"MRT"

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MRT:

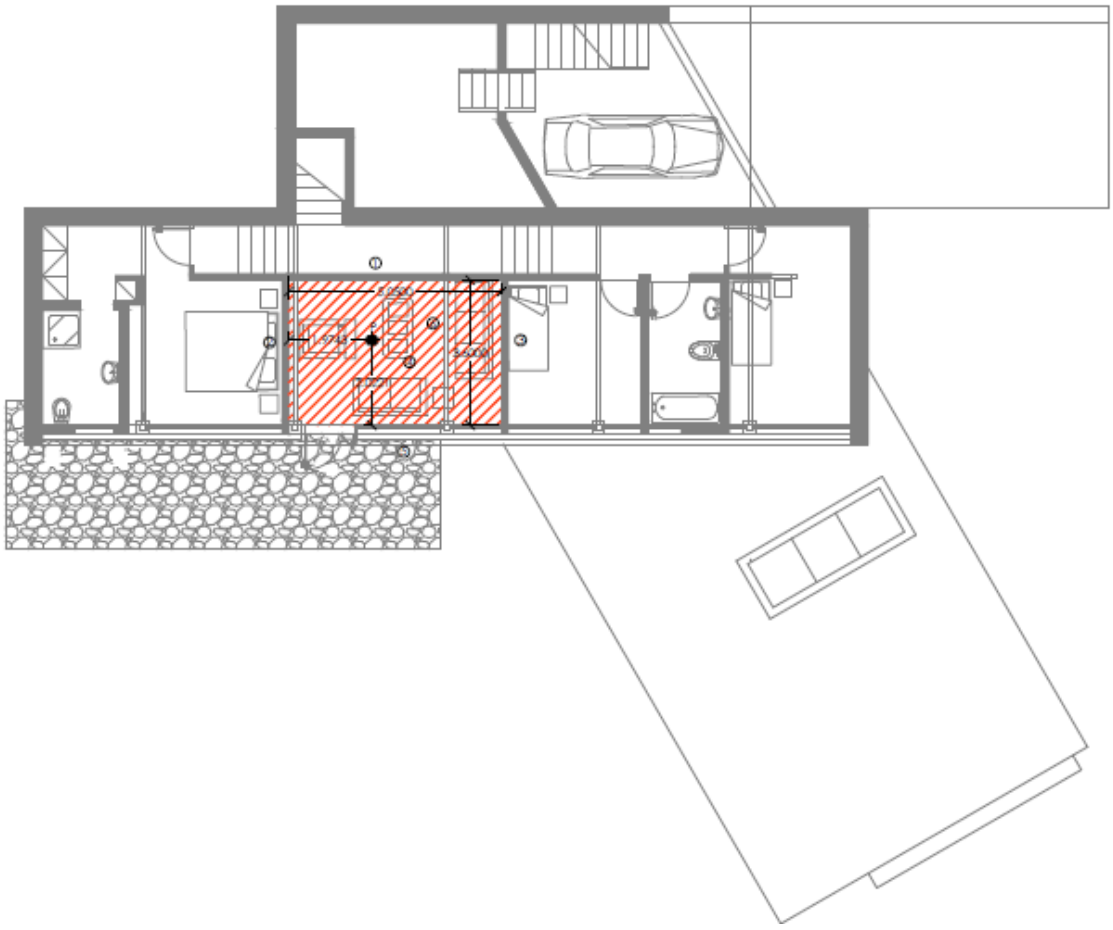
The mean radiant temperature is the total radiation located in one point of a room, it's calculated applying the following formula:

MRT = Σi (tiFv,i)

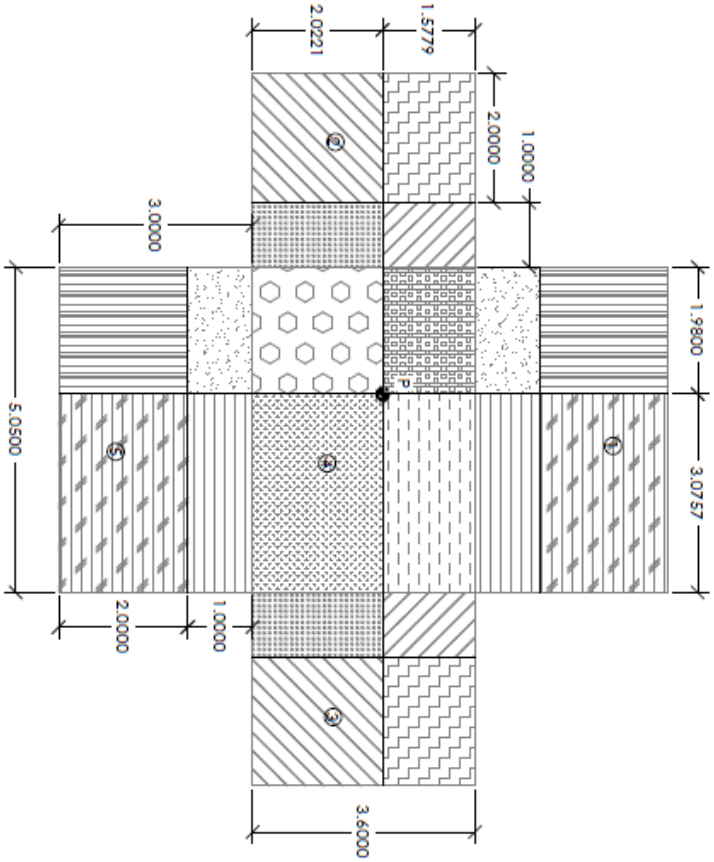
Where:

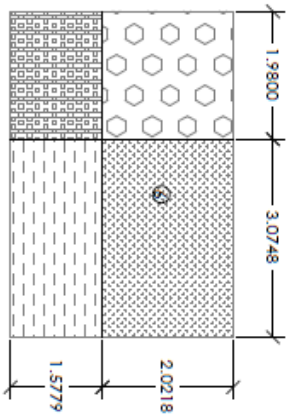
- **ti : are the indoor surface temperatures of the elements enclosing the space.**
- **Fv,i : are the shape factors of the different surfaces from a specific point of the room, and energy leaving the surface a by radiation and reaching the "surface" in P.**

Location of the room:

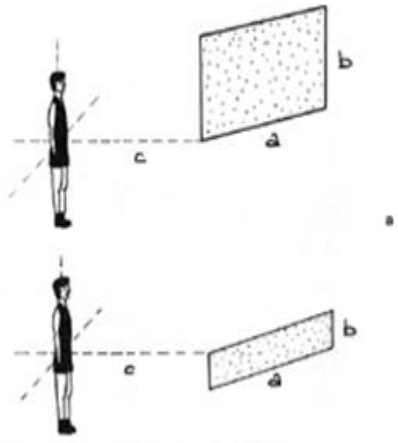


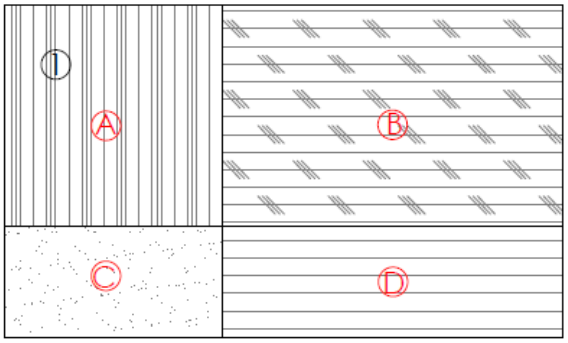
Decomposition of the room:





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	1,98
b	2
c	1,58

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

$F_{p,i}$	0,05558

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	3,07
b	2
c	1,58

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

$F_{p,i}$	0,06708

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	1,98
b	1
c	1,58

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

$F_{p,i}$	0,04015

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:

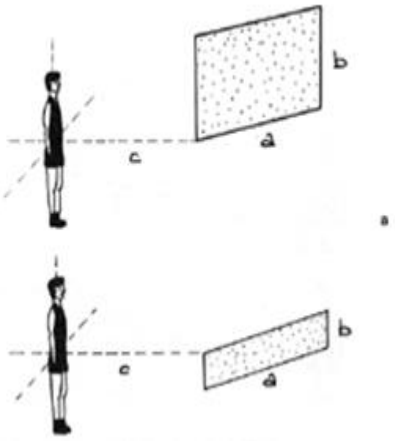
SURFACES	(m)
a	3,07
b	1
c	1,58

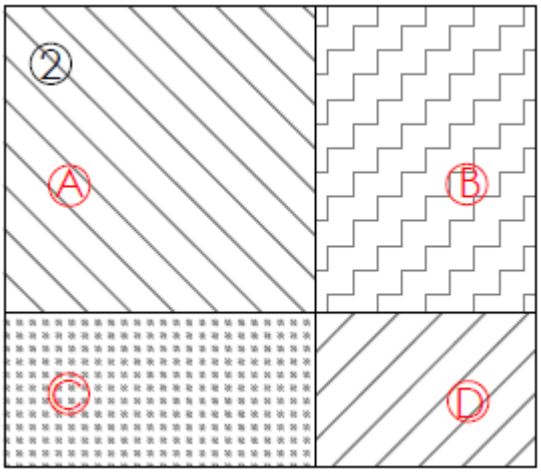
Then we using the formula we obtain the Fp,I for the surface A in this wall:

$F_{p,i}$	0,04788

SHAPES	$F_{p,i}$
A	0,05558
B	0,06708
C	0,04015
D	0,04788
∑=	0,21069

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:

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

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

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	2,02
b	2
c	1,98

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

$F_{p,i}$	0,04563

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	1,58
b	2
c	1,98

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

$F_{p,i}$	0,03934

For the shape C:

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	2,02
b	1
c	1,98

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

$F_{p,i}$	0,03142

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:

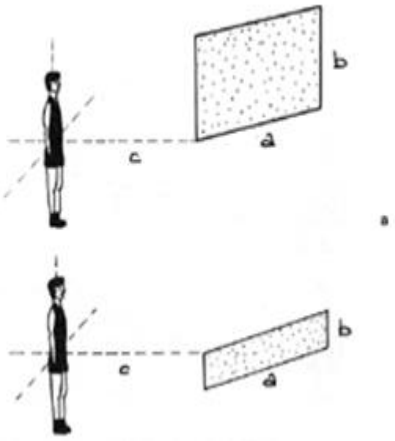
SURFACES	(m)
a	1,58
b	1
c	1,98

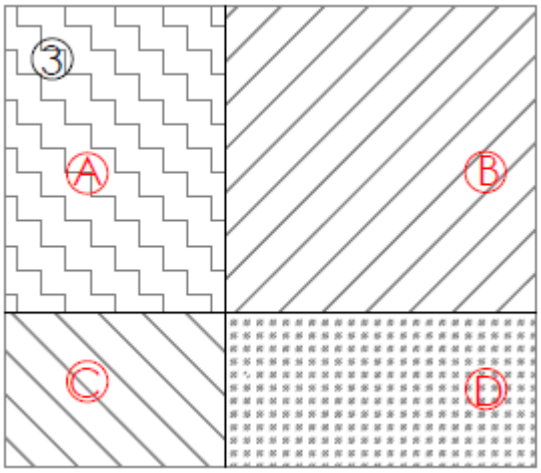
Then we using the formula we obtain the Fp,I for the surface A in this wall:

$F_{p,i}$	0,02719

SHAPES	$F_{p,i}$
A	0,04563
B	0,03934
C	0,03142
D	0,02719
∑=	0,14358

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	1,58
b	2
c	3,07

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

$F_{p,i}$	0,02343

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	2,02
b	2
c	3,07

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

$F_{p,i}$	0,02793

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	1,58
b	1
c	3,07

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

$F_{p,i}$	0,01485

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:

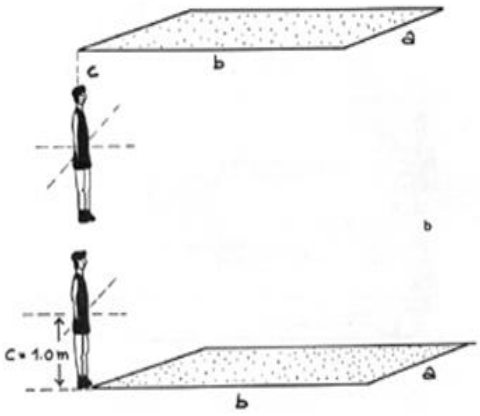
SURFACES	(m)
a	2,02
b	1
c	3,07

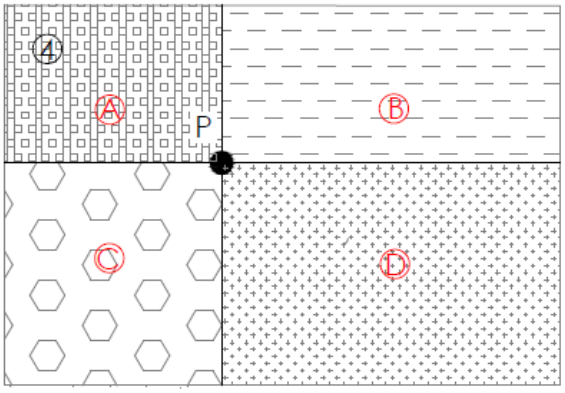
Then we using the formula we obtain the Fp,I for the surface A in this wall:

$F_{p,i}$	0,01766

SHAPES	$F_{p,i}$
A	0,02343
B	0,02793
C	0,01485
D	0,01766
∑=	0,08387

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	1,98
b	1,58
c	1

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

$F_{p,i}$	0,05185

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	3,07
b	1,58
c	1

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

$F_{p,i}$	0,06089

For the shape C:

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
0,116	1,59512	0,12788	1,22643	0,04621	0,04434

And the surfaces are:

SURFACES	(m)
a	1,98
b	2,02
c	1

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

$F_{p,i}$	0,05810

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:

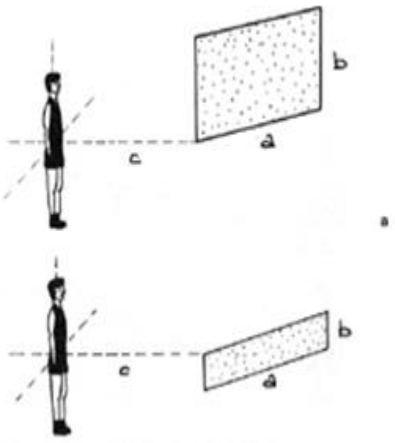
SURFACES	(m)
a	3,07
b	2,02
c	1

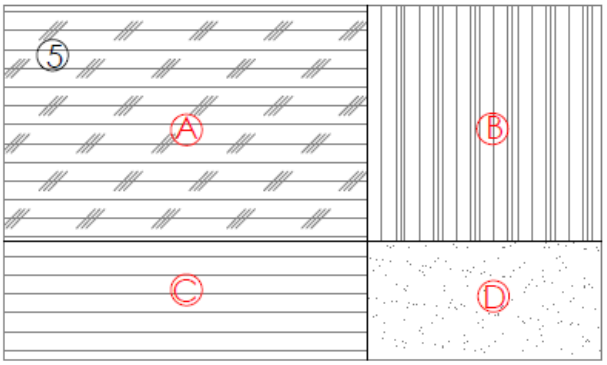
Then we using the formula we obtain the Fp,I for the surface A in this wall:

$F_{p,i}$	0,06846

SHAPES	$F_{p,i}$
A	0,05185
B	0,06089
C	0,05810
D	0,06846
∑=	0,2393

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)
12,72

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	3,07
b	2
c	2,02

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

$F_{p,i}$	0,05520

For the shape B:

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

T (°C)
12,72

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	1,98
b	2
c	2,02

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

$F_{p,i}$	0,04422

For the shape C:

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

T (ºC)
12,72

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	3,07
b	1
c	2,02

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

$F_{p,i}$	0,03752

For the shape D:

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

T (°C)
12,72

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:

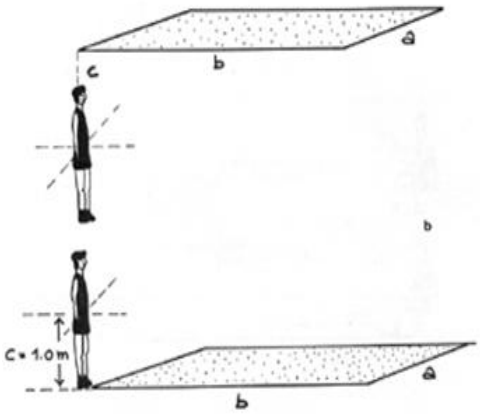
SURFACES	(m)
a	1,98
b	1
c	2,02

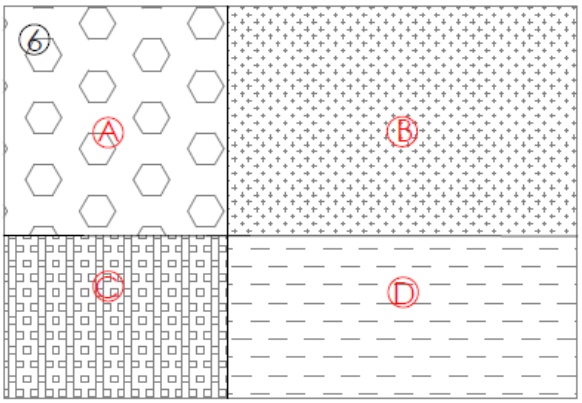
Then we using the formula we obtain the Fp,I for the surface A in this wall:

$F_{p,i}$	0,03033

SHAPES	$F_{p,i}$
B	0,04422
A	0,05520
D	0,03033
C	0,03752
∑=	0,16727

Shape 6: Ceiling.





For the shape A:

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

T (ºC)
19,26

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	1,98
b	2,02
c	2

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

$F_{p,i}$	0,02717

For the shape B:

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

T (ºC)
19,26

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	3,07
b	2,02
c	2

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

$F_{p,i}$	0,03532

For the shape C:

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

T (ºC)
19,26

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	1,98
b	1,58
c	2

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

$F_{p,i}$	0,02301

For the shape D:

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

T (°C)
19,26

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	3,07
b	1,58
c	2

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

$F_{p,i}$	0,02988

SHAPES	$F_{p,i}$
A	0,02717
B	0,03532
C	0,02301
D	0,02988
∑=	0,11538

	TEMPERATURE (°C)	Fp,i	MRTp
WALL 1	20	0,21069	4,2138
WALL 2	20	0,14358	2,8716
WALL 3	20	0,08387	1,6774
FLOOR 4	20	0,2393	4,786
WALL 5	12,72	0,16727	2,1276744
CEILING 6	19,29	0,11538	2,2256802

∑=17,9 °C

MRT= 17,9 °C ≈ 18 °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 + 18) /2 = 19 °C

Top = 19 °C 19 °C < Top < 20 °C