"MRT"

BEDROOM

Alejandro García Aguilera

MRT:

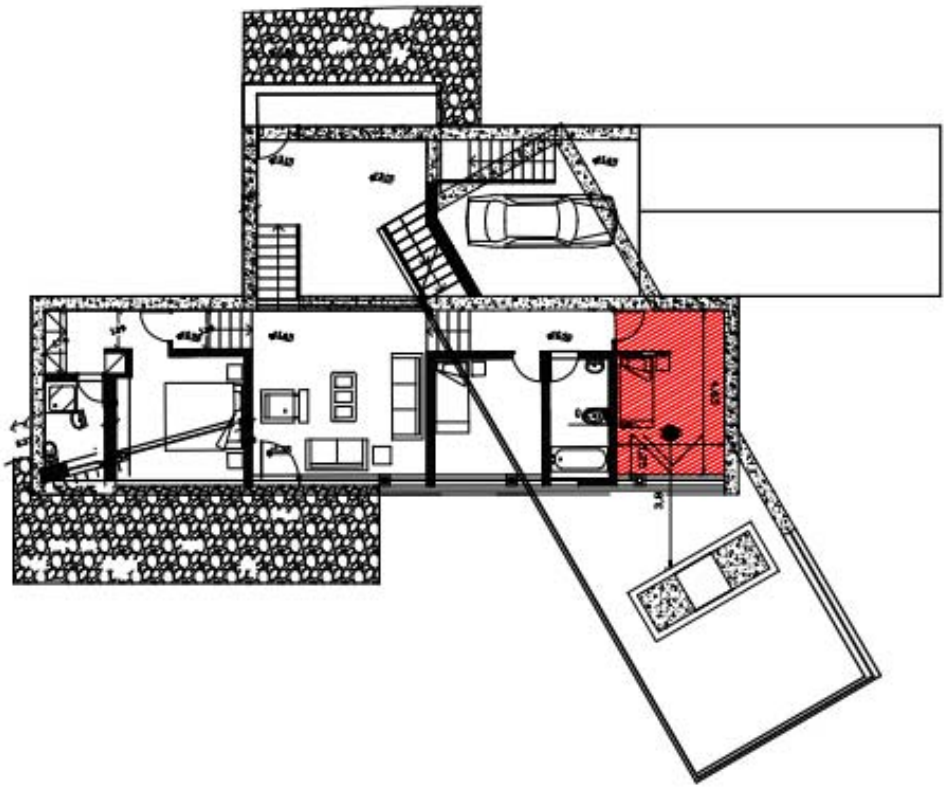
The mean radiant temperature is the total radiation located in one point of a room, it's calculated applying the following formula:

MRT = Σi (tiFv,i)

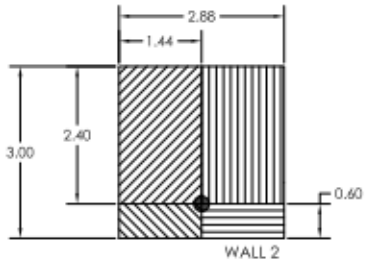
Where:

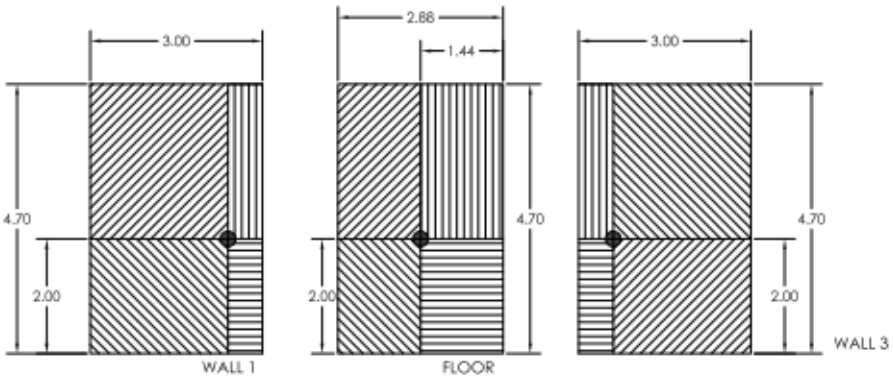
- **ti : are the indoor surface temperatures of the elements enclosing the space.**
- **Fv,i : are the shape factors of the different surfaces from a specific point of the room, and energy leaving the surface a by radiation and reaching the "surface" in P.**
-

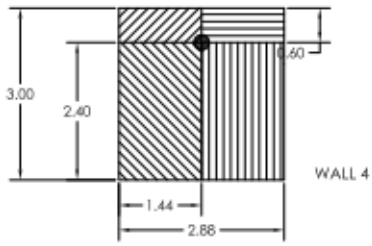
Location of the room:

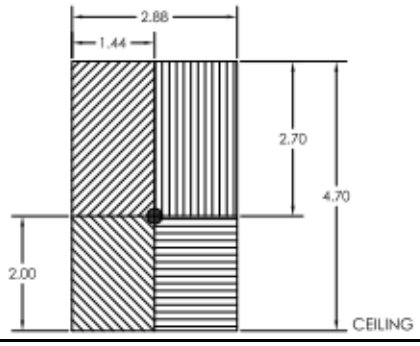


Decomposition of the room:

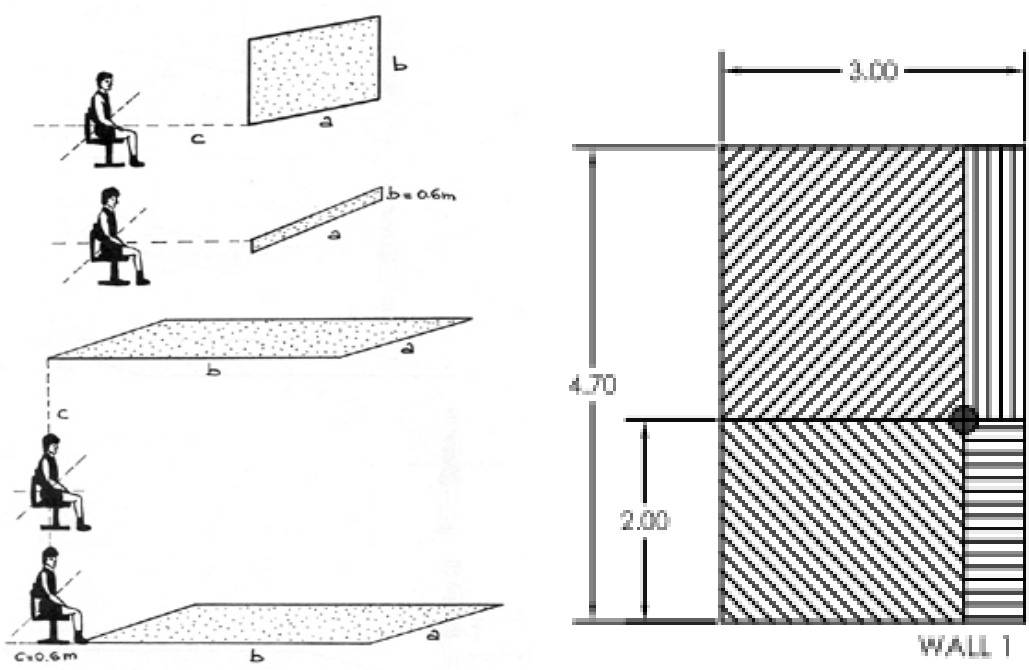








Shape 1: Interior Wall.



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 sitting , 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
0,118	1,2159	0,16890	0,71739	0,08733	0,05267

And the surfaces are:

SURFACES	(m)
a	2,00
b	2,40
c	1,4

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

$F_{p,i}$	0,06047

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
0,118	1,2159	0,16890	0,71739	0,08733	0,05267

And the surfaces are:

SURFACES	(m)
a	2,70
b	2,40
c	1,44

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

$F_{p,i}$	0,06859

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
0,118	1,2159	0,16890	0,71739	0,08733	0,05267

And the surfaces are:

SURFACES	(m)
a	2,00
b	0,60
c	1,44

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

$F_{p,i}$	0,02880

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
0,118	1,2159	0,16890	0,71739	0,08733	0,05267

And the surfaces are:

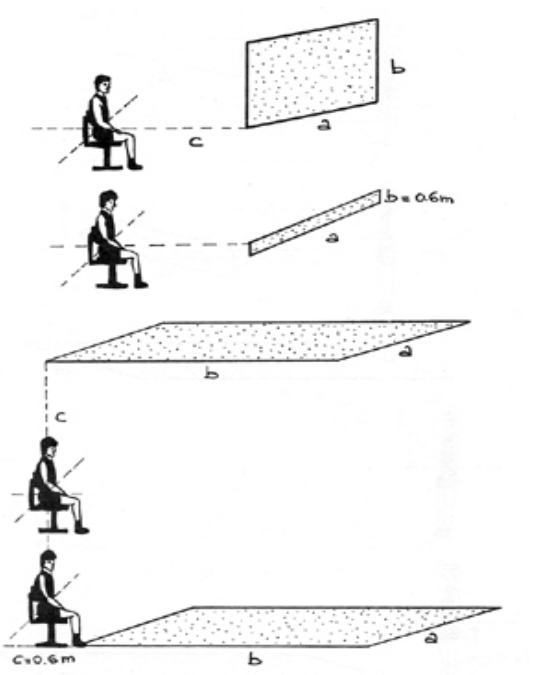
SURFACES	(m)
a	2,70
b	0,60
c	1,44

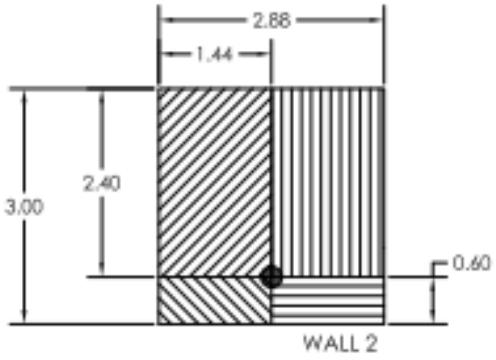
Then we using the formula we obtain the Fp,I for the surface A in this wall:

$F_{p,i}$	0,03222

SHAPES	$F_{p,i}$
A	0,06047
B	0,06859
C	0,02880
D	0,03222
∑=	0,19008

Shape WALL 2:





For the shape A:

The temperature in this shape is 19,04 ºC , because it's an EXTERIOR wall (Stone).

T (ºC)
19,04

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
0,118	1,2159	0,16890	0,71739	0,08733	0,05267

And the surfaces are:

SURFACES	(m)
a	1,44
b	2,40
c	2,70

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

$F_{p,i}$	0,02613

For the shape B:

The temperature in this shape is 19,04 °C , because it's an external wall (stone).

T (°C)
19,04

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
0,118	1,2159	0,16890	0,71739	0,08733	0,05267

And the surfaces are:

SURFACES	(m)
a	1,44
b	2
c	2,70

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

$F_{p,i}$	0,02613

For the shape C:

The temperature in this shape is 19,04 ºC , because it's an external wall (stone).

T (ºC)
19,04

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
0,118	1,2159	0,16890	0,71739	0,08733	0,05267

And the surfaces are:

SURFACES	(m)
a	1,44
b	0,60
c	2,70

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

$F_{p,i}$	0,00998

For the shape D:

The temperature in this shape is 19,04 ºC , because it's an external wall (stone).

T (ºC)
19,04

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
0,118	1,2159	0,16890	0,71739	0,08733	0,05267

And the surfaces are:

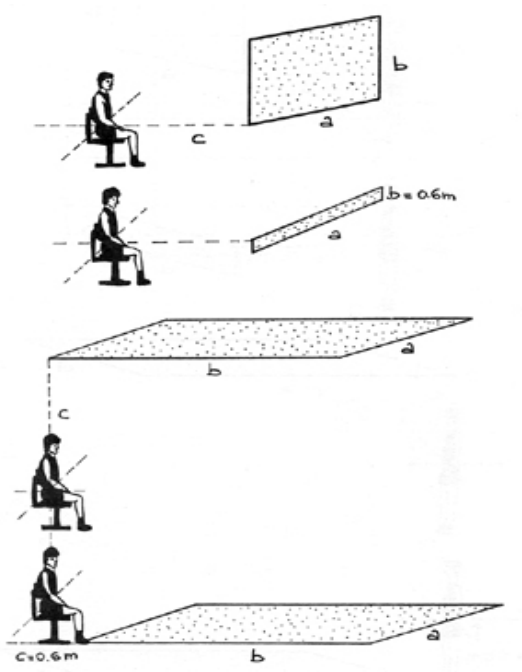
SURFACES	(m)
a	1,44
b	0,60
c	2,70

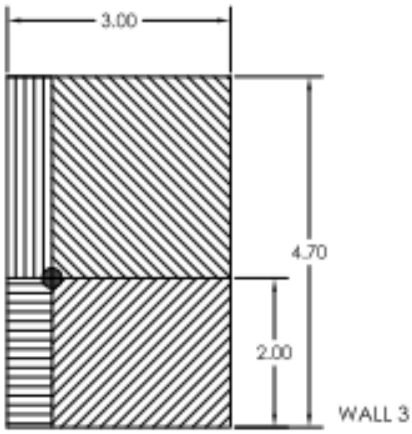
Then we using the formula we obtain the Fp,I for the surface A in this wall:

$F_{p,i}$	0,00998

SHAPES	$F_{p,i}$
A	0,02613
B	0,02613
C	0,00998
D	0,00998
∑=	0,07222

Shape 3: Exterior Wall.





For the shape A:

The temperature in this shape is 19,04 °C , because it's an external wall (stone).

T (°C)
19,04

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
0,118	1,2159	0,16890	0,71739	0,08733	0,05267

And the surfaces are:

SURFACES	(m)
a	2,70
b	2,40
c	1,44

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

$F_{p,i}$	0,06859

For the shape B:

The temperature in this shape is 19,04 ºC , because it's an external wall (stone).

T (ºC)
19,04

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
0,118	1,2159	0,16890	0,71739	0,08733	0,05267

And the surfaces are:

SURFACES	(m)
a	2,00
b	2,40
c	1,44

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

$F_{p,i}$	0,06047

For the shape C:

The temperature in this shape is 19,04°C , because it's an external wall (stone).

T (°C)
19,04

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
0,118	1,2159	0,16890	0,71739	0,08733	0,05267

And the surfaces are:

SURFACES	(m)
a	2,70
b	0,60
C	1,44

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

$F_{p,i}$	0,0322

For the shape D:

The temperature in this shape is 19,04°C , because it's an external wall (stone).

T (°C)
19,04

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
0,118	1,2159	0,16890	0,71739	0,08733	0,05267

And the surfaces are:

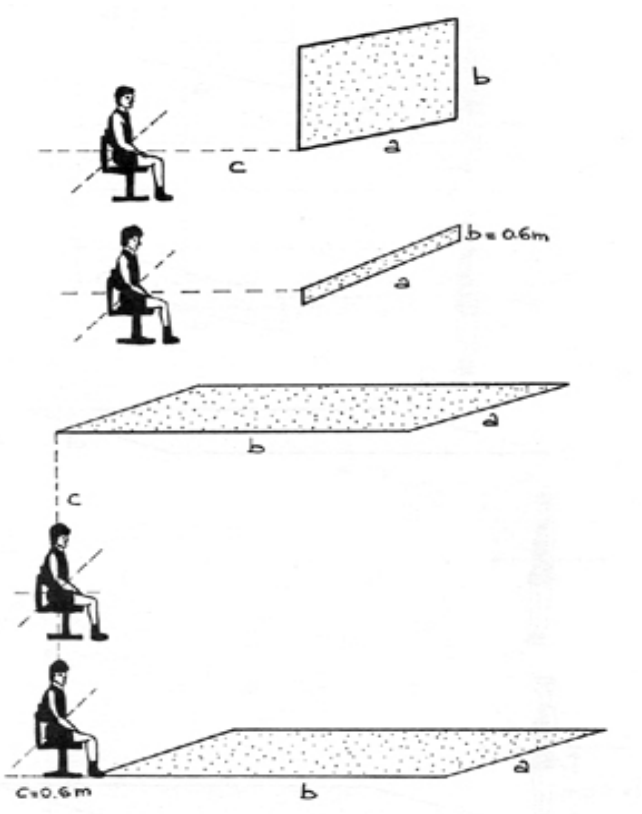
SURFACES	(m)
a	2,70
b	0,60
c	1,44

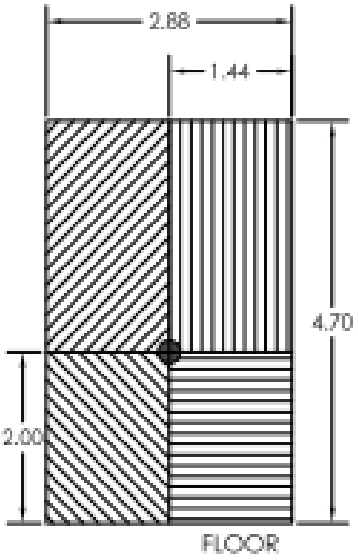
Then we using the formula we obtain the Fp,I for the surface A in this wall:

$F_{p,i}$	0,02880

SHAPES	$F_{p,i}$
A	0,06859
B	0,06047
C	0,0322
D	0,02880
∑=	0,19006

Shape: FLOOR.





For the shape A:

The temperature in this shape is 19,10ºC.

T (ºC)
19,10

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	1,39569	0,01302	0,95093	0,07967	0,05458

And the surfaces are:

SURFACES	(m)
a	1,44
b	2,70
c	0,60

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

$F_{p,i}$	0,09027

For the shape B:

The temperature in this shape is 19,10 ºC .

T (ºC)
19,10

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	1,39569	0,01302	0,95093	0,07967	0,05458

And the surfaces are:

SURFACES	(m)
a	1,44
b	2,70
c	0,60

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

$F_{p,i}$	0,09027

For the shape C:

The temperature in this shape is 19,10ºC.

T (ºC)
19,10

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	1,39569	0,01302	0,95093	0,07967	0,05458

And the surfaces are:

SURFACES	(m)
a	1,44
b	2,00
c	0,60

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

$F_{p,i}$	0,08647

For the shape D:

The temperature in this shape is 19,10ºC.

T (ºC)
19,10

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	1,39569	0,01302	0,95093	0,07967	0,05458

And the surfaces are:

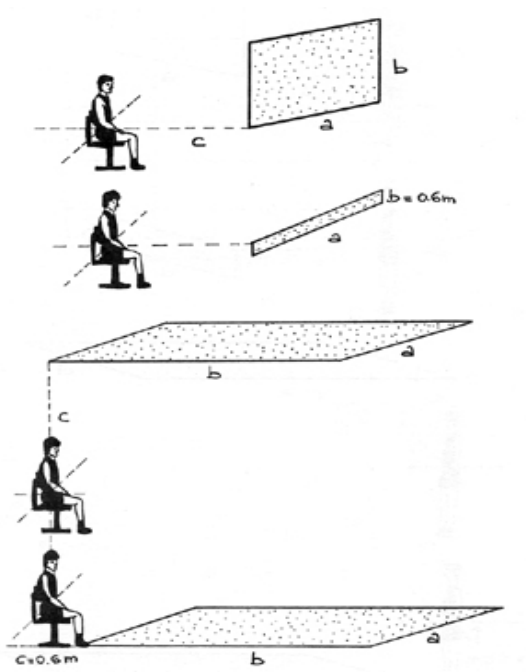
SURFACES	(m)
a	1,44
b	2,00
c	0,60

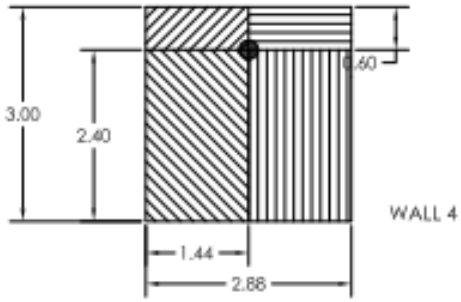
Then we using the formula we obtain the Fp,I for the surface A in this wall:

$F_{p,i}$	0,08647

SHAPES	$F_{p,i}$
A	0,09027
B	0,09027
C	0,08647
D	0,08647
∑=	0,35348

Shape 4: 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:

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

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

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
0,118	1,2159	0,16890	0,71739	0,08733	0,05267

And the surfaces are:

SURFACES	(m)
a	1,44
b	2,40
c	2,00

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

$F_{p,i}$	0,03696

For the shape B:

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) / τ]}{1 – exp [- (b/c) / γ]}

τ = A + B a/c
γ = 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
0,118	1,2159	0,16890	0,71739	0,08733	0,05267

And the surfaces are:

SURFACES	(m)
a	1,44
b	2,40
c	2,00

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

$F_{p,i}$	0,03696

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
0,118	1,2159	0,16890	0,71739	0,08733	0,05267

And the surfaces are:

SURFACES	(m)
a	1,44
b	0,60
c	2,00

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

$F_{p,i}$	0,01566

For the shape D:

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
0,118	1,2159	0,16890	0,71739	0,08733	0,05267

And the surfaces are:

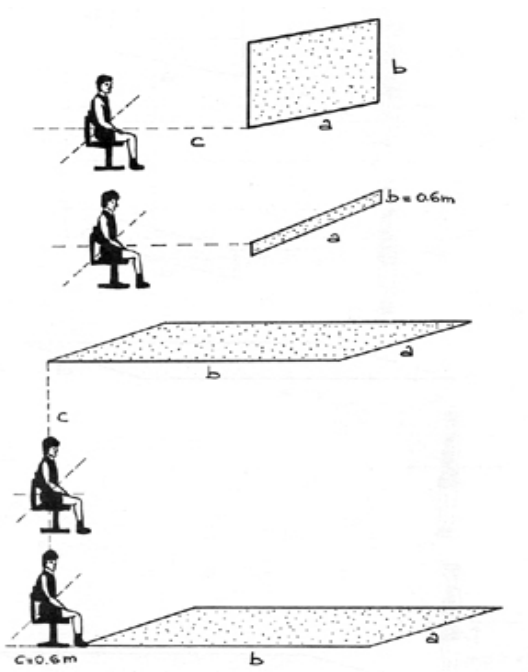
SURFACES	(m)
a	1,44
b	0,60
c	2,00

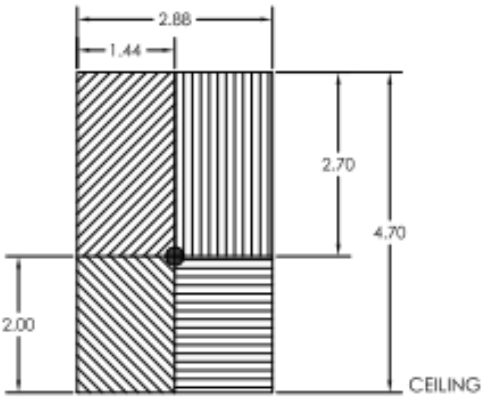
Then we using the formula we obtain the Fp,I for the surface A in this wall:

$F_{p,i}$	0,01566

SHAPES	$F_{p,i}$
B	0,03696
A	0,03696
D	0,01566
C	0,01566
∑=	0,10524

Shape: Ceiling.





For the shape A:

The temperature in this shape is 19,49 ºC.

T (ºC)
19,49

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	1,39569	0,01302	0,95093	0,07967	0,05458

And the surfaces are:

SURFACES	(m)
a	1,44
b	2,70
c	2,40

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

$F_{p,i}$	0,02621

For the shape B:

The temperature in this shape is 19,49 °C.

T (°C)
19,49

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	1,39569	0,01302	0,95093	0,07967	0,05458

And the surfaces are:

SURFACES	(m)
a	1,44
b	2,70
c	2,40

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

$F_{p,i}$	0,02621

For the shape C:

The temperature in this shape is 19,49 ºC.

T (ºC)
19,49

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	1,39569	0,01302	0,95093	0,07967	0,05458

And the surfaces are:

SURFACES	(m)
a	1,44
b	2,00
c	2,40

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

$F_{p,i}$	0,02210

For the shape D:

The temperature in this shape is 19,49 °C.

T (°C)
19,49

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	1,39569	0,01302	0,95093	0,07967	0,05458

And the surfaces are:

SURFACES	(m)
a	1,44
b	2,00
c	2,40

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

$F_{p,i}$	0,002210

SHAPES	$F_{p,i}$
A	0,02621
B	0,02621
C	0,002210
D	0,002210
∑=	0,09662

	TEMPERATURE (°C)	Fp,i	MRTp
WALL 1	20	0,19008	3,80
WALL 2	19,40	0,07222	1,375
WALL 3	19,04	0,19006	3,618
WALL 4	12,72	0,10524	1,3386
FLOOR	19,10	0,35348	6,7514
CEILING	19,49	0,09662	1,8831

∑=18,76°C

MRT= 18,76 °C

<u>OPERATING TEMPERATURE:</u>

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 + 18,76) /2 = 19,38 °C

Top = 19,38 °C 19 °C < Top < 20 °C