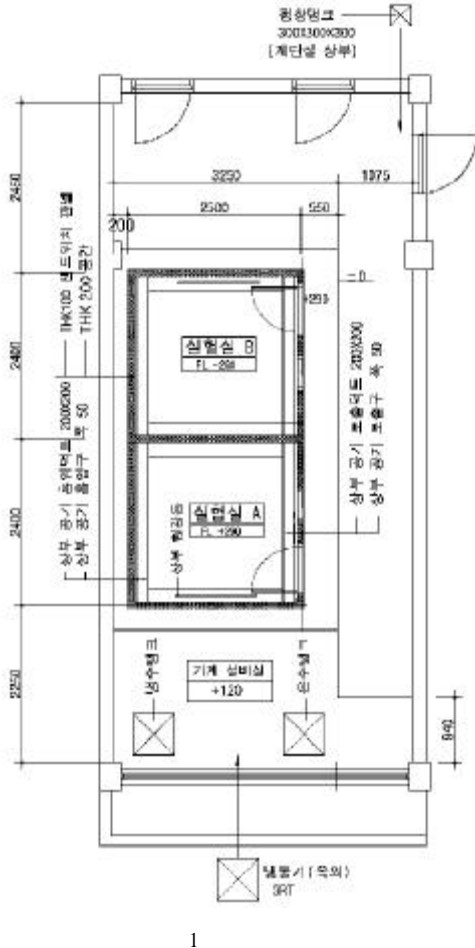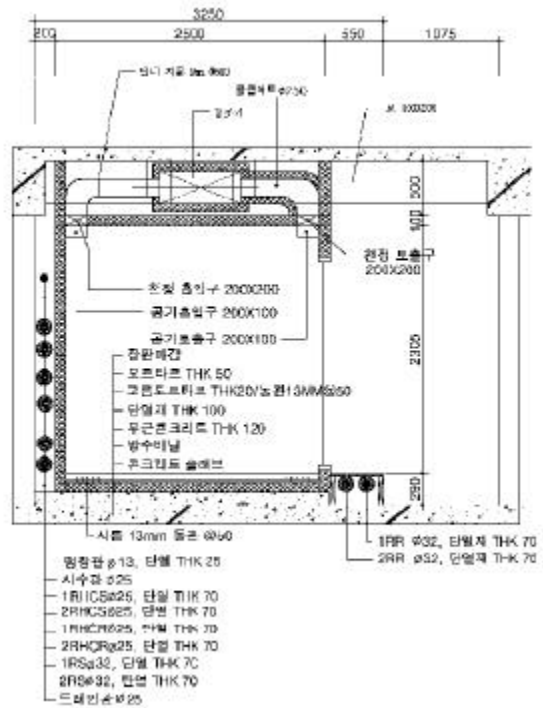   24
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25   39   .   ,
                                                          18   .

                        .   Olesen, Fanger

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12mm

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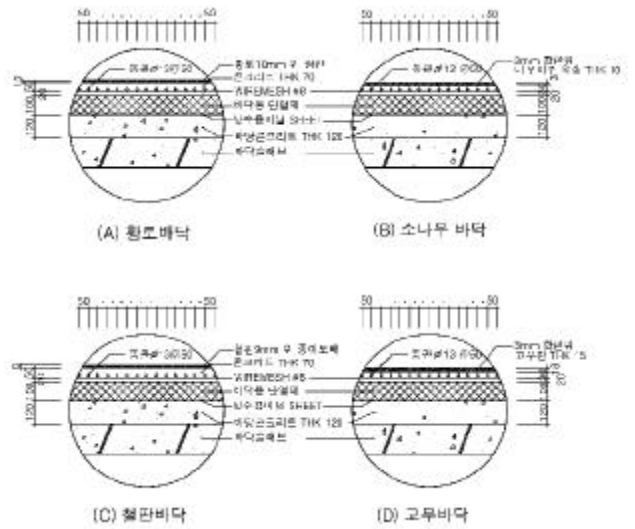
KS, ASTM, DIN, JIS ,

(Guarded Hot Box), . 5cm

(Calibrated Hot Box), (Heat Flow Meter) .

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$$\frac{1}{k} = - \; \varDelta \frac{T}{dq}$$
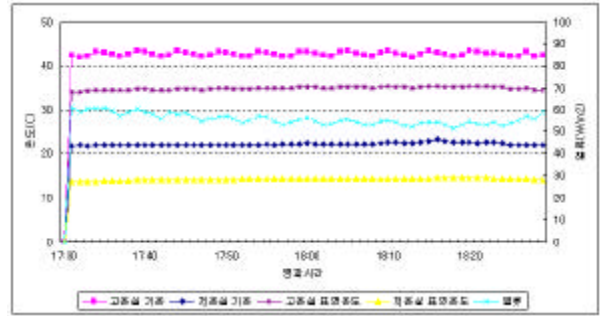
, k :   (W/mh   )

q :   (W/m^2)

d :   (m)

$\varDelta T$:   (   )
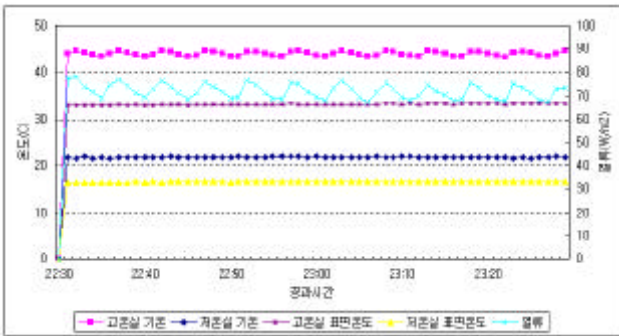
1   60
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1

	(mm)	(W/m^2)	( )	( )	(W/mh)
	9	71.91	33.23	33.10	4.978
	15	38.73	37.69	26.88	0.054
	10	55.82	34.86	28.66	0.090
	10	80.04	32.23	30.37	0.430

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2		234 , 56

80.6%

	, ,	,
	234	216

216   58   .

	56	58
Total	290	274

78.8%

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18   33   ,

21.98 ,   21.18

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24
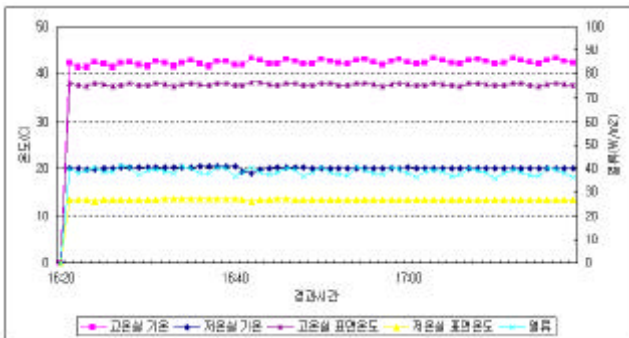
3

,	,
9	5
17	9
96	113
31	31
107	92
30	24
290	274

‘   ’ 113 (41%), 96 (33%) , ‘   ’ 92 (33%) 107 (37%) 462 (35.6%), ‘   ’ 383 (29.6%)

7   .

4

3	
2	4
104	109
106	79
58	61
17	21
290	274

‘   ’ 104   109 , ‘   ’ 106   79

5

,	0.564004
,	0.429883

ASHARE   Clo

$Clo = 0.82 \times \Sigma(\quad clo)$

0.564   0.429

109 , 136 , 99 , 64   176 , 148 , 175 , 208

6

109	136	99	64
176	148	175	208
4	5		
1	1		2
290	290	274	274

4.2

12   36

7

12	5	16	9					30
15	3	19	8					30
18		10	15	4	1			30
21		6	17	7				30
24		2	15	10	3			30
27			9	21				30
30			1	15	13	1		30
33				7	12	8	3	30
34				3	4	2		9
35				1	4	4	2	11
36				5	12	12	1	30
	8	53	74	73	49	27	6	290
12	4	11	13	1	1			30
15	3	11	15	1				30
18		6	18	5				29
21		2	19	9				30
24		1	15	11	3			30
27			6	21	3			30
30			2	12	15	1		30
33				5	14	10	1	30
34				4	5			9
35				1	6	3	1	11
36				8	13	8	1	30
	7	31	88	78	60	22	3	289
12	9	19	2					30
15	4	20	6					30
18	5	6	15	4				30
21	1	10	15	4				30
24		7	11	11	1			30
27			14	15	1			30
30			1	21	8			30
33				11	9	9	1	30
34				7	2			9
35				2	1	6	2	11
36				11	8	11		30
	19	62	64	86	30	26	3	290

8

表 8

12	4	11	12	1	1			29
15	2	9	10	1				22
18		5	15	5				25
21		1	14	8				23
24			8	4	2			14
27			3	7	1			11
30			1	6	7			14
33				2	10	2		14
34				2	3			5
35				1	4		1	6
36				4	5	8		17
	6	26	63	41	33	10	1	180
12	8	19	2					29
15	3	15	4					22
18	4	5	13	4				26
21		7	12	4				23
24		5	4	4	1			14
27			6	5				11
30				10	4			14
33				6	5	3		14
34				3	2			5
35				1	1	3	1	6
36				9	2	6		17
	15	51	41	46	15	12	1	181

表 9 .

表 9

12				1				1
15	1	2	5					8
18		1	3					4
21		1	5	1				7
24		1	7	7	1			16
27			3	14	2			19
30			1	6	8	1		16
33				3	4	8	1	16
34				2	2			4
35					2	3		5
36				4	8		1	13
	1	5	25	37	27	12	2	109
12	1							1
15	1	5	2					8
18	1	1	2					4
21	1	3	3					7
24		2	7	7				16
27			8	10	1			19
30			1	11	4			16
33				5	4	6	1	16
34				4				4
35				1		3	1	5
36				2	6	5		13
	4	11	23	40	15	14	2	109

4.3

‘ ’， ‘ ’
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‘ ’
19 ， 62
， 57 .
.
18 30
. 27
33 ‘ ’ .
12 36 ‘ ’
290 158 ， 86
.
.

10 .

表 10

12	1	5	19	5				30
15	1	2	21	6				30
18		1	13	16				30
21			2	27	1			30
24			5	23	2			30
27		1	1	21	7			30
30				12	14	4		30
33				5	16	6	3	30
34				1	6	1	1	9
35				1		7	3	11
36				7	6	14	3	30
	2	9	61	124	52	32	10	290
12		4	21	5				30
15	1	3	20	6				30
18		1	12	17				30
21			3	24	2	1		30
24			6	18	6			30
27			2	22	5	1		30
30			1	10	15	4		30
33				7	10	10	3	30
34				1	7		1	9
35				1		7	3	11
36				6	6	16	2	30
	1	8	65	117	51	39	9	290
12		6	21	3				30
15		3	18	9				30
18		1	9	20				30
21			2	28				30
24			4	24	2			30
27			3	24	3			30
30				19	10	1		30
33				8	11	9	2	30
34				4	4	1		9
35				2	4	2	3	11
36				17	5	8		30
		10	57	158	39	21	5	290

290
154 ， 136 .
181 ， 109 . 18
16% (22/ 136)
12% (13/ 109)
.

.

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Table 11

12		1	2				27
15	2	13	3				18
18	1	7	15				23
21		2	16	2	1		21
24		1	5	4			10
27		1	5	2	1		9
30		1	3	5	1		10
33			4	3			7
34			1	4		1	6
35					7	1	8
36			4	4	7		15
	6	44	61	24	17	2	154
12	5	19	3				27
15	2	11	5				18
18	1	6	16				23
21		2	19				21
24		1	8	1			10
27		1	7	1			9
30			6	4			10
33			4	2	1		7
34			2	3	1		6
35			1	3	2	2	8
36			14	1			15
	8	40	85	15	4	2	154

(Note: first row reads 12 | 3 | 19 | 5 | | | | 27)

12   .

Table 12

12		1	2					3
15	1	1	7	3				12
18			5	2				7
21			1	8				9
24			5	13	2			20
27			1	17	3			21
30				7	10	3		20
33				3	7	10	3	23
34					3			3
35				1			2	3
36				2	2	9	2	15
	1	2	21	56	27	22	7	136
12	1	2					3	
15	1	7	4				12	
18		3	4				7	
21			9				9	
24		3	16	1			20	
27		2	17	2			21	
30			13	6	1		20	
33			4	9	8	2	23	
34			2	1			3	
35			1	1		1	3	
36			3	4	8		15	
	2	17	73	24	17	3	136	

4.3

24
.

Table 13

12	5	16	8	1				30
15	4	18	7	1				30
18		7	18	6				31
21	1	3	16	10				30
24		2	17	12	1			32
27			1	27	2			30
30				5	23	3		31
33				4	9	17		30
36				2	2	16	10	30
	10	46	67	68	37	36	10	274
12	1	17	11	1				30
15	1	15	13	1				30
18		5	14	12				31
21		4	9	17				30
24		2	12	18				32
27				23	7			30
30				6	23	2		31
33				4	9	16	1	30
36				1	8	14	7	30
	2	43	59	83	47	32	8	274
12	15	10	5					30
15	9	17	4					30
18	3	12	15	1				31
21	1	6	15	8				30
24		3	24	4	1			32
27			7	22	1			30
30				21	7	3		31
33				18	7	5		30
36				3	9	14	4	30
	28	48	70	77	25	22	4	274

14   .

Table 14

12	1	17	11	1				30
15	1	14	12	1				28
18		5	13	12				30
21		4	9	9				22
24		2	8	8				18
27				10	5			15
30				6	14	2		22
33				3	7	10	1	21
36					7	11	6	24
	2	42	53	50	33	23	7	210
12	15	10	5					30
15	8	16	4					28
18	3	11	15	1				30
21	1	4	12	5				22
24		2	14	2				18
27			2	12	1			15
30				17	3	2		22
33				14	4	3		21
36				3	8	10	3	24
	27	43	52	54	16	15	3	210

表15

12								
15		1	1					2
18			1					1
21				8				8
24			4	10				14
27				13	2			15
30					9			9
33				1	2	6		9
36				1	1	3	1	6
		1	6	33	14	9	1	64
12								
15	1	1						2
18		1						1
21		2	3	3				8
24	1	10	2	1				14
27			5	10				15
30				4	4	1		9
33				4	3	2		9
36				1	4	1		6
	1	5	18	23	9	7	1	64

　　　　　　　　　　　　　210 ,　　　　64

　　　　274

　　.

　　　.　　　12

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24

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　　4.4

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　.27

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　　　　　　　　12

‘　,’

　　　　　.　　27

　‘　’

　　　　　　　　　.

　　　　274　175

(63.9%)　　　　99 (36.1%)　　.

　　　.

　　12　　36　　　.

表16

12		5	18	7			30
15		3	22	5			30
18		1	10	20			31
21			5	25			30
24			2	27	3		32
27			1	10	17	2	30
30					9	22	31
33				2	6	17	5	30
36				2		12	16	30
		9	58	98	35	53	21	274
12		5	18	7			30
15		4	17	9			30
18		1	8	22			31
21		1	7	22			30
24			1	29	2		32
27				13	14	3	30
30				1	17	13	31
33				1	7	19	3	30
36				1	2	13	14	30
		11	51	105	42	48	17	274
12			7	23			30
15			7	23			30
18			2	29			31
21				30			30
24			1	28	3		32
27				6	20	4	30
30				1	15	12	3	31
33				4	14	10	2	30
36				3	3	20	4	30
			17	147	55	46	9	274

　　　　17　　　.

表17

12			15	6			26
15			9	5			17
18			6	14			21
21			5	10			15
24				12	2		14
27				4	10	2	16
30				1	12	11	24
33				1	2	11	3	17
36					2	10	13	25
			35	53	28	34	16	175
12			7	19			26
15			4	13			17
18			2	19			21
21				15			15
24			1	11	2		14
27				2	11	3	16
30				1	10	11	2	24
33				2	7	7	1	17
36				3	3	16	3	25
			14	85	33	37	6	175

18

12			3	1			4
15			8	4			13
18			2	8			10
21			2	12			15
24			1	17			18
27				9	4	1	14
30					5	2	7
33					5	8	13
36				1		3	1	5
			16	52	14	14	1	99
12			4				4
15			10				13
18			10				10
21			15				15
24			17	1			18
27			4	9	1		14
30				5	1	1	7
33			2	7	3	1	13
36					4	1	5
			62	22	9	3	99

4.3

SPSS

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R^2

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0.8

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4.5

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30

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30

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. 19   .

19

			R^2			
		$y = 0.145x + 0.123$	0.707	26.7	23.3	30.2
		$y = 0.125x + 0.716$	0.646	26.3	22.3	30.3
		$y = 0.146x - 0.138$	0.692	28.3	24.9	31.8
		$y = 0.173x - 0.663$	0.678	27.0	24.1	29.8
		$y = 0.138x + 0.323$	0.574	26.6	23.0	30.3
		$y = 0.171x - 0.848$	0.662	28.4	25.4	31.3
		$y = 0.136x + 0.342$	0.707	26.9	23.2	30.6
		$y = 0.12x + 0.822$	0.656	26.0	21.8	30.2
		$y = 0.137x + 0.06872$	0.687	28.7	25.0	32.3
		$y = 0.112x + 1.45$	0.612	22.8	18.3	27.2
		$y = 0.110x + 1.52$	0.592	22.5	18.0	27.1
		$y = 0.08514x + 1.960$	0.502	24.0	18.1	29.8
		$y = 0.126x + 1.049$	0.588	23.4	19.5	27.4
		$y = 0.137x + 0.766$	0.607	23.6	20.0	27.3
		$y = 0.104x + 1.529$	0.505	23.8	19.0	28.6
		$y = 0.104x + 1.634$	0.608	22.8	17.9	27.6
		$y = 0.09722x + 1.839$	0.582	22.2	17.1	27.4
		$y = 0.07077x + 2.222$	0.466	25.1	18.1	32.2
		$y = 0.148x + 0.910$	0.76	20.9	17.5	24.3
		$y = 0.141x + 1.043$	0.746	21.0	17.4	24.5
		$y = 0.09532 + 2.285$	0.598	18.0	12.7	23.2
		$y = 0.138x + 1.018$	0.719	21.6	18.0	25.2
		$y = 0.122x + 1.337$	0.658	21.8	17.7	25.9
		$y = 0.09363x + 2.226$	0.562	18.9	13.6	24.3
		$y = 0.152x + 0.902$	0.781	20.4	17.1	23.7
		$y = 0.147 + 0.975$	0.786	20.6	17.2	24.0
		$y = 0.0958 + 2.330$	0.617	17.4	12.2	22.7
		$y = 0.169x - 0.244$	0.773	25.1	22.2	28.1
		$y = 0.150x + 0.331$	0.744	24.5	21.1	27.8
		$y = 0.160x - 0.457$	0.746	27.9	24.7	31.0
		$y = 0.202x - 1.151$	0.809	25.5	23.0	28.0
		$y = 0.151x + 0.308$	0.664	24.5	21.1	27.8
		$y = 0.193x - 1.314$	0.669	27.5	24.9	30.1
		$y = 0.166x - 0.154$	0.761	25.0	22.0	28.0
		$y = 0.15x + 0.333$	0.743	24.4	21.1	27.8
		$y = 0.156x - 0.362$	0.753	28.0	24.8	31.2

12
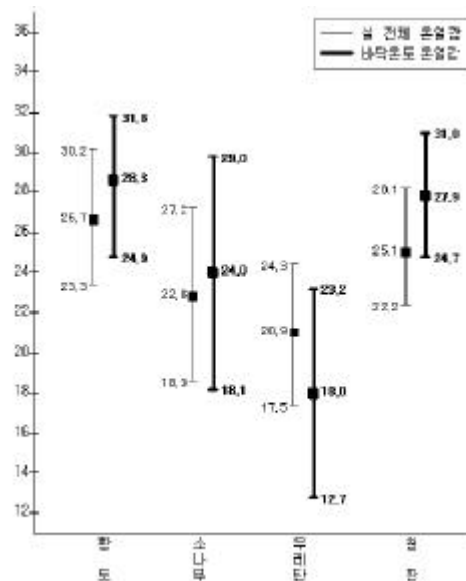
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16   2   (136), 2000. 2.
2.   1 , "
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3.   , "   ",   1990
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4.   , "
                                              ",   11
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5.   , "   ",
                        24   6 , 1995.
6.   2 , "
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1988.
7.   2 , "
                        ",
                4   3   17 , 1988
8.   2 , "
                ",   4   6   20
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9.   , "
                (I)",   5   6   26 , 1989
10.   1 , "
                ",   6   2   28   , 1990
11.   2 , "
                        ",   9
        6   56 , 1993
12.   3 , "
                        ",   10   2
                64 , 1994
13.   1 , "
                ",   , 1992. 4
14. Fanger P.O. "Thermal comfort analysis and
    applications in environmental engineering."
    MacGraw-Hill, New York, 1970.
15. ASHARE HANDBOOK, "1997 FUNDERMENTALS",
    1997.

.   1   2000   4   4   6

1   , 2
    7   3   8   30
                    .
            12   36   3
                30   .
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            27   23   30   .
(2)
    28   25   32   .
(3)
        23   18   27   .
(4)
    24   18   30   .
(5)
    21   18   24   .
(6)
            18   12   23   .
(7)   25
                22   28   .
(8)
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(9)
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