Chapter 12

Grouted Rat-trap bond Masonry infilled RC frames with Horizontal and Vertical Reinforcement (GRTIB):

12.1 Introduction:

In this study the behavior of grouted rat-trap masonry with horizontal and vertical reinforcement is studied. The behavior is compared with bare RC frame, plain masonry infilled RC frame, GRTI, GRIH and GRTIV. The table no.12.1 shows the nomenclature of the models studied. Fig.12.1 shows the typical descritized model.

<table>
<thead>
<tr>
<th>Sr No</th>
<th>Model No</th>
<th>Aspect Ratio</th>
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<tbody>
<tr>
<td>1</td>
<td>GRTIV4203</td>
<td>1.23</td>
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<tr>
<td>2</td>
<td>GRTIV4523</td>
<td>1.41</td>
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<tr>
<td>3</td>
<td>GRTIV5023</td>
<td>1.60</td>
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![Fig.12.1: Typical Descritized Model](image)

12.2 Natural frequency:

Ten modal frequencies are captured. It is observed that the natural frequency has increased as the aspect ration increases. The variation in the natural frequency with the aspect ratio is shown in the fig.12.2 and the typical mode shapes are shown in fig.12.3.

![Fig.12.2: Natural frequency](image)
Grouted Rat-trap bond masonry infilled RC frames with Horizontal & Vertical Reinforcement

Mode 1

Mode 2

Mode 3

Mode 4

Mode 5

Mode 6

Aspect Ratio 1.60, masonry with horizontal and vertical reinforcement

Fig. 12.3: Modal Shapes of Reinforced rat-trap Bond Masonry infilled RC frames
12.3 Stiffness:

The typical deflection contours are presented in fig. 12.4. The variation of components of deflection for different aspect ratio is presented in Fig. 12.5.

12.3.1 Deflection:

**Load case 1:** Grouted rat-trap bond masonry infilled RC frames with horizontal and vertical reinforcement showed an improved resistance towards the lateral sway when compared to the other infills. The X-component of deflection reduces as aspect ratio increases and reduction varies from 18.68% to 32.13%. In case of Y-component the reduction varies from 10.78% to 19.33%. The Z-component of deflection is almost negligible.

When compared to bare RC frame the X-component of deflection reduces and the reduction varies from 73.73% to 76.64%. The increase in deflection in the Y-component varies from 0.93% to 14.46%.

When compared to plain masonry infilled RC frame the deflection has reduced in all the three components. In the X-component the reduction in deflection varies from 28.02% to 34.21%. Similarly in case of Y-component the reduction varies from 11.51% to 12.14%.

It is observed that, the deflection has reduced in all the three components and the higher reduction is observed in case of X-component and it varies from 11.44% to 14.00% when compared with GRTI.

When compared to GRTIH, marginal reduction in deflection is observed in the X-component and it varies from 7.31% to 8.16%. In case of Y-component the reduction varies from 3.55% to 4.38%. In other two components it is negligible.

When compared with GRTIV the deflection has reduced in the X and Y-component and the reduction in X-component varies from 5.39% to 6.28%. Similarly the reduction in the Y-component varies from 3.12% to 3.23%.

**Load case 2:** In this case the X-component of deflection reduces and the reduction varies from 18.67% to 32.13%. Reduction is also noticed in the Y-component. The Z-component of deflection is almost negligible.

When compared to bare RC frame, the deflection has reduced in X-component and the reduction varies from 73.71% to 76.63%. In case of the Y-component of
Grouted Rat-trap bond masonry infilled RC frames with Horizontal & Vertical Reinforcement

deflection the reduction varies from 1.07% to 14.78%. Higher reduction is noticed in case of the frames with aspect ratio 1.23.

When compared to plain masonry infilled RC frame, it is observed that the deflection reduces in all the three components. The reduction in deflection in X-component varies from 28.08% to 33.73% and in case of Y-component the reduction is around 11.5%.

When compared to GRTI, the deflection has reduced in all the three components and the reduction varies from 11.62% to 14.09% in the X-component. The reduction in the Y-component varies from 5.45% to 6.21%.

When compared to GRTIH, the reduction of deflection in the X-component varies from 7.30% to 8.9% and the reduction varies from 4.3% to 4.50% in case of Y-component.

When compared with GRTIV the reduction is noticed in X and Y-component and varies from 5.40% to 6.5% and it varies from 3.19% to 3.24% in the Y-component.

**Load case 3:** In this case the maximum deflection is noticed in the X-component. The deflection varies from 0.070 to 36.824 mm. In case of Y-component the deflections are less than 6.5 mm and the deflection in Z-component is almost negligible. The deflection has increased when compared to load case 1 and load case 2 to a larger extent.

When compared to bare RC frame, the deflection has reduced predominantly in the X-component and it varies from 77.26% to 79.98%. Marginal variation is noticed in the Y-component.

When compared to plain masonry infilled RC frame, the deflection has reduced in all the three components and the reduction in deflection varies from 30.45% to 36.45% in the X-component and 14.53% to 15.89% in the Y-component.

When compared to GRTI, the reduction in deflection is noticed in all the three components. The reduction in X-component varies from 12.71% to 15.58% and it varies from 7.28% to 8.03% in the Y-component.

When compared to GRTIH, marginal reduction is observed in X and Y-components. The reduction in X-component of deflection varies from 8.0% to 8.92% and reduction varies from 4.93% to 5.35% in case of Y-component.
Grouted Rat-trap bond masonry infilled RC frames with Horizontal & Vertical Reinforcement

The maximum deflection in the X-component is located at the top right hand corner in the frame, whereas the maximum deflection in the Y-component is located in the top floor right corner.

![Deflection Contours of Reinforced rat-trap Bond Masonry infilled RC frames](image)

Zone 4

Zone 5

Kobe

MX : Maximum deflection; MN = Minimum deflection

(a) X- Component  
(b) Y-Component

Aspect Ratio: 1.23, Masonry with Horizontal and Vertical Reinforcement

Fig. 12.4: Deflection Contours of Reinforced rat-trap Bond Masonry infilled RC frames
12.4 Stresses:

The variation of the stresses for different aspect ratios and load cases is studied.

12.4.1 Normal stresses:

The typical contours and the variation of stresses is shown in figure 12.6, 12.7 & 12.8.

Load case 1:

a) *RC frame:* The stresses in the frame vary from 1.110 to 7.550 N/mm². In case of X-component the stresses decrease and decrease in stresses varies from 3.39% to 13.20%. The Y-components of stresses are higher when compared to X-component and the stresses reduced as the aspect ratio increased. The Z-components of stresses are less than 1.5 N/mm².

b) *Masonry:* Masonry stresses vary from 0.049 to 0.586 N/mm². The stresses are higher in the Y-component. The stresses are almost negligible in the Z-component.
Grouted Rat-trap bond masonry infilled RC frames with Horizontal & Vertical Reinforcement

Zone 4

Zone 5

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MX : Maximum stress; MN = Minimum stress

(a) infilled RC frame (IFF) (b) Masonry (MS)

Aspect Ratio: 1.23, Masonry with Horizontal and Vertical Reinforcement

Fig. 12.6: Normal Stress Contours of Reinforced rat-trap Bond Masonry infilled RC frames (X-Component)

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Zone 4

Kobe
MX: Maximum stress; MN = Minimum stress
(a) infilled RC frame (IFF) (b) Masonry (MS)
Aspect Ratio: 1.23, Masonry with Horizontal and Vertical Reinforcement

Fig. 12.7: Normal Stress Contours of Reinforced rat-trap Bond Masonry infilled RC frames (Y-Component)
When compared to bare RC frame, the stresses in the frame have reduced in the X-component and reduction varies from 62.51% to 71.74%. The stresses in the frame have increased in the Y and Z-component.

When compared with plain masonry infilled RC frame, it is observed that the stresses in the frame have reduced in all the three components. A higher reduction was observed in the X-component and it varies from 22.42% to 23.58%. In case of the masonry stresses, higher increase is observed in the Y-component and the increase varies from 1.50 to 1.58 times. In the X-component the increase in masonry stresses varies from 37.34% to 68.65%.

When compared with GRTI, the stresses in the frame decrease in all the three components. The reduction in stresses in the X-component varies from 8.89% to 9.80%. The masonry stresses have increased in all the three components. Higher increase is noticed in case of Y-component and it varies from 44.22% to 46.51%. In the X-component the increase in stress varies from 18.75% to 56.94%.

When compared with GRTIH, the reduction in the stresses of the frame is observed in all the three components. The reduction in the Y-component varies from 1.17% to 2.22% whereas in case of X-component the reduction varies from 6.9% to 7.25%. The masonry stresses have increased in all the components and the increase varies from 38.94% to 50.55%. The variation is almost negligible in case of other two components. In case of Y and Z-component the reduction is around 2%.

When compared with GRTIV, the stresses in the masonry have reduced in all the three components. In the X-component the reduction of stress varies from 4.83% to 5.35%. In the other two components the reduction is around 1.5%. In case of masonry stresses the stresses have increased in all the three components and it is observed that the increase in stress varies from 12.87% to 34.69% in case of X-component and it varies from 12.77% to 20.26% in case of Y-component.

Load case 2:

a) RC frame: In this case the stresses in the frame vary from 1.680 to 11.400 N/mm². In this case also the stresses in the Y-component are higher. The stresses reduce as the aspect ratio increases.
Grouted Rat-trap bond masonry infilled RC frames with Horizontal & Vertical Reinforcement

b) Masonry: The masonry stresses vary from 0.074 to 0.888 N/mm². The masonry stresses are higher in case of Y-component. The stresses reduce as the aspect ratio increases. The masonry stresses in the Z-component are almost negligible.

When compared to bare RC frame, the stresses in the X-component decrease and the percentage decrease varies from 62.69% to 71.76%. In the case of the Y-component of stresses the increase varies from 24.64% to 36.82%.

When compared to plain masonry infilled RC frame the stresses in the frame have reduced in all the three components. The higher reduction is observed in case of X-component and it varies from 22.40% to 23.68%. Masonry stresses have increased in the Y-component and increase varies 1.50 to 1.6 times. Masonry stresses of X-component have increased and the percentage increase varies from 38.40% to 69.30%.

When compared with GRT1, the stresses in the frame have reduced in all the three components. Higher reduction is observed in the X-component and it varies from 8.70% to 9.84%. Increase in masonry stresses is noticed in all the three components and in case of Y-component the increase varies from 43.7% to 46.34% and in case of X-component the increase varies from 19.31% to 58.33%.

When compared to GRT1H, the stresses in the frame have reduced and the reduction in the X-component varies from 6.7% to 7.2% and the reduction in Y-component varies from 1.72% to 2.14%. The masonry stresses have increased in all the components. In the X-component the increase in stress varies from 15.33% to 51.32% and it varies from 24% to 26.07% in case of the Y-component.

When compared with GRTIV the stresses in the frame have reduced in all the components. The stresses have predominantly reduced in the X-component and reduction varies from 4.90% to 5.42%. The masonry stresses have also increased in the three components. Higher increase is noticed in case of X-component and the increase varies from 13.81% to 35.13%.

Load case 3:

a) RC frame: In this case stresses in the frame vary from 4.480 to 31.600 N/mm². In this case also Y-component stresses are higher. In all the three components the stresses reduce as the aspect ratio increases.
b) Masonry: The stresses in the masonry are predominant in the Y-component and they vary from 1.870 to 2.46 N/mm².

When compared to bare RC frame the stresses in the frame reduce in the X-component and the reduction varies from 67.69% to 75.52%. In the other two components also the stresses have increased.

When compared to plain masonry infilled RC frame the stresses in the frame have decreased in all the three components. Higher decrease is observed in case of X-component and the decrease varies from 25.53% to 27.00%. The stresses in masonry have increased and the percentage increase is higher in case of Y-component and the increase varies from 1.40 to 1.47 times. In the other two components the increase in the masonry stress varies from 33.52% to 58.90%.

When compared to GRTI, the stresses in the frame have reduced in all the three components. The maximum reduction is noticed in case of X-component and it varies from 10.25% to 10.86%. In the other two components the reduction is less than 5%. The masonry stresses have increased in all the three components. In the X-component the increase varies from 18.09% to 55.78%. It is noticed that the increase in stresses are higher in the Y-component and it varies from 41.89% to 44.70%.

When compared to GRTIH the stresses in the frame have reduced in all the three components. The reduction varies from 7.89% to 8.21% in the X-component and it is less than 3.6% in the other two components. The masonry stresses have increased and the higher increase is observed in case of X-component and it varies from 14.35% to 50.16%. In case of the Y-component the stresses increased and the increase varies from 22.80% to 24.87%.

When compared with GRTIV the stresses in the frame have reduced in all the three components. The reduction in the X-component varies from 5.40 to 5.88% and in case of Y-component the reduction varies from 1.55% to 2.54%. The masonry stresses have increased in all the three components in the X-component the increase varies from 13.25% to 34.87% and in case of Y-component the stresses increase and the increase varies from 16.66% to 19.10%.

The maximum normal stress in X-component is located at bottom right corner of the frame, whereas the masonry stress is maximum in the bottom infill panel.
12.4.2 Principal stresses:

The typical contours and the variation of stresses is shown in figure 12.9, 12.10 & 12.11.

Load case 1:

a) RC frame: The stresses in the frame vary from 0.75 to 7.62 N/mm². The maximum stresses are noticed in the first principal stress. The reduction in the first principal stress is noticed as the aspect ratio increases. The similar reduction is also noticed in the second principal and the third principal stress.

b) Masonry: The masonry stresses vary from 0.013 to 0.65 N/mm². The second and third principal stresses in the masonry are almost negligible. The masonry stresses are higher in case of the first principal stresses and they vary from 0.53 to 0.65 N/mm².

When compared to bare RC frame, the principal stresses decrease in the first principal plane and second principal plane and the stresses increase in the third principal plane. A decrease of 20.04% is observed in case of first principal stress for aspect ratio 1.23. In case of second principal stress the stresses decrease and the decrease varies from
Grouted Rat-trap bond masonry infilled RC frames with Horizontal & Vertical Reinforcement

32.87% to 57.47%. The increase in the stress in the third principal plane varies from 20.12% to 50.17%.

When compared to plain masonry infilled RC frame, the principal stresses decrease in all the three planes. The maximum reduction is observed in the second principal stresses and it varies from 14.85% to 19.45%. Similarly it is noticed that the stresses in the masonry have increased in all the three planes. The increase in first principal stress varies from 117.07% to 125.43%. In case of Y-component the increase in masonry stresses varies from 50.55% to 58.06%.

Variation is also observed when the stresses are compared with GRTI. The stresses in the frame have reduced in the first principal plane and second principal plane. The predominant stress reduction is noticed in second principal plane and the reduction varies from 5.09% to 9.37%. In case of masonry stresses the stresses have increased in all the planes. In case of first principal stress the increase in stress varies from 40.89% to 42.91% and in case of second principal stress the increase varies from 5.66% to 7.01%.

When compared with GRTIH, marginal variation is noticed in all the three planes. These stresses have reduced in all the planes and predominant reduction is noticed in the second principal stress and it varies from 3.87% to 7.05%. The stresses in the masonry have also varied and the stresses in first principal plane have increased and increase in stresses varies from 23.12% to 24.71%.

When compared with GRTIV the stresses in the frame have reduced in all the components, higher reduction is noticed in case of second principal stress. The reduction varies from 1.32% to 5.22%. In case of masonry stresses the stresses have increased in all the planes. Higher increase is noticed in the first principal stress and it varies from 17.03% to 18.40%.

Load case 2:

a) RC frame: The stresses in the frame vary from 1.150 to 11.500 N/mm². Higher stresses in the frame are observed in the first principal plane. The masonry stresses are higher in the first principal plane.

b) Masonry: The masonry stresses are almost negligible in the second principal plane and third principal plane.
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When compared to bare RC frame, the variation is almost similar to the variation observed in load case 1. The stresses have decreased in all the three planes. The stresses have decreased in the first and second principal plane, whereas the stresses have increased in third principal plane. The decrease in stress in the second principal stress varies from 32.72% to 57.53%.

When compared to plain masonry infilled RC frame, the stresses in the frame have reduced in all the three planes and the reduction in the second principal plane varies from 15.09% to 19.29%. The masonry stresses have also increased in the first principal plane, the increase in masonry stresses varies from 1.17 to 1.24 times.

When compared to GRTI, the stresses in the frame have reduced in the first principal plane and second principal plane, whereas increase is observed in case of the third principal plane. The stresses in the second principal plane decrease and it varies from 5.46% to 9.09%. The decrease is lower in case of frames with aspect ratio 1.41 and it is higher in the other two aspect ratios. The masonry stresses have increased and the percentage increase in the first principal plane varies from 40.88% to 42.81%.

Variation is also observed when the stresses are compared with GRTIH. The stresses have reduced in the frame in all the three principal planes. The maximum reduction is noticed in the second principal stress and it varies from 3.84% to 7.17%. The masonry stresses increase predominantly in the first principal plane and the increase varies from 23.24% to 24.71%.

When compared with GRTIV the stresses in the frame have reduced in all the planes. The predominant reduction is noticed in the second principal stress and the reduction varies from 1.74% to 4.76%. The masonry stresses have increased in all the three planes. The increase in the first principal stress varies from 16.97% to 18.42%.

Load case 3:

a) RC frame: The principal stresses in the frame vary from 3.05 to 31.90 N/mm². The stresses have increased when compared to load case 1 and load case 2.

b) Masonry: The masonry stresses vary from 0.05 to 2.75 N/mm². Higher stresses are observed in the first principal plane. The stresses reduce as the aspect ratio increases. The masonry stresses are negligible in the third principal stress.
When compared to bare RC frame the stresses in the frame have reduced in the first principal plane and second principal plane, whereas they have increased in third principal plane. In the first principal stress the decrease in stress varies from 16.56% to 30.80% whereas in case of second principal stress, the decrease varies from 42.64% to 63.18%.

Fig. 12.9: Principal Stress Contours of Reinforced rat-trap Bond Masonry infilled RC frames (1st Principal Stress)
Grouted Rat-trap bond masonry infilled RC frames with Horizontal & Vertical Reinforcement

Zone 4

Kobe
MX : Maximum stress; MN = Minimum stress
(a) infilled RC frame (IFF) (b) Masonry (MS)
Aspect Ratio: 1.23, Masonry with Horizontal and Vertical Reinforcement

Fig. 12.10: Principal Stress Contours of Reinforced rat-trap Bond Masonry infilled RC frames (2nd Principal Stress)

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Grouted Rat-trap bond masonry infilled RC frames with Horizontal & Vertical Reinforcement

When compared to plain masonry infilled RC frame the stresses in the frame have reduced in all the three planes. The reduction in the first principal and second principal stress varies from 9.63% to 22.45%. The masonry stresses have increased in all the three principal planes. The increase in the first principal stress varies from 1.07 to 1.18 times. The stresses in the second principal plane have also increased and the increase varies from 48.38% to 52.30%.

When compared to GRTI marginal reduction in the stresses of the frame is noticed in the first principal and second principal planes. The masonry stresses have increased in all the three principal planes and the predominant increase is noticed in the first principal stress and it varies from 38.46% to 41.02%.

When compared with GRTIH the stresses in the frame have reduced in all the three principal planes. The higher reduction is noticed in case of second principal stress and it varies from 4.68% to 8.30%. The stresses in the masonry have increased marginally. Higher increase is noticed in case of first principal stress and the increase varies from 22.11% to 23.87%.
Grouted Rat-trap bond masonry infilled RC frames with Horizontal & Vertical Reinforcement

When compared with GRTIV the stresses in the frame have reduced in all the principal planes and the predominant reduction is noticed in the second principal stress and the reduction varies from 2.39% to 5.64%. The masonry stresses have increased in all the three planes, higher increase is noticed in the first principal stress and the increase varies from 16.26% to 17.39%.

The first principal stress is maximum in the right bottom corner at support, whereas the maximum principal stresses in the masonry is located at the bottom right corner of the ground floor infill panel.

12.4.3 Shear stresses:

The typical contours and the variation of stresses is shown in figure 12.12, 12.13 & 12.14.

Load case 1:

a) RC frame: The stresses in the frame vary from 0.067 to 1.050 N/mm². Higher stresses were observed in the XY plane. The stresses reduce as the aspect ratio increase in all the three planes.

b) Masonry: The masonry stresses are almost negligible in YZ and XZ planes. In case of XY plane the stresses vary from 0.23 to 0.26 N/mm².

When compared with bare RC frame the stresses in the frame have reduced in the XY plane and XZ plane and stresses have increase in the YZ plane and increase varies from 24.0 to 51.38%.

When compared with plain masonry infilled RC frame the stresses in the frame have shown mixed response. In case of frames with aspect ratio 1.23 the decrease in stresses is around 13.23%, whereas in case of aspect ratio 1.41 the increase in stress is around 21.27%. The marginal variation is observed in case of frames with aspect ratio 1.60. The increase in frame stresses is varies from 44.44% to 47.29% in case of the YZ plane. The masonry stresses also have increased in all the three planes. The stresses in the masonry have increased predominantly in the XY plane and decrease varies from 42.68% to 49.71%.

When compared with GRTI the stresses in the frame have reduced in all the three planes, but the reduction is higher in YZ plane and it varies from 58.89% to 62.68%. In
Grouted Rat-trap bond masonry infilled RC frames with Horizontal & Vertical Reinforcement

case of the masonry stresses increase is observed in all the three principal planes. The percentage increase varies from 21.87% to 25% in case of the XY plane.

When compared with GRTIH the stresses in the frame have increased in the XY and XZ planes. Marginal increase is noticed in these two planes. The masonry stresses have increased in the XY plane and the increase varies from 13.12% to 15.21%.

When compared with GRTIV the stresses in the XY and XZ plane have increased whereas the stresses in the YZ plane have reduced. Marginal variation in stresses is observed in all the three planes. In case of masonry stresses, the stresses have increased in all the three planes. Stresses increase in the XY plane and the increase varies from 9.85% to 10.83%.

Load case 2:

a) RC frame: The shear stresses in the frame vary from 0.102 to 1.730 N/mm². The stresses are higher in case of frames with aspect ratio 1.41 in the XY plane. The stresses have increased when compared to load case 1.

b) Masonry: The masonry stresses in the XY plane vary from 0.354 to 0.379 N/mm². The stresses in the other two planes are almost negligible.

When compared to bare RC frame the stresses in the frame have reduced in case of XY and XZ planes and they have increased in the YZ plane. The increase in the YZ plane varies from 24.03% to 50%.

When compared to plain masonry infilled RC frame the stresses in the frame have increased in XY and YZ plane and they have reduced in the XZ plane. The masonry stresses have also increased in all the three planes. In the XY plane the reduction of stresses is observed in the frame with aspect ratio 1.23 whereas increase in masonry stresses is observed for the other two aspect ratios.

When compared to GRTI all the stresses in the frame have increased in all the three planes. Higher increase is noticed in YZ plane and it varies from 60.55% to 70.10%. The masonry stresses have increased in all the planes, but in case of the frame with aspect ratio 1.23 the stress has reduced in the XY-component.

When compared to GRTIH the stresses in the frame have increased in XY and XZ plane, and they have decreased in the YZ plane. In case of masonry stresses the stresses
Grouted Rat-trap bond masonry infilled RC frames with Horizontal & Vertical Reinforcement in the XY plane have shown mixed response. The reduction is observed in case of frame with aspect ratio 1.23 and increase in stresses is observed for the other two aspect ratios.

Zone 4

Zone 5

Kobe

MX : Maximum stress; MN = Minimum stress

(a) infilled RC frame (IFF)  (b) Masonry (MS)

Aspect Ratio: 1.23, Masonry with Horizontal and Vertical Reinforcement

Fig. 12.12: Shear Stress Contours of Reinforced rat-trap Bond Masonry infilled RC frames (XY-Plane)
Grouted Rat-trap bond masonry infilled RC frames with Horizontal & Vertical Reinforcement

Zone 4

Zone 5

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MX : Maximum stress; MN = Minimum stress

(a) infilled RC frame (IFF) (b) Masonry (MS)

Aspect Ratio: 1.23, Masonry with Horizontal and Vertical Reinforcement

Fig. 12.13: Shear Stress Contours of Reinforced rat-trap Bond Masonry infilled RC frames (YZ-Plane)
When compared with GRTIV the stresses in the frame have increased in XY and XZ planes, whereas they have decreased in YZ plane. Marginal variation is noticed in all the three planes. In this case also the masonry stresses have shown mixed response in XY plane. The stresses have reduced of aspect ratio 1.23 and they have increased for other two aspect ratios.

Load case 3:

a) RC frame: The stresses in the frame vary from 0.274 to 4.680 N/mm² which are higher when compared to the other two load cases. Higher stresses are observed in the XY plane. The stresses decrease as the aspect ratio increases.

b) Masonry: The masonry stresses vary from 0.008 to 1.030 N/mm². The stresses are higher in XY plane. The stresses are almost negligible in XZ and YZ planes.

When compared to bare RC frame the stresses in the XY and XZ planes have reduced and the stresses in the YZ plane have increased. The stresses in the YZ plane have increased as the aspect ratio increased whereas; in case of the XY plane shear stresses have reduced as the aspect ratio increases.

When compared to plain masonry infilled RC frame the stresses in the XY and YZ plane have increased. Higher increase is noticed in case of YZ plane and it varies from 39.57% to 42.09%. The stresses have decreased in the XZ plane and the decrease percentage varies from 7.33% to 12.73%. When compared with the masonry stresses, the stresses have increased in all the three components. The increase in stresses in the XY plane varies from 36.02% to 43.96%.

The stresses in the frame have increased in all the planes when compared with GRTI. Higher increase is noticed in case of YZ plane and it varies from 58.41% to 66.03%. The masonry stresses have increased in all the planes. The increase in the masonry stresses varies from 19.49% to 22.92% in the XY plane.

When compared with GRTIH the stresses in the frame have reduced in the YZ plane and the reduction varies from 2.58% to 3.93%. Increase in stresses is noticed in other two planes. The masonry stresses have also increased. The percentage increase in the XY plane varies from 11.98% to 14.08%.

When compared with GRTIV the stresses in the frame have marginal varied in all the three planes. The decrease in stress is observed in the YZ plane and it varies from
1.72% to 2.65%. In the other two planes marginal increase in stresses is noticed. In case of masonry stresses the stresses have increased predominantly in the XY plane and the increase varies from 8.75% to 10.16%.

The location of the maximum shear stress in the XY-plane is at the right corner of bottom floor of the frame whereas; the maximum masonry stress is located in the ground floor panel at the bottom.

Fig. 12.14
Maximum shear Stress

12.5 Acceleration:

The acceleration contours are shown in fig 12.15. The variation of acceleration is shown in Fig. 12.16.

Load case 1: The accelerations vary from 0.018 to 8.770 m/sec². In all the three planes the acceleration varies in accordance with the aspect ratios. As the aspect ratio increases the acceleration increases in Y and Z-components, whereas, it reduces in case of the X-component. The acceleration in the Z component is almost insignificant.
Grouted Rat-trap bond masonry infilled RC frames with Horizontal & Vertical Reinforcement

Zone 4

Zone 5

Kobe

MX : Maximum acceleration; MN = Minimum acceleration

(a) X-Component  
(b) Y- Component

Aspect Ratio: 1.23, Masonry with Horizontal and Vertical Reinforcement

Fig. 12.15: Acceleration Contours of Reinforced rat-trap Bond Masonry infilled RC frames

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Grouted Rat-trap bond masonry infilled RC frames with Horizontal & Vertical Reinforcement

When compared with bare RC frames the acceleration has increased in all the three components. When compared with plain masonry infilled RC frames the acceleration has increased in all the three components and the increase varies from 2.57% to 38.46%. When compared with GRTI the acceleration has increased and the increase varies from 0.80% to 12.50%. When compared with GRTIH, in this case also the acceleration has increased in all the three components. When compared with GRTIV the acceleration is again increased in all the three components.

Load case 2: The accelerations vary from 0.028 to 13.288 m/sec^2. In this case also the acceleration in Y and Z-component has increased as the aspect ratio increases. But again the reduction is observed in case of X-component, where the acceleration is higher. When compared with bare RC frames the acceleration has increased in all the three components. Similar increase in acceleration is noticed when compared with plain masonry infilled RC frames. When compared with GRTI and GRTIH the increase in acceleration is noticed in all the three components. Higher increase in acceleration is noticed in the Y-component. When compared with GRTIV the acceleration has increased in all the three components and the increase in acceleration varies from 2.67% to 4.03% in the Y-component.

![Graphs showing maximum acceleration](Fig. 12.16 Maximum Acceleration)
Analysis of infilled RC frames

with

Stilt floor
Load case 3: The accelerations vary from 0.073 to 36.722 m/sec². These values are higher when compared with load case 1 and load case 2. In case of the X-component the acceleration reduces as the aspect ratio increases, whereas in case of Y and Z component it is vice versa.

When compared with bare RC frames the acceleration has decreased and the decrease percentage in the X-component varies from 1.42% to 3.82% whereas the acceleration has increased in the Y and Z component.

When compared with plain masonry infilled RC frames the acceleration has reduced in X-component whereas it is increased in Y and Z component. Similar observation is observed when compared with GRTI, GRTIH and GRTIV.

12.6 Summary

- The reinforced infill has brought down the lateral drift considerably, when compared to all other type of infills.

- Reduction in principal stresses and normal stresses in the bounding frame members is an indication of the favourable combined system, setup by the reinforcement. Increase in shear force is observed in the masonry but the stresses are localized in the ground floor panel and the critical stresses are found to be located at few locations. The stresses have diminished in the immediate neighbourhood.