Egzamin z Mechaniki Konstrukcji, 19.12.2015
Exam on the Mechanics of Structures

NAZWISKO, Imię LAST NAME, First Name				
ocena zadania 1	ocena zadania 2	ocena zadania 3	ocena egzaminu	ocena łączna

Zadanie 1 (Rys. 1) **Problem #1 (Fig. 1)**
Oblicz siłę podłużną w pręcie *B-C*.

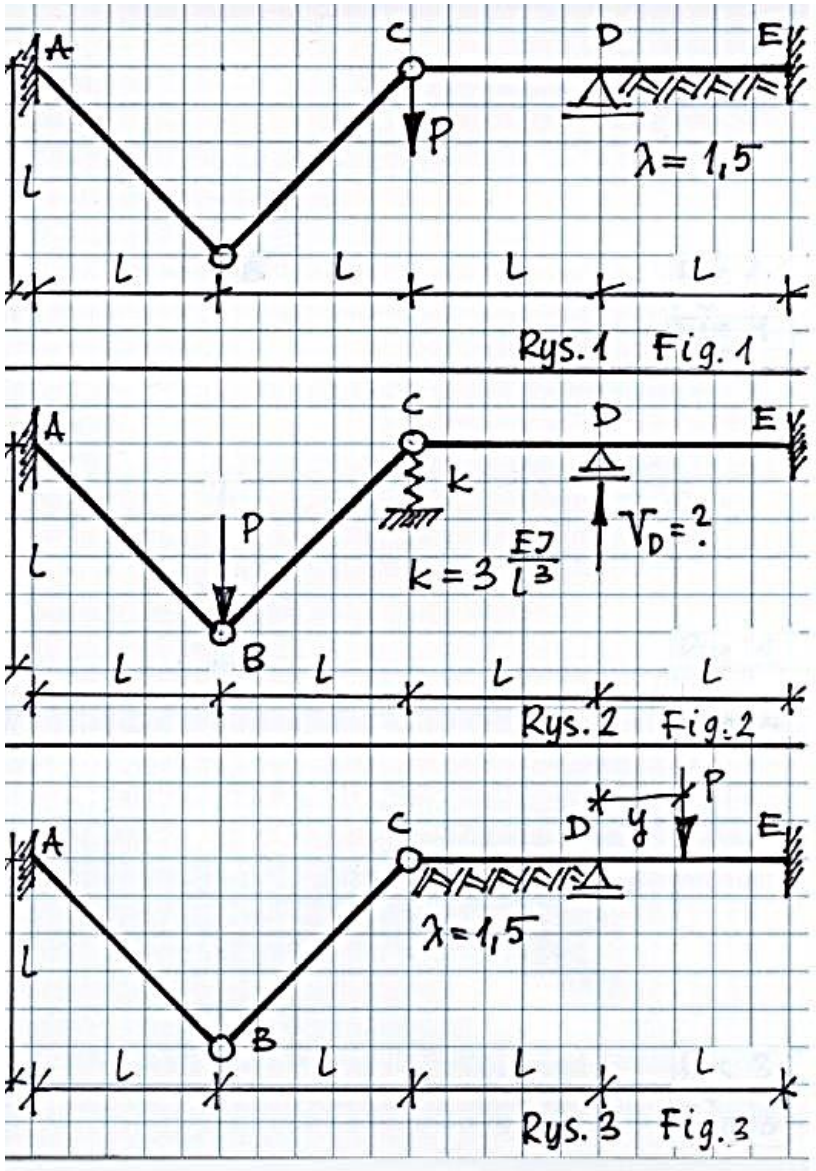
Calculate the normal force in the *B-C* bar.

Zadanie 2 (Rys. 2) **Problem #2 (Fig. 2)**
Oblicz wartość reakcji V_D.

Calculate the reaction V_D.

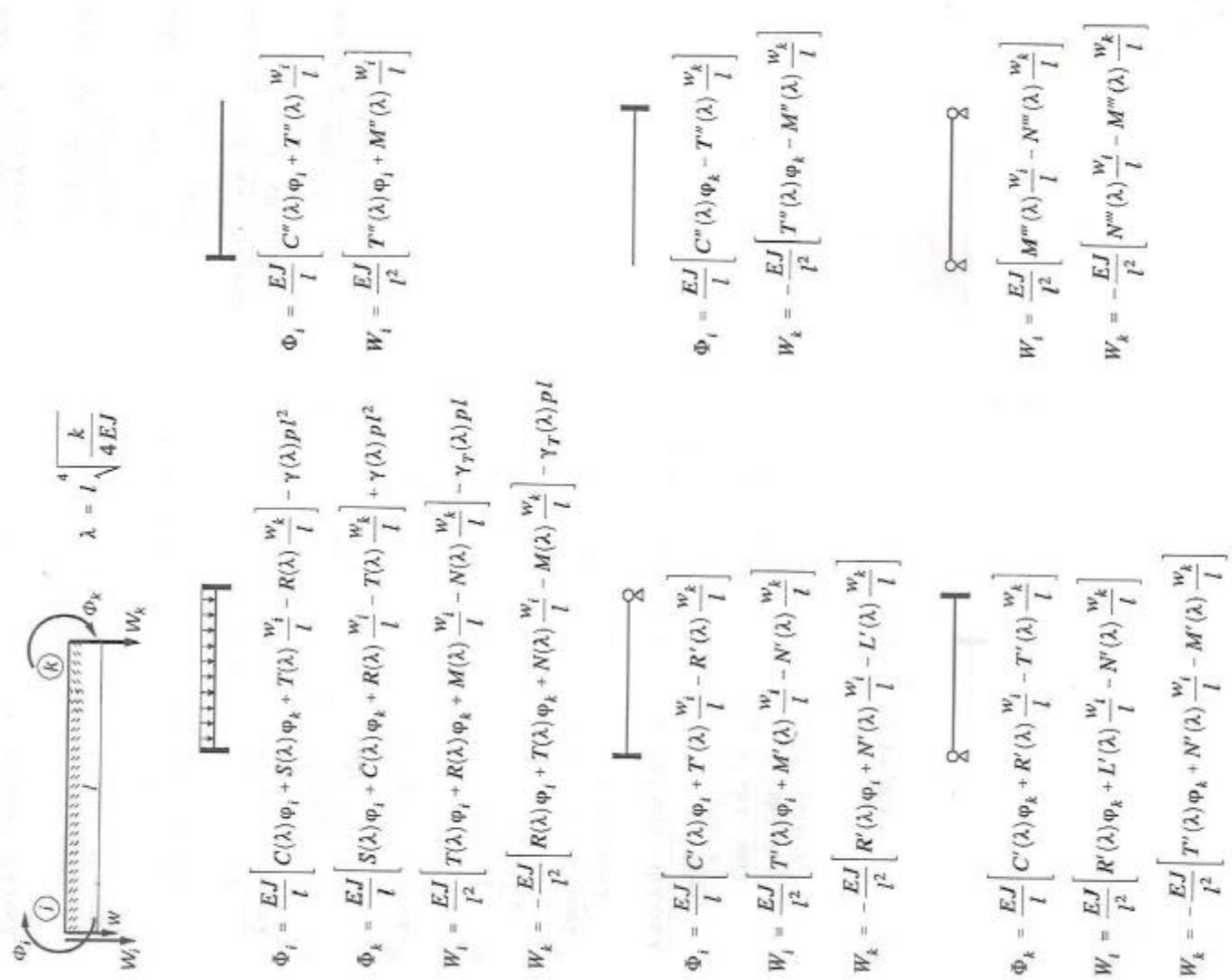
Zadanie 3 (Rys. 3) **Problem #3 (Fig. 3)**
Wyznacz położenie siły *P* na odcinku *D-E* tak, aby $|M_E|$, tj. wartość bezwzględna momentu zginającego w podporze *E*, była największa.

Find the position of force *P* in the interval *D-E* for which $|M_E|$, that is the absolute value of the bending moment at the support *E*, is maximal.



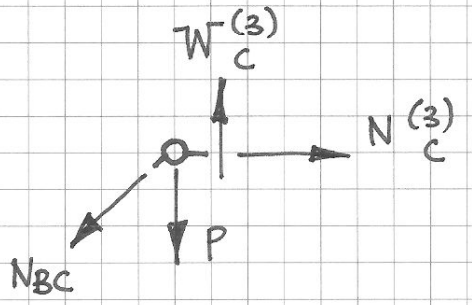
λ	C(λ)	S(λ)	T(λ)	R(λ)	M(λ)	N(λ)	C'(λ)	T'(λ)	R'(λ)
0,0	**4,000**	**2,000**	**6,000**	**6,000**	**12,000**	**12,000**	**3,000**	**3,000**	**3,000**
0,1	4,000	2,000	6,000	6,000	12,000	12,000	3,000	3,000	3,000
0,2	4,000	2,000	6,000	6,000	12,002	11,999	3,000	3,001	3,000
0,3	4,000	2,000	6,002	5,999	12,012	11,996	3,001	3,003	2,999
0,4	4,001	1,999	6,005	5,997	12,038	11,987	3,002	3,009	2,996
0,5	**4,002**	**1,998**	**6,013**	**5,992**	**12,093**	**11,968**	**3,005**	**3,021**	**2,990**
0,6	4,005	1,996	6,027	5,984	12,192	11,933	3,010	3,044	2,980
0,7	4,009	1,993	6,050	5,970	12,356	11,877	3,018	3,082	2,962
0,8	4,016	1,988	6,086	5,949	12,608	11,790	3,031	3,140	2,936
0,9	4,025	1,981	6,137	5,919	12,972	11,665	3,050	3,223	2,898
1,0	**4,038**	**1,972**	**6,208**	**5,877**	**13,480**	**11,491**	**3,075**	**3,338**	**2,846**
1,1	4,055	1,959	6,304	5,821	14,163	11,258	3,109	3,492	2,776
1,2	4,078	1,942	6,429	5,748	15,056	10,956	3,153	3,692	2,687
1,3	4,107	1,920	6,589	5,656	16,197	10,573	3,209	3,944	2,575
1,4	4,143	1,894	6,787	5,541	17,624	10,100	3,277	4,254	2,438
1,5	**4,186**	**1,862**	**7,030**	**5,402**	**19,377**	**9,526**	**3,359**	**4,629**	**2,275**
1,6	4,239	1,823	7,323	5,236	21,498	8,844	3,455	5,071	2,086
1,7	4,301	1,778	7,670	5,041	24,026	8,049	3,566	5,586	1,871
1,8	4,373	1,726	8,075	4,818	27,000	7,136	3,693	6,174	1,632
1,9	4,456	1,666	8,541	4,564	30,459	6,106	3,833	6,835	1,370
2,0	**4,550**	**1,600**	**9,073**	**4,280**	**34,438**	**4,962**	**3,988**	**7,568**	**1,091**

λ	M'(λ)	N'(λ)	L'(λ)	C''(λ)	T''(λ)	M''(λ)	M'''(λ)	N'''(λ)
0,0	**3,000**	**3,000**	**3,000**	**0,000**	**0,000**	**0,000**	**0,000**	**0,000**
0,1	3,000	3,000	3,000	0,000	0,000	0,000	0,000	0,000
0,2	3,003	2,999	3,002	0,002	0,003	0,006	0,002	-0,001
0,3	3,016	2,995	3,008	0,011	0,016	0,032	0,011	-0,005
0,4	3,050	2,986	3,024	0,034	0,051	0,102	0,034	-0,017
0,5	**3,121**	**2,965**	**3,059**	**0,082**	**0,123**	**0,247**	**0,083**	**-0,042**
0,6	3,251	2,928	3,122	0,166	0,250	0,505	0,172	-0,086
0,7	3,465	2,867	3,226	0,298	0,449	0,918	0,318	-0,158
0,8	3,793	2,774	3,385	0,484	0,734	1,520	0,541	-0,268
0,9	4,267	2,639	3,615	0,726	1,107	2,340	0,861	-0,424
1,0	**4,925**	**2,454**	**3,934**	**1,017**	**1,563**	**3,394**	**1,301**	**-0,635**
1,1	5,807	2,209	4,363	1,342	2,087	4,688	1,884	-0,910
1,2	6,954	1,893	4,920	1,686	2,658	6,225	2,630	-1,253
1,3	8,408	1,500	5,626	2,031	3,258	8,008	3,560	-1,665
1,4	10,213	1,021	6,503	2,363	3,871	10,052	4,689	-2,144
1,5	**12,408**	**0,455**	**7,571**	**2,675**	**4,492**	**12,380**	**6,029**	**-2,681**
1,6	15,031	-0,200	8,847	2,963	5,119	15,027	7,587	-3,263
1,7	18,117	-0,941	10,350	3,228	5,756	18,031	9,368	-3,872
1,8	21,694	-1,759	12,093	3,472	6,411	21,438	11,372	-4,487
1,9	25,786	-2,642	14,088	3,700	7,092	25,290	13,599	-5,085
2,0	**30,412**	**-3,573**	**16,347**	**3,915**	**7,807**	**29,631**	**16,049**	**-5,642**



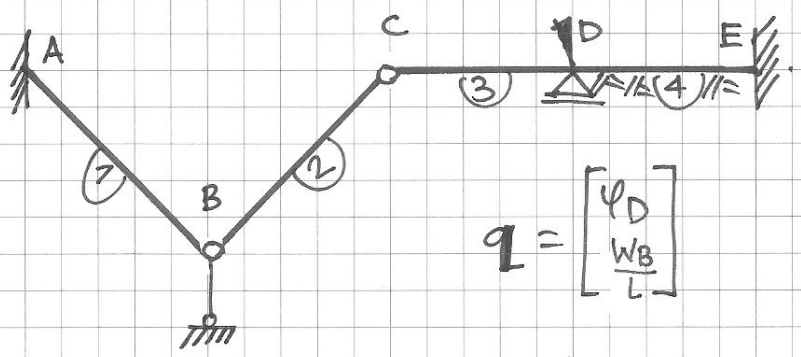
Egzamin z MK3 (IPB), 19 XII 2015, zadanie 1

Siły działające w węźle C:



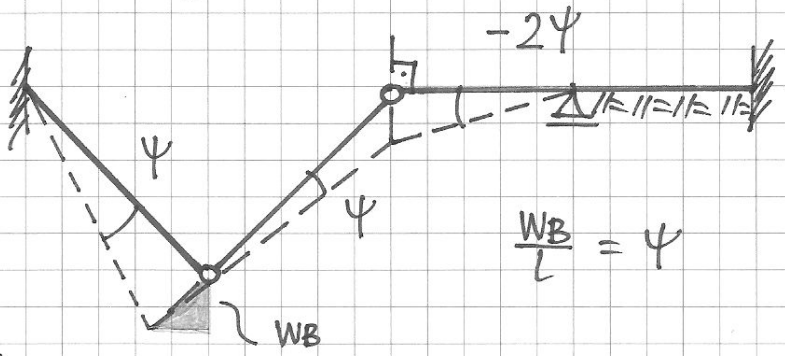
$$N_{BC} \cdot \frac{\sqrt{2}}{2} + P - W_C^{(3)} = 0 \quad \rightarrow \quad N_{BC} = \sqrt{2}\left(W_C^{(3)} - P\right)$$

Obliczamy $W_C^{(3)}$:



$$q = \begin{bmatrix} \varphi_D \\ \frac{W_B}{l} \end{bmatrix}$$

Plan przesunięć:



$$\frac{W_B}{l} = \psi$$

Równania równowagi:

$$\begin{cases} \Phi_D^{(3)} + \Phi_D^{(4)} = 0 \\ W_B^{(1)} \cdot \sqrt{2}\, l\, \bar{\psi} + W_C^{(3)} \cdot 2l\, \bar{\psi} = P \cdot 2l \cdot \bar{\psi} \end{cases}$$

$$\varphi_D = -0{,}183 \frac{Pl^2}{EJ}$$

$$\frac{W_B}{l} = 0{,}219 \frac{Pl^2}{EJ}$$

Wzory transformacyjne:

$$\Phi_D^{(3)} = \frac{3EJ}{l}\left[\varphi_D + 2\frac{W_B}{l}\right]$$

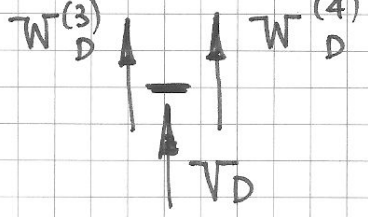
$$\Phi_D^{(4)} = \frac{EJ}{l}\left[C(1{,}5)\,\varphi_D\right]$$

$$W_B^{(1)} = -\frac{3EJ}{2l^2}\left[-\frac{W_B}{l}\right]$$

$$W_C^{(3)} = \frac{3EJ}{l^2}\left[\varphi_D + 2\frac{W_B}{l}\right] = 0{,}767P \qquad N_{BC} = -0{,}329\,P$$

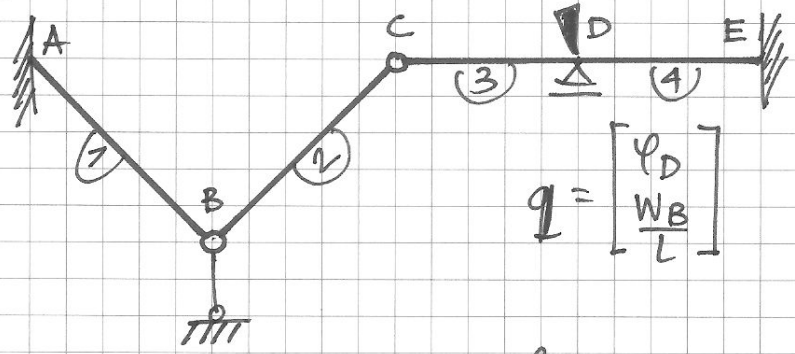
Egzamin z MK3 (IPB), 19 XII 2015, zadanie 2

Siły działające w węźle D:

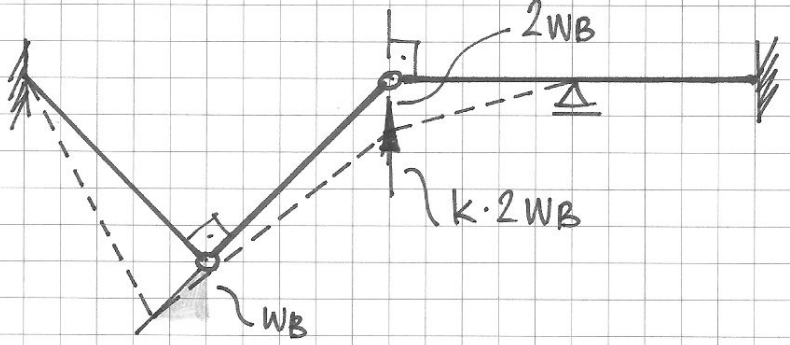


$$V_D = -\left(W_D^{(3)} + W_D^{(4)}\right)$$

Obliczamy $W_D^{(3)}$, $W_D^{(4)}$:



Plan przesunięć:



Równania równowagi:

$$\Phi_D^{(3)} + \Phi_D^{(4)} = 0$$

$$W_B^{(1)} \cdot (\sqrt{2}\,\bar{w}_B) + W_C^{(3)} \cdot (2\bar{w}_B) = P\bar{w}_B + k \cdot 2w_B \cdot (-2\bar{w}_B)$$

Wzory transformacyjne:

$$\Phi_D^{(3)} = \frac{3EJ}{l}\left[\varphi_D + \frac{2w_B}{l}\right]$$

$$\Phi_D^{(4)} = \frac{2EJ}{l}\left[2\varphi_D\right]$$

$$W_B^{(1)} = -\frac{3EJ}{2l^2}\left[-\frac{w_B}{l}\right]$$

$$W_C^{(3)} = \frac{3EJ}{l^2}\left[\varphi_D + \frac{2w_B}{l}\right]$$

$$W_D^{(4)} = \frac{6EJ}{l^2}\left[\varphi_D\right] = -0{,}245P$$

$$W_D^{(3)} = -W_C^{(3)} = -0{,}163P$$

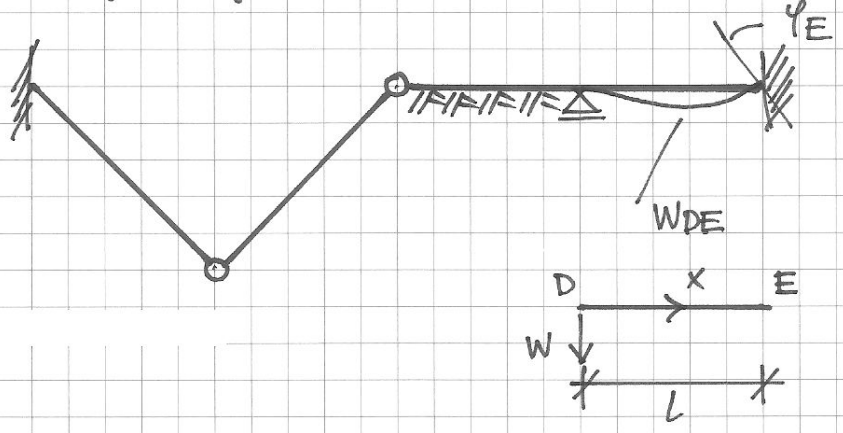
$$\varphi_D = -0{,}041\,\frac{Pl^2}{EJ}$$

$$\frac{w_B}{l} = 0{,}048\,\frac{Pl^2}{EJ}$$

$$V_D = 0{,}408P$$

Egzamin z MK3, 19 XI 2015, zadanie 3

W rozwiązaniu skorzystamy z tw. Bettiego. W związku z tym najpierw znajdziemy linię ugięcia w_{DE} stowarzyszoną z $\varphi_E = -1$.



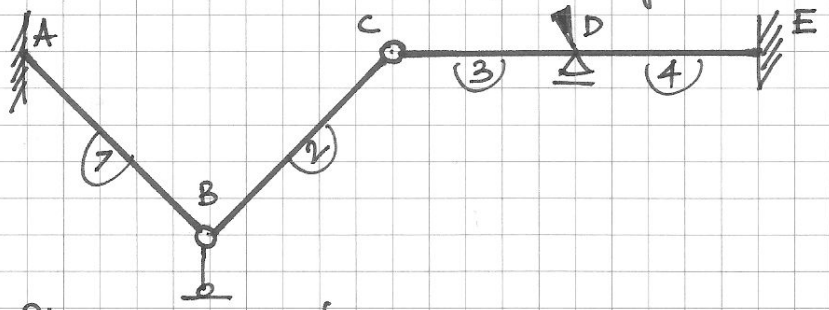
$$w_{DE}(x) = C_0 + C_1 x + C_2 x^2 + C_3 x^3$$

Warunki brzegowe:

$w_{DE}(0) = 0$ $\qquad$ $w_{DE}(L) = 0$

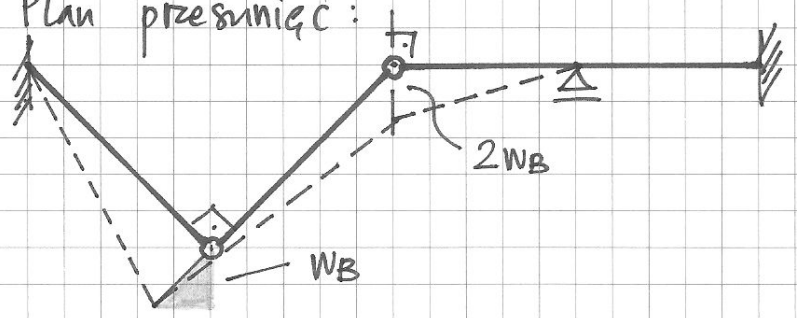
$w'_{DE}(0) = \varphi_D$ $\qquad$ $w'_{DE}(L) = \varphi_E = -1$

Kąt obrotu φ_D znajdziemy Metodą Przemieszczeń:



$$q = \begin{bmatrix} \varphi_D \\ \frac{w_B}{l} \end{bmatrix}$$

Plan przesunięć:



Równania równowagi:

$$\Phi_D^{(3)} + \Phi_D^{(4)} = 0$$

$$W_B^{(1)} \cdot (\sqrt{2}\,\bar{w}_B) + W_C^{(3)} \cdot (2\bar{w}_B) = 0$$

Wzory transformacyjne:

$$\Phi_D^{(3)} = \frac{EJ}{l}\left[c'(1,5)\varphi_D + R'(1,5)\cdot\frac{2w_B}{l}\right]$$

$$\Phi_D^{(4)} = \frac{2EJ}{l}\left[2\varphi_D\right] - \frac{2EJ}{l}$$

$$W_B^{(1)} = -\frac{3EJ}{2L^2}\left[-\frac{w_B}{l}\right]$$

$$W_C^{(3)} = \frac{EJ}{L^2}\left[R'(1,5)\,\varphi_D + L'(1,5)\,\frac{2w_B}{l}\right]$$

$$\varphi_D = 0{,}298$$

$$\frac{w_B}{l} = -0{,}042$$

Linia ugięcia:

$c_0 = 0$

$c_1 = 0{,}298$

$c_0 + c_1 l + c_2 l^2 + c_3 l^3 = 0$

$c_1 + 2c_2 l + 3c_3 l^2 = -1$

$$w_{DE}(x) = l \cdot \left[0{,}298 \left(\frac{x}{l}\right) + 0{,}404 \left(\frac{x}{l}\right)^2 - 0{,}702 \left(\frac{x}{l}\right)^3 \right]$$

Z tw. Bettiego:

$$-M_E(y) \cdot 1 + P \cdot w_{DE}(y) = 0$$

$$M_E(y) = P \cdot w_{DE}(y)$$

$$\frac{dM_E}{dy}(y) = P \frac{dw_{DE}}{dy}(y) = 0 \longrightarrow y^*$$

$$\frac{dw_{DE}}{dy}(y) = 0{,}298 + 0{,}808 \frac{y}{l} - 2{,}106 \frac{y^2}{l^2} = 0$$

$$\frac{y^*}{l} = 0{,}614$$