"MRT"

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MRT:

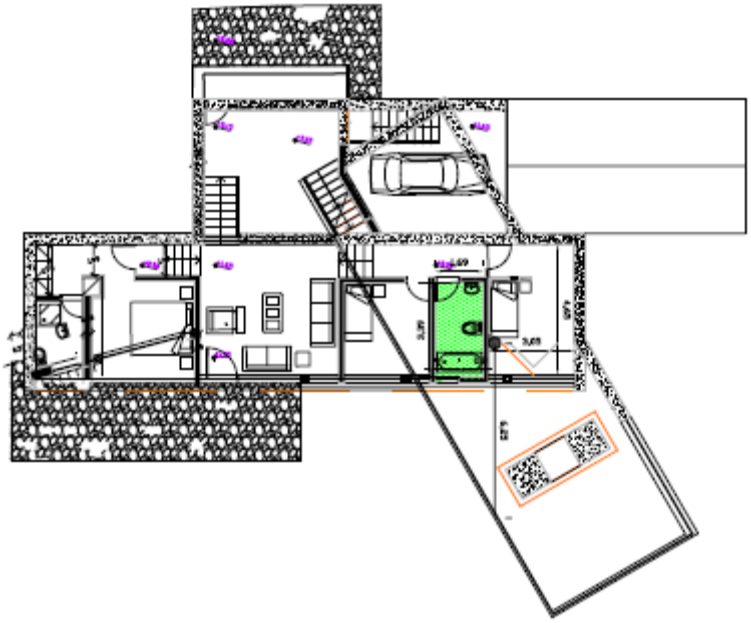
The mean radiant temperature is the total radiation located in one point of a room, it's calculated applying the following formula:

MRT = Σi (tiFv,i)

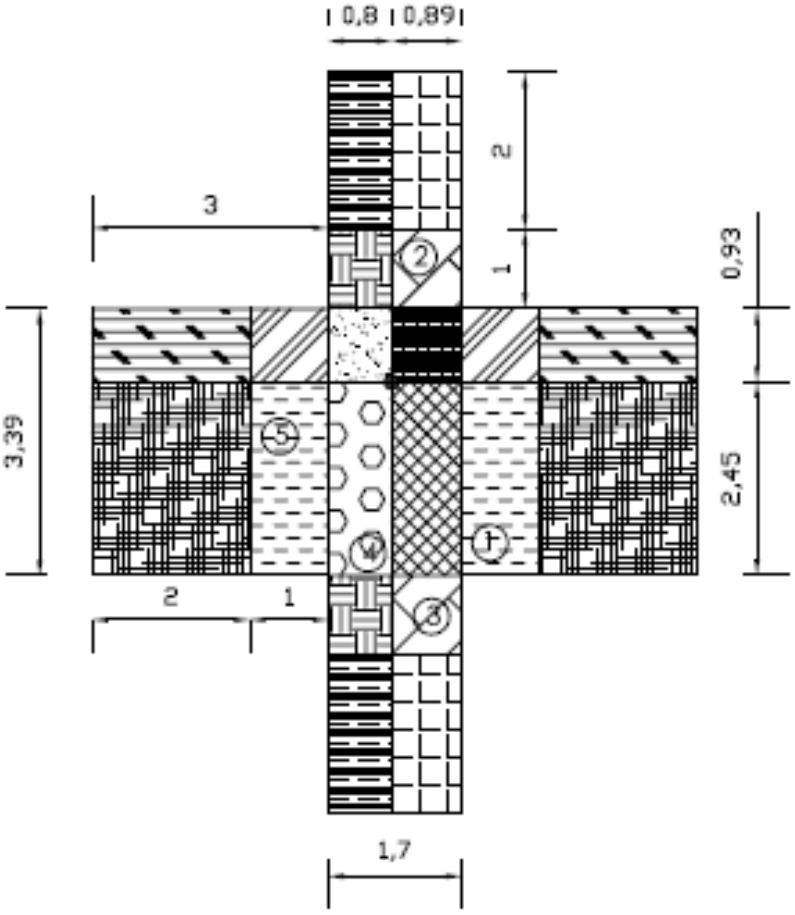
Where:

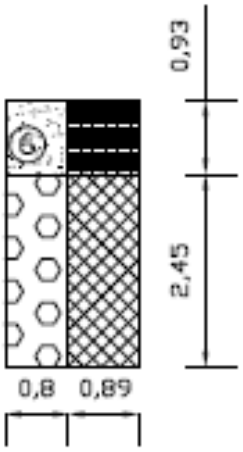
- **ti : are the indoor surface temperatures of the elements enclosing the space.**
- **Fv,i : are the shape factors of the different surfaces from a specific point of the room, and energy leaving the surface a by radiation and reaching the "surface" in P.**

Location of the room:

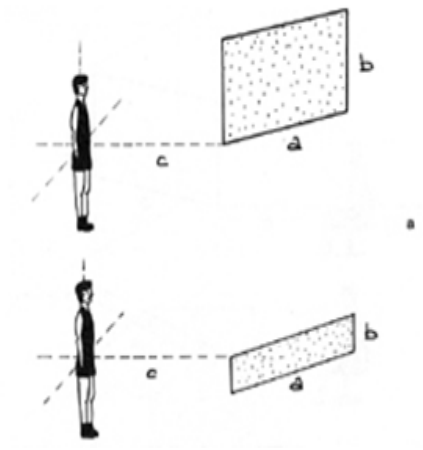


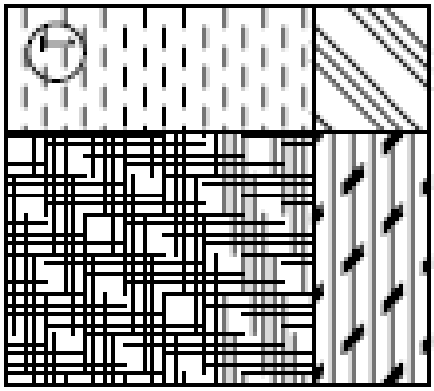
Decomposition of the room:





Shape 1: Interior Wall.





For the shape A:

The temperature in this shape is 20 °C , because it's an interior wall.

T (°C)
20

To calculate the Fv, it's necessary apply this formula:

$$F_{p,i} = F^* \{1 - \exp [- (a/c) / \tau]\}\{1 - \exp [- (b/c) / \gamma]\}$$

$$\tau = A + B\, a/c$$
$$\gamma = C + D\, b/c + E\, a/c$$

How the Observer is stand up, and we need to calculate a wall, the values that we need use to calculate the Fp,i are:

F*	A	B	C	D	E
0,120	1,24186	0,16730	0,61648	0,08165	0,05128

And the surfaces are:

SURFACES	(m)
a	0.93
b	2
c	0.89

Then we using the formula we obtain the Fp,I for the surface A in this wall:

$F_{p,i}$	0,05811

For the shape B:

The temperature in this shape is 20 ºC , because it's an interior wall.

T (ºC)
20

To calculate the Fv, it's necessary apply this formula:

$$Fp,i = F^* \{1 - \exp [- (a/c) / \tau]\}\{1 - \exp [- (b/c) / \gamma]\}$$

$$\tau = A + B\ a/c$$
$$\gamma = C + D\ b/c + E\ a/c$$

How the Observer is stand up, and we need to calculate a wall, the values that we need use to calculate the Fp,i are:

F*	A	B	C	D	E
0,120	1,24186	0,16730	0,61648	0,08165	0,05128

And the surfaces are:

SURFACES	(m)
a	2.45
b	2
c	0.89

Then we using the formula we obtain the Fp,I for the surface A in this wall:

$F_{p,i}$	0,08735

For the shape C:

The temperature in this shape is 20 °C , because it's an interior wall.

T (°C)
20

To calculate the Fv, it's necessary apply this formula:

$$Fp,i = F^* \{1 - \exp [- (a/c) / \tau]\}\{1 - \exp [- (b/c) / \gamma]\}$$

$$\tau = A + B\ a/c$$
$$\gamma = C + D\ b/c + E\ a/c$$

How the Observer is stand up, and we need to calculate a wall, the values that we need use to calculate the Fp,i are:

F*	A	B	C	D	E
0,120	1,24186	0,16730	0,61648	0,08165	0,05128

And the surfaces are:

SURFACES	(m)
a	0.93
b	1
c	0.89

Then we using the formula we obtain the Fp,I for the surface A in this wall:

$F_{p,i}$	0,04828

For the shape D:

The temperature in this shape is 20 °C , because it's an interior wall.

T (°C)
20

To calculate the Fv, it's necessary apply this formula:

$$F_{p,i} = F^* \{1 - \exp [- (a/c) / \tau]\}\{1 - \exp [- (b/c) / \gamma]\}$$

$$\tau = A + B\ a/c$$
$$\gamma = C + D\ b/c + E\ a/c$$

How the Observer is stand up, and we need to calculate a wall, the values that we need use to calculate the Fp,i are:

F*	A	B	C	D	E
0,120	1,24186	0,16730	0,61648	0,08165	0,05128

And the surfaces are:

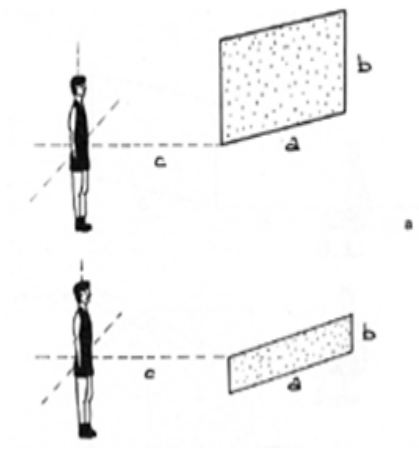
SURFACES	(m)
a	2.45
b	1
c	0.89

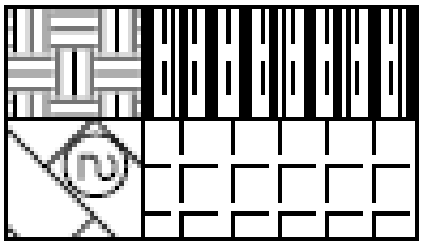
Then we using the formula we obtain the Fp,I for the surface A in this wall:

$F_{p,i}$	0,07056

SHAPES	$F_{p,i}$
A	0,05811
B	0,08735
C	0,04828
D	0,07056
∑=	0,2643

Shape 2:





For the shape A:

The temperature in this shape is 20 °C , because it's an interior wall.

T (°C)
20

To calculate the Fv, it's necessary apply this formula:

$$F_{p,i} = F^* \{1 - \exp [- (a/c) / \tau]\}\{1 - \exp [- (b/c) / \gamma]\}$$

$$\tau = A + B\, a/c$$
$$\gamma = C + D\, b/c + E\, a/c$$

How the Observer is stand up, and we need to calculate a wall, the values that we need use to calculate the Fp,i are:

F*	A	B	C	D	E
0,120	1,24186	0,16730	0,61648	0,08165	0,05128

And the surfaces are:

SURFACES	(m)
a	0.8
b	2
c	0.93

Then we using the formula we obtain the Fp,I for the surface A in this wall:

$F_{p,i}$	0,05126

For the shape B:

The temperature in this shape is 20 °C , because it's an interior wall.

T (°C)
20

To calculate the Fv, it's necessary apply this formula:

$$Fp,i = F^* \{1 - \exp [- (a/c) / \tau]\}\{1 - \exp [- (b/c) / \gamma]\}$$

$$\tau = A + B\ a/c$$
$$\gamma = C + D\ b/c + E\ a/c$$

How the Observer is stand up, and we need to calculate a wall, the values that we need use to calculate the Fp,i are:

F*	A	B	C	D	E
0,120	1,24186	0,16730	0,61648	0,08165	0,05128

And the surfaces are:

SURFACES	(m)
a	0.89
b	2
c	0.93

Then we using the formula we obtain the Fp,I for the surface A in this wall:

$F_{p,i}$	0,05476

For the shape C:

The temperature in this shape is 20 °C , because it's an interior wall.

T (°C)
20

To calculate the Fv, it's necessary apply this formula:

$$Fp,i = F^* \{1 - \exp [- (a/c) / \tau]\}\{1 - \exp [- (b/c) / \gamma]\}$$

$$\tau = A + B\ a/c$$
$$\gamma = C + D\ b/c + E\ a/c$$

How the Observer is stand up, and we need to calculate a wall, the values that we need use to calculate the Fp,i are:

F*	A	B	C	D	E
0,120	1,24186	0,16730	0,61648	0,08165	0,05128

And the surfaces are:

SURFACES	(m)
a	0.8
b	1
c	0.93

Then we using the formula we obtain the Fp,I for the surface A in this wall:

$F_{p,i}$	0,05126

For the shape D:

The temperature in this shape is 20 °C , because it's an interior wall.

T (°C)
20

To calculate the Fv, it's necessary apply this formula:

$$Fp,i = F^* \{1 - \exp [- (a/c) / \tau]\}\{1 - \exp [- (b/c) / \gamma]\}$$

$$\tau = A + B\ a/c$$
$$\gamma = C + D\ b/c + E\ a/c$$

How the Observer is stand up, and we need to calculate a wall, the values that we need use to calculate the Fp,i are:

F*	A	B	C	D	E
0,120	1,24186	0,16730	0,61648	0,08165	0,05128

And the surfaces are:

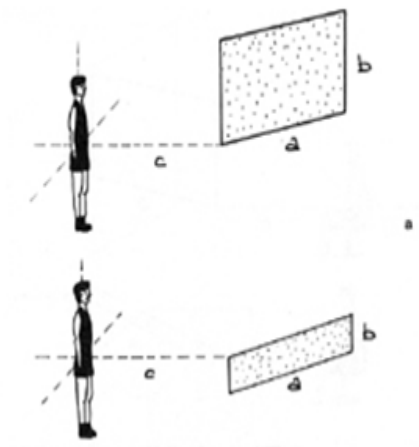
SURFACES	(m)
a	0.89
b	1
c	0.93

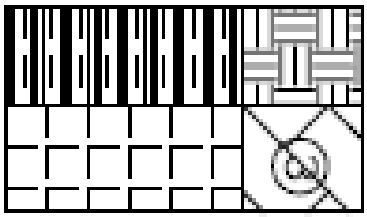
Then we using the formula we obtain the Fp,I for the surface A in this wall:

$F_{p,i}$	0,04512

SHAPES	$F_{p,i}$
A	0,05126
B	0,05476
C	0,05126
D	0,04512
∑=	0,2024

Shape 3: Wall.





For the shape A:

The temperature in this shape is 20 ºC , because it's an interior wall.

T (ºC)
20

To calculate the Fv, it's necessary apply this formula:

$$F_{p,i} = F^* \{1 - \exp [- (a/c) / \tau]\}\{1 - \exp [- (b/c) / \gamma]\}$$

$$\tau = A + B\, a/c$$
$$\gamma = C + D\, b/c + E\, a/c$$

How the Observer is stand up, and we need to calculate a wall, the values that we need use to calculate the Fp,i are:

F*	A	B	C	D	E
0,120	1,24186	0,16730	0,61648	0,08165	0,05128

And the surfaces are:

SURFACES	(m)
a	0.8
b	2
c	2.45

Then we using the formula we obtain the Fp,I for the surface A in this wall:

$F_{p,i}$	0,01840

For the shape B:

The temperature in this shape is 20 °C , because it's an interior wall.

T (°C)
20

To calculate the Fv, it's necessary apply this formula:

$$Fp,i = F^* \{1 - \exp [- (a/c) / \tau]\}\{1 - \exp [- (b/c) / \gamma]\}$$

$$\tau = A + B\ a/c$$
$$\gamma = C + D\ b/c + E\ a/c$$

How the Observer is stand up, and we need to calculate a wall, the values that we need use to calculate the Fp,i are:

F*	A	B	C	D	E
0,120	1,24186	0,16730	0,61648	0,08165	0,05128

And the surfaces are:

SURFACES	(m)
a	0.89
b	2
c	2.45

Then we using the formula we obtain the Fp,I for the surface A in this wall:

$F_{p,i}$	0,02008

For the shape C:

The temperature in this shape is 20 °C , because it's an interior wall.

T (°C)
20

To calculate the Fv, it's necessary apply this formula:

$$Fp,i = F^* \{1 - \exp [- (a/c) / \tau]\}\{1 - \exp [- (b/c) / \gamma]\}$$

$$\tau = A + B\ a/c$$
$$\gamma = C + D\ b/c + E\ a/c$$

How the Observer is stand up, and we need to calculate a wall, the values that we need use to calculate the Fp,i are:

F*	A	B	C	D	E
0,120	1,24186	0,16730	0,61648	0,08165	0,05128

And the surfaces are:

SURFACES	(m)
a	0.8
b	1
c	2.45

Then we using the formula we obtain the Fp,I for the surface A in this wall:

$F_{p,i}$	0,01223

For the shape D:

The temperature in this shape is 20 °C , because it's an interior wall.

T (°C)
20

To calculate the Fv, it's necessary apply this formula:

$$Fp,i = F^* \{1 - \exp [- (a/c) / \tau]\}\{1 - \exp [- (b/c) / \gamma]\}$$

$$\tau = A + B\ a/c$$
$$\gamma = C + D\ b/c + E\ a/c$$

How the Observer is stand up, and we need to calculate a wall, the values that we need use to calculate the Fp,i are:

F*	A	B	C	D	E
0,120	1,24186	0,16730	0,61648	0,08165	0,05128

And the surfaces are:

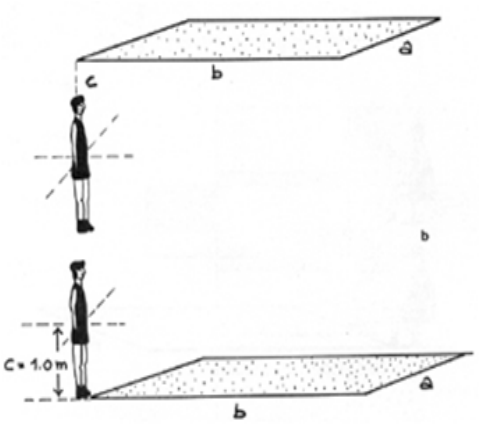
SURFACES	(m)
a	0.89
b	1
c	2.45

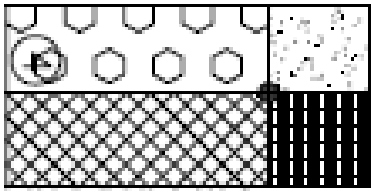
Then we using the formula we obtain the Fp,I for the surface A in this wall:

$F_{p,i}$	0,01335

SHAPES	$F_{p,i}$
A	0,01840
B	0,02008
C	0,01223
D	0,01335
∑=	0,06406

Shape 4: FLOOR.





For the shape A:

The temperature in this shape is 20 ºC , because it's an interior wall.

T (ºC)
20

To calculate the Fv, it's necessary apply this formula:

$F_{p,i} = F^* \{1 - \exp [- (a/c) / \tau]\}\{1 - \exp [- (b/c) / \gamma]\}$

$\tau = A + B\ a/c$
$\gamma = C + D\ b/c + E\ a/c$

How the Observer is stand up, and we need to calculate a wall, the values that we need use to calculate the Fp,i are:

F*	A	B	C	D	E
0,116	1,59512	0,12788	1,22643	0,04621	0,04434

And the surfaces are:

SURFACES	(m)
a	0.93
b	0.89
c	1

Then we using the formula we obtain the Fp,I for the surface A in this wall:

$F_{p,i}$	0,04089

For the shape B:

The temperature in this shape is 20 °C , because it's an interior wall.

T (°C)
20

To calculate the Fv, it's necessary apply this formula:

$$Fp,i = F^* \{1 - \exp [- (a/c) / \tau]\}\{1 - \exp [- (b/c) / \gamma]\}$$

$$\tau = A + B\ a/c$$
$$\gamma = C + D\ b/c + E\ a/c$$

How the Observer is stand up, and we need to calculate a wall, the values that we need use to calculate the Fp,i are:

F*	A	B	C	D	E
0,116	1,59512	0,12788	1,22643	0,04621	0,04434

And the surfaces are:

SURFACES	(m)
a	2.45
b	0.89
c	1

Then we using the formula we obtain the Fp,I for the surface A in this wall:

$F_{p,i}$	0,06165

For the shape C:

The temperature in this shape is 20 °C , because it's an interior wall.

T (°C)
20

To calculate the Fv, it's necessary apply this formula:

$$Fp,i = F^* \{1 - \exp [- (a/c) / \tau]\}\{1 - \exp [- (b/c) / \gamma]\}$$

$$\tau = A + B\ a/c$$
$$\gamma = C + D\ b/c + E\ a/c$$

How the Observer is stand up, and we need to calculate a wall, the values that we need use to calculate the Fp,i are:

F*	A	B	C	D	E
0,116	1,59512	0,12788	1,22643	0,04621	0,04434

And the surfaces are:

SURFACES	(m)
a	0.93
b	0.8
c	1

Then we using the formula we obtain the Fp,I for the surface A in this wall:

$F_{p,i}$	0,03884

For the shape D:

The temperature in this shape is 20 °C , because it's an interior wall.

T (°C)
20

To calculate the Fv, it's necessary apply this formula:

$Fp,i = F^* \{1 - \exp [- (a/c) / \tau]\}\{1 - \exp [- (b/c) / \gamma]\}$

$\tau = A + B\ a/c$
$\gamma = C + D\ b/c + E\ a/c$

How the Observer is stand up, and we need to calculate a wall, the values that we need use to calculate the Fp,i are:

F*	A	B	C	D	E
0,116	1,59512	0,12788	1,22643	0,04621	0,04434

And the surfaces are:

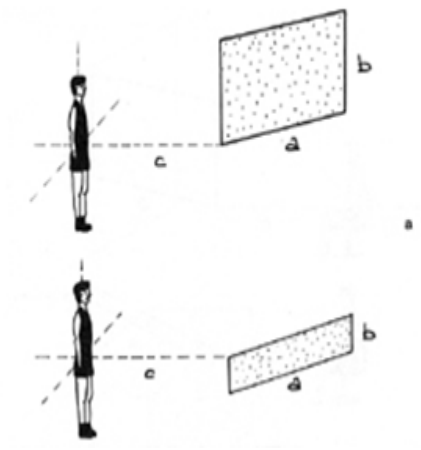
SURFACES	(m)
a	2.45
b	0.8
c	1

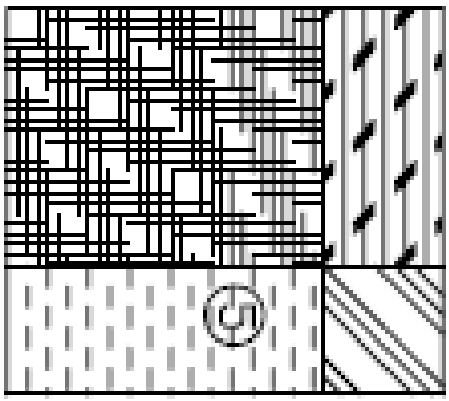
Then we using the formula we obtain the Fp,I for the surface A in this wall:

$F_{p,i}$	0,05833

SHAPES	$F_{p,i}$
A	0,04089
B	0,06165
C	0,03884
D	0,05833
∑=	0,19971

Shape 5: External Wall.





For the shape A:

The temperature in this shape is 12,72 ºC , because it's an external wall.

T (ºC)
20

To calculate the Fv, it's necessary apply this formula:

$F_{p,i} = F^* \{1 - \exp [- (a/c) / \tau]\}\{1 - \exp [- (b/c) / \gamma]\}$

$\tau = A + B\ a/c$
$\gamma = C + D\ b/c + E\ a/c$

How the Observer is stand up, and we need to calculate a wall, the values that we need use to calculate the Fp,i are:

F*	A	B	C	D	E
0,120	1,24186	0,16730	0,61648	0,08165	0,05128

And the surfaces are:

SURFACES	(m)
a	2.45
b	2
c	0.8

Then we using the formula we obtain the Fp,I for the surface A in this wall:

$F_{p,i}$	0,09138

For the shape B:

The temperature in this shape is 12,72 ºC , because it's an external wall.

T (ºC)
20

To calculate the Fv, it's necessary apply this formula:

$$Fp,i = F^* \{1 - \exp [- (a/c) / \tau]\}\{1 - \exp [- (b/c) / \gamma]\}$$

$$\tau = A + B\ a/c$$
$$\gamma = C + D\ b/c + E\ a/c$$

How the Observer is stand up, and we need to calculate a wall, the values that we need use to calculate the Fp,i are:

F*	A	B	C	D	E
0,120	1,24186	0,16730	0,61648	0,08165	0,05128

And the surfaces are:

SURFACES	(m)
a	0.93
b	2
c	0.8

Then we using the formula we obtain the Fp,I for the surface A in this wall:

$F_{p,i}$	0,06269

For the shape C:

The temperature in this shape is 12,72 ºC , because it's an external wall.

T (ºC)
20

To calculate the Fv, it's necessary apply this formula:

$$Fp,i = F^* \{1 - \exp [- (a/c) / \tau]\}\{1 - \exp [- (b/c) / \gamma]\}$$

$$\tau = A + B\ a/c$$
$$\gamma = C + D\ b/c + E\ a/c$$

How the Observer is stand up, and we need to calculate a wall, the values that we need use to calculate the Fp,i are:

F*	A	B	C	D	E
0,120	1,24186	0,16730	0,61648	0,08165	0,05128

And the surfaces are:

SURFACES	(m)
a	2.45
b	1
c	0.8

Then we using the formula we obtain the Fp,I for the surface A in this wall:

$F_{p,i}$	0,07530

For the shape D:

The temperature in this shape is 12,72 ºC , because it's an external wall.

T (ºC)
20

To calculate the Fv, it's necessary apply this formula:

$$Fp,i = F^* \{1 - \exp [- (a/c) / \tau]\}\{1 - \exp [- (b/c) / \gamma]\}$$

$$\tau = A + B\ a/c$$
$$\gamma = C + D\ b/c + E\ a/c$$

How the Observer is stand up, and we need to calculate a wall, the values that we need use to calculate the Fp,i are:

F*	A	B	C	D	E
0,120	1,24186	0,16730	0,61648	0,08165	0,05128

And the surfaces are:

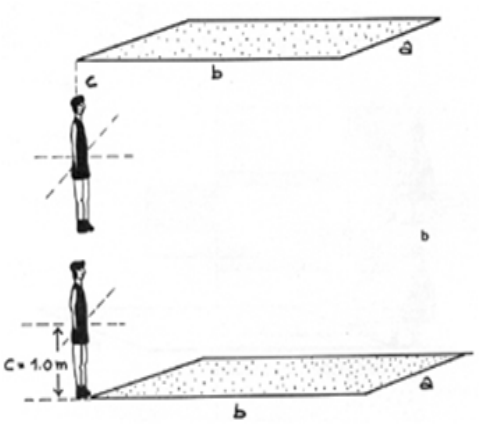
SURFACES	(m)
a	0.93
b	1
c	0.8

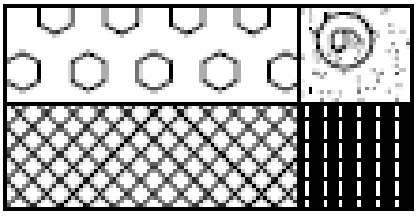
Then we using the formula we obtain the Fp,I for the surface A in this wall:

$F_{p,i}$	0,05322

SHAPES	$F_{p,i}$
B	0,09138
A	0,06269
D	0,07530
C	0,05322
∑=	0,28259

Shape 6: Ceiling.





For the shape A:

The temperature in this shape is 19,26 ºC , because it's an external wall.

T (ºC)
20

To calculate the Fv, it's necessary apply this formula:

$$F_{p,i} = F^* \{1 - \exp [- (a/c) / \tau]\}\{1 - \exp [- (b/c) / \gamma]\}$$

$$\tau = A + B\, a/c$$
$$\gamma = C + D\, b/c + E\, a/c$$

How the Observer is stand up, and we need to calculate a wall, the values that we need use to calculate the Fp,i are:

F*	A	B	C	D	E
0,116	1,59512	0,12788	1,22643	0,04621	0,04434

And the surfaces are:

SURFACES	(m)
a	0.93
b	0.89
c	2

Then we using the formula we obtain the Fp,I for the surface A in this wall:

$F_{p,i}$	0,01717

For the shape B:

The temperature in this shape is 19,26 ºC , because it's an external wall.

T (ºC)
20

To calculate the Fv, it's necessary apply this formula:

$$Fp,i = F^* \{1 - \exp [- (a/c) / \tau]\}\{1 - \exp [- (b/c) / \gamma]\}$$

$$\tau = A + B\ a/c$$
$$\gamma = C + D\ b/c + E\ a/c$$

How the Observer is stand up, and we need to calculate a wall, the values that we need use to calculate the Fp,i are:

F*	A	B	C	D	E
0,116	1,59512	0,12788	1,22643	0,04621	0,04434

And the surfaces are:

SURFACES	(m)
a	2.45
b	0.89
c	2

Then we using the formula we obtain the Fp,I for the surface A in this wall:

$F_{p,i}$	0,03174

For the shape C:

The temperature in this shape is 19,26 ºC , because it's an external wall.

T (ºC)
20

To calculate the Fv, it's necessary apply this formula:

$$Fp,i = F^* \{1 - \exp [- (a/c) / \tau]\}\{1 - \exp [- (b/c) / \gamma]\}$$

$$\tau = A + B\ a/c$$
$$\gamma = C + D\ b/c + E\ a/c$$

How the Observer is stand up, and we need to calculate a wall, the values that we need use to calculate the Fp,i are:

F*	A	B	C	D	E
0,116	1,59512	0,12788	1,22643	0,04621	0,04434

And the surfaces are:

SURFACES	(m)
a	0.93
b	0.8
c	2

Then we using the formula we obtain the Fp,I for the surface A in this wall:

$F_{p,i}$	0,01597

For the shape D:

The temperature in this shape is 19,26 ºC , because it's an external wall.

T (ºC)
20

To calculate the Fv, it's necessary apply this formula:

$$Fp,i = F^* \{1 - \exp [- (a/c) / \tau]\}\{1 - \exp [- (b/c) / \gamma]\}$$

$$\tau = A + B\ a/c$$
$$\gamma = C + D\ b/c + E\ a/c$$

How the Observer is stand up, and we need to calculate a wall, the values that we need use to calculate the Fp,i are:

F*	A	B	C	D	E
0,116	1,59512	0,12788	1,22643	0,04621	0,04434

And the surfaces are:

SURFACES	(m)
a	2.45
b	0.8
c	2

Then we using the formula we obtain the Fp,I for the surface A in this wall:

$F_{p,i}$	0,0246

SHAPES	$F_{p,i}$
A	0,01717
B	0,03174
C	0,01597
D	0,0246
∑=	0,08948

	TEMPERATURE (°C)	Fp,i	MRTp
WALL 1	20	0,2643	5,2
WALL 2	20	0,2024	4,04
WALL 3	12,72	0,06406	0,8008
FLOOR 4	20	0,19971	3,0942
WALL 5	20	0,28259	5,0018
CEILING 6	20	0,08948	1,78

MRT= 19,91 °C

OPERATING TEMPERATURE:

Once MRT is known, it is possible to calculate the "operating temperature", that is a good indicator of thermal comfort.

Top = (DBT + MRT) / 2

Where DBT is the Dry Bulb Temperature and it's 20°C

Top = (20 + 19,91) /2 = 19,9 °C

Top = 19,9 °C 19 °C < Top < 20 °C