Range-add load combination

Range-add load combination is useful for pattern-type loading to obtain the maximum and minimum response from a range of possible load combinations.

For example, the bays of a multi-story building may be subjected to many different vertical load patterns. The beam in Figure 1 is divided into eight equal-length segments to simulate the structural configuration of an eight-bay system. Any combination of bays may be loaded. A separate load case is defined for the loading of each individual bay. Range-add load combination is then implemented to envelope the response from all possible combinations.
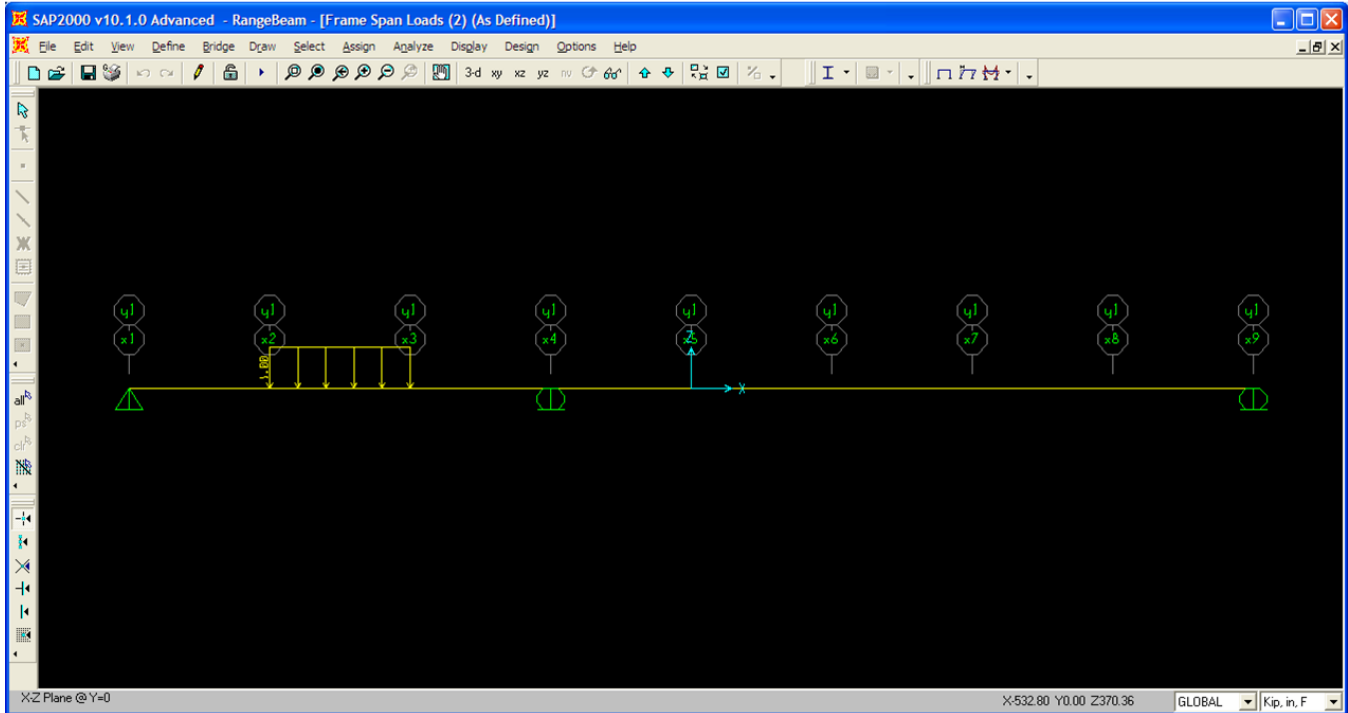

Figure 1 - Structural configuration with second bay loaded

When all eight load cases are added together using an algebraic-add load combination, the beam is subjected to a uniformly-distributed load along its entire length. The moment diagram for this load combination is given in Figure 2:
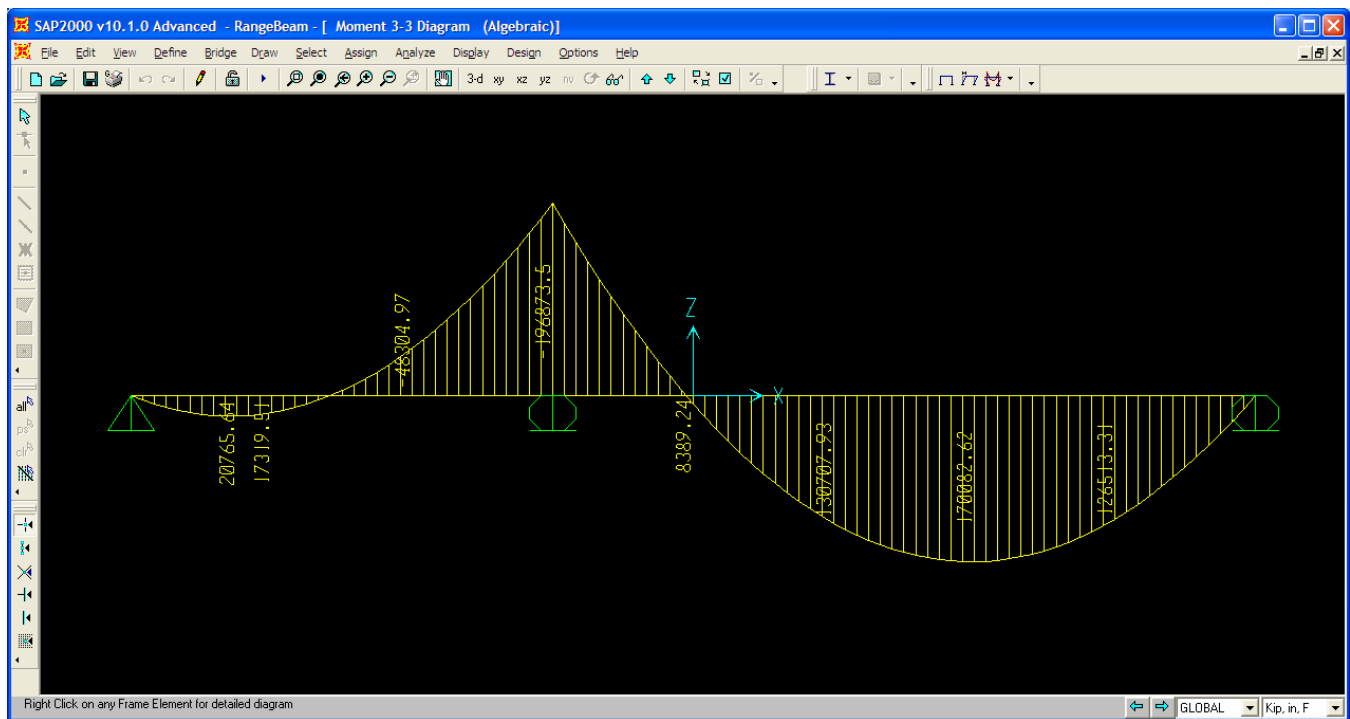
Figure 2 - Moment from uniformly-distributed load

If each load case is applied independently, an envelope load combination may be applied to envelope the maximum and minimum response which results from the individual loading of each separate bay. This moment diagram is given in Figure 3:
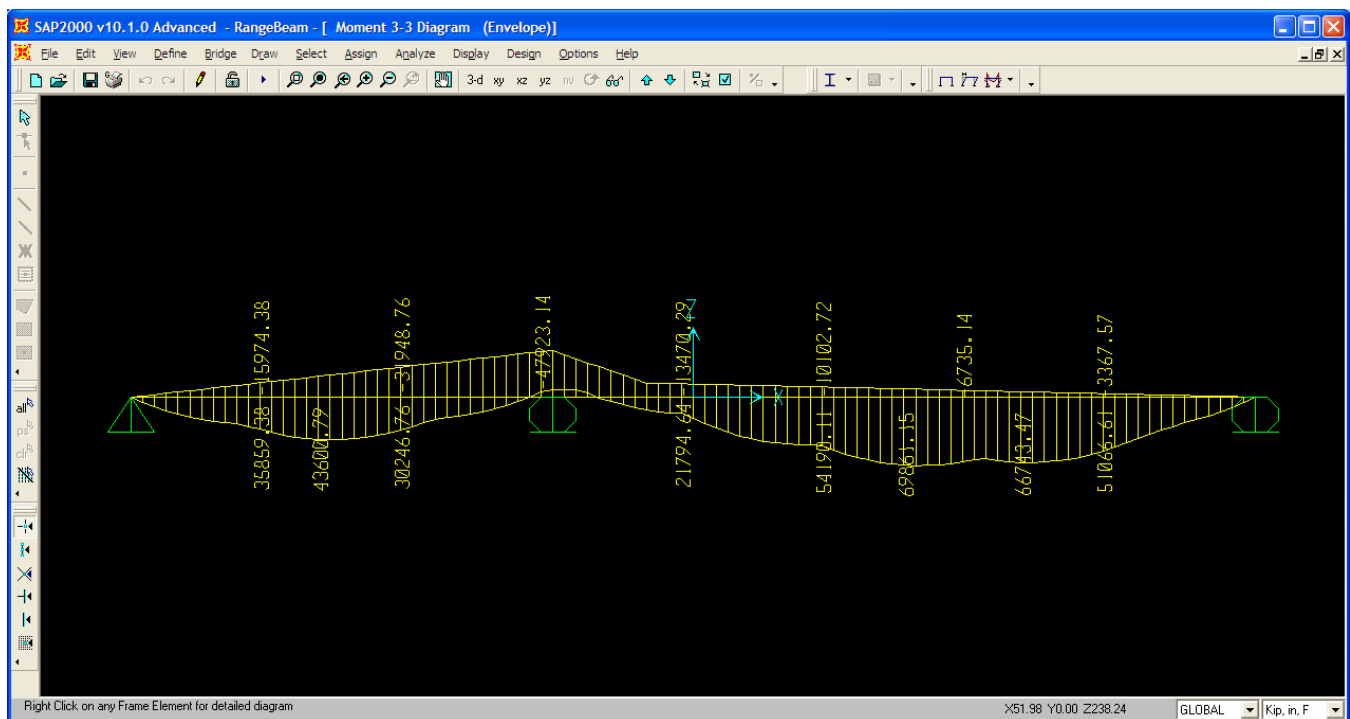

Figure 3 - Moment from envelope load combination

For pattern-type loading, all possible load combinations are considered. An envelope is generated for response from the following combinations:

- Any single load case (8 permutations)
- Any pair of load cases (28 permutations)
- Any three load cases (56 permutations)
- Any four (70)
- Any five (56)
- Any six (28)
- Any seven (8)
- All eight (1)

As a result, pattern-type loading involves 255 possible permutations. Without the range-add feature, definition would require 255 additive combinations, plus an additional combination to envelope response. The same output may be achieved using a single range-add load combination.

An summary of the range-add process is as follows:

- The computation begins with Max and Min results from zero loading
- For each contributing case:
    - Positive values add to the Max
    - Negative values add to the Min
- If the contributing case is another combination:
    - Positive Max values add to the Max
    - Negative Min values add to the Min
- Results represent the envelope of all possible combinations
- Specification is streamlined, and computation is expedited

The moment diagram for a single range-add load combination, which includes all eight load cases and 256 permutations, is given in Figure 4:
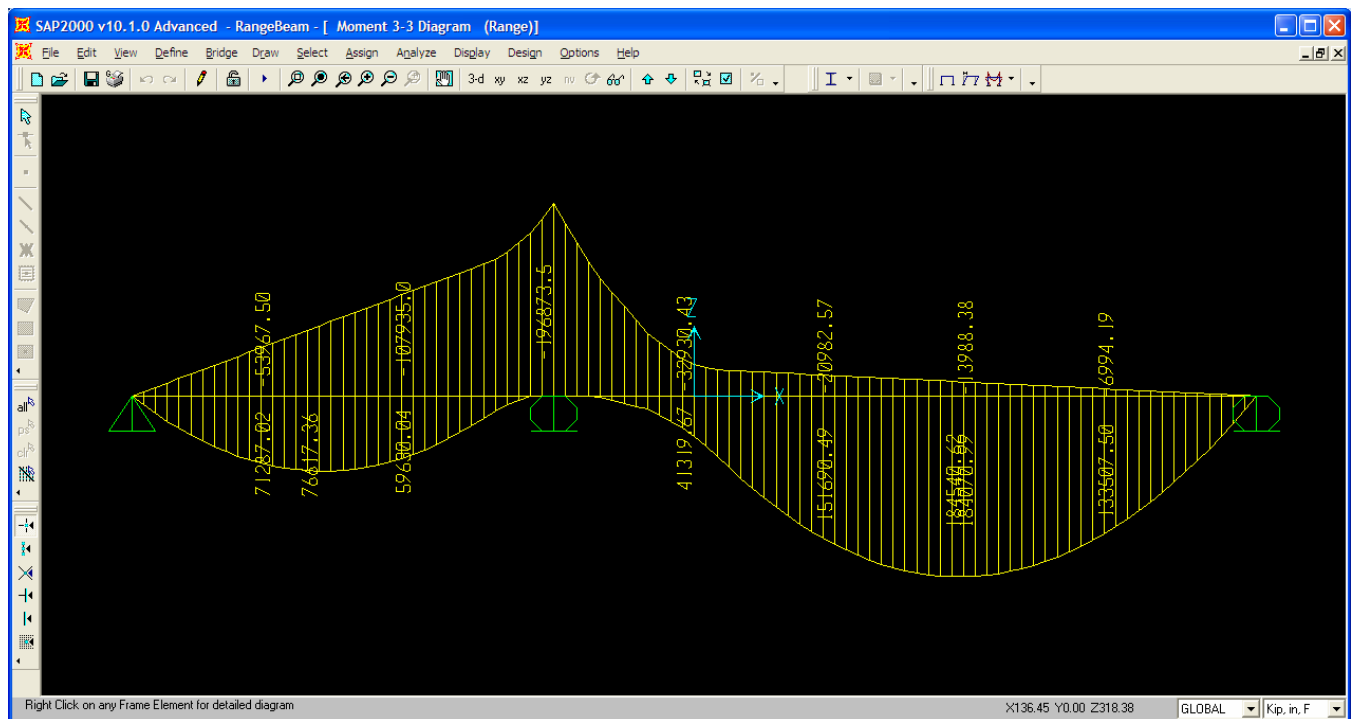

Figure 4 - Moment from range-add load combination

See Also

- Reducible live load

Attachments

- Range-Add Load Combination presentation (PDF)