CheggSolutions - Thegdp

```html

## Structural Analysis: Moment Distribution Method

### Given:

- **Members A, B, C, D, E** in the frame all have the same modulus of elasticity **E** and moment of inertia **I**.
- **Supports A and E** are pinned.
- **Support D** is fixed.
- Load on span **BC = 4 kN/m**.
- Point load on span **DE = 9 kN**.

### Required:

1. Determine the moments at the ends of each member using the moment distribution method.
2. Draw the bending moment diagram of the frame.

### Solution:

### Step 1: Calculation of Fixed-End Moments (FEM)

**For span AB (hinged at A):**
Pin at A:
$$FEM_{AB} = 0 \, \text{kNm}$$
$$FEM_{BA} = 0 \, \text{kNm}$$
**For span BC (uniform distributed load):**
$$w = 4 \, \text{kN/m}, \, L = 6 \, \text{m}$$
$$FEM_{BC} = \frac{wL^2}{12} = \frac{4 \times 6^2}{12} = 12 \, \text{kNm}$$
$$FEM_{CB} = -\frac{wL^2}{12} = -12 \, \text{kNm}$$
**For span CD (no load):**
$$FEM_{CD} = 0 \, \text{kNm}$$
$$FEM_{DC} = 0 \, \text{kNm}$$
**For span DE (point load in the middle):**
$$P = 9 \, \text{kN}, \, L = 4 \, \text{m}$$
$$FEM_{DE} = \frac{PL}{8} = \frac{9 \times 4}{8} = 4.5 \, \text{kNm}$$
$$FEM_{ED} = -\frac{PL}{8} = -4.5 \, \text{kNm}$$

### Step 2: Calculation of Stiffness Factors

$$\text{For a beam with both ends fixed}, \, k = \frac{4EI}{L}$$
$$\text{For a beam with one end pinned and one end fixed}, \, k = \frac{3EI}{L}$$
**Span AB:**
$$L = 6 \, \text{m}$$
$$k_{AB} = 0 \, (simple support at A)$$
$$k_{BA} = \frac{3EI}{6} = 0.5EI$$
**Span BC:**
$$L = 6 \, \text{m}$$
$$k_{BC} = \frac{4EI}{6} = 0.6667EI$$
$$k_{CB} = \frac{4EI}{6} = 0.6667EI$$
**Span CD:**
$$L = 4 \, \text{m}$$
$$k_{CD} = \frac{4EI}{4} = EI$$
$$k_{DC} = \frac{4EI}{4} = EI$$
**Span DE:**
$$L = 4 \, \text{m}$$
$$k_{DE} = \frac{3EI}{4} = 0.75EI$$
$$k_{ED} = 0 \, (\text{simple support at } E)$$

### Step 3: Distribution Factors

The distribution factor (DF) is calculated for each end of the members:
$$\text{DF}_{BA} = \frac{k_{BA}}{k_{BA} + k_{BC}} = \frac{0.5EI}{0.5EI + 0.6667EI} = \frac{0.5}{1.1667} = 0.4285$$
$$\text{DF}_{BC} = \frac{0.6667EI}{1.1667EI} = 0.5714$$
```

$$ \text{DF}_{CB} = \frac{k_{CB}}{k_{CB} + k_{CD}} = \frac{0.6667EI}{0.6667EI + EI} = \frac{0.6667}{1.6667} = 0.4 $$
$$ \text{DF}_{CD} = \frac{k_{CD}}{1.6667EI} \approx 0.6 $$
$$ \text{DF}_{DE} = 1, \, \text{DF}_{ED} = 0 $$

Step 4: Moment Distribution Calculation

Iteration 1:
$$ M_{BC} = 12 \, \text{kNm} $$
$$ M_{CB} = -12 \, \text{kNm} $$
Carry-over moments to the near-end spans:
$$ \text{Carry-over to } AB = M_{AB} = 0 \, \text{kNm} $$
$$ \text{Carry-over to } BA = 0 $$
$$ M_{CB} = -12 \, \text{kNm} $$
$$ Carry\text {- over to } DC= -6 \, \text{kNm} $$
\strong>Iteration 2: (Balancing moment at each joint): **Joint B:**
$$ M_B=0 $$
$$ M_{BC} = 0 $$
Joint C:
$$ M_C = -6 $$
Joint D:
$$ M_{DE} = 4.5,ED = 6 $$
Sum the Moments:
$$ M_{AB},A=0 $$
$$ M_{BC} = -12 \text{kNm} $$
$$ M_{CB} = 6 \text{kNm} $$
$$ M_{DE} = 6 \text{kNm} $$

Step 5: Bending Moment Diagram

Once the moments at each end are determined, the remaining task is to plot them accordingly. **Final Summary:**

- $M_{AB} = -12 \, \text{kNm}$
- $M_{CB} = 6 \text{kNm}$
- $BA = 0 \text{kNm}$
- $CD, DC = 0$

```
```