

Transport vositasiga ta'sir qiluvchi kuchlar va momentlar, shina-yo'l aloqa kuchlari

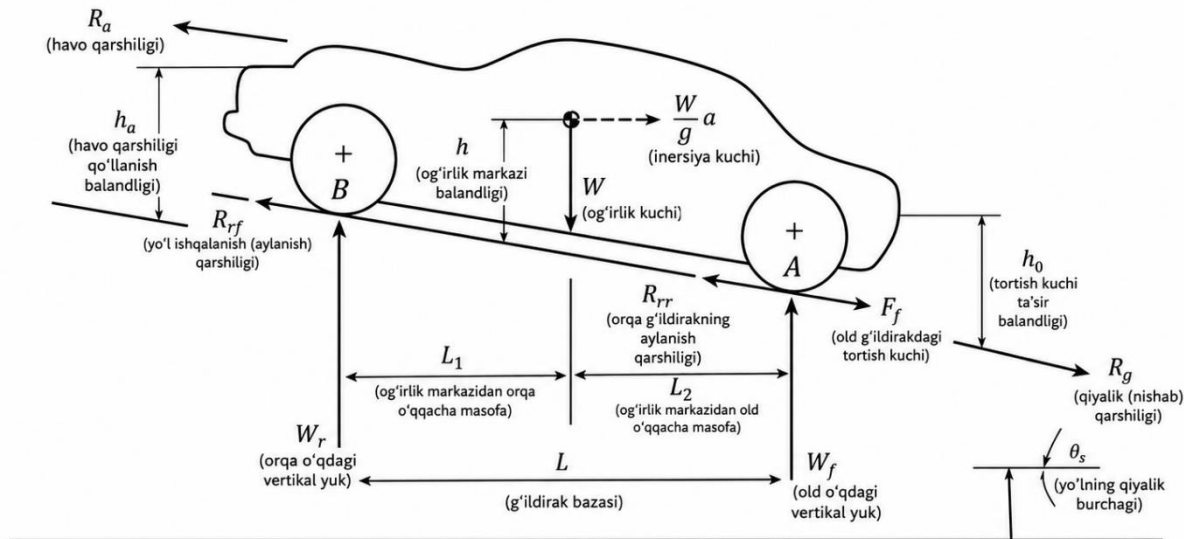
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Sustainable Transportation within the Framework of Green Deal - SPHERE

Call: ERASMUS-EDU-2023-CBHE-STRAND-2

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Avtomobilga ta'sir etuvchi kuchlar



Belgilar izohi:

R_a - havo qarshiligi kuchi

h_a - havo qarshiligi qo'llanish balandligi

R_{rf} - yo'l ishqalanish (aylanish) qarshiligi

W_r - orqa o'qdagi vertikal yuk

B - orqa o'q markazi

L_1 - og'irlik markazidan orqa o'qqacha masofa

L - g'ildirak bazasi

h - og'irlik markazi balandligi

W - og'irlik kuchi

$\frac{W}{g} a$ - inersiya kuchi

L_2 - og'irlik markazidan old o'qqacha masofa

W_f - old o'qdagi vertikal yuk

A - old o'q markazi

R_{rr} - orqa g'ildirakning aylanish qarshiligi

F_f - old g'ildirakdagi tortish kuchi

h_0 - tortish kuchi ta'sir balandligi

R_g - qiyalik (nishab) qarshiligi

θ_s - yo'lning qiyalik burchagi

$$m \frac{d^2x}{dt^2} = \frac{W}{g} a = F_f + F_r - R_a - R_{rf} - R_{rr} - R_d - R_g \quad \text{-----}(1)$$

Inersiya kuchi tushunchasini kiritib, yuqoridagi tenglama quyidagi ko'rinishda qayta yozilishi mumkin:

$$F_f + F_r - \left(R_a + R_{rf} + R_{rr} + R_d + R_g + \frac{aW}{g} \right) = 0 \quad \text{-----}(2)$$

yoki

$$F = R_a + R_r + R_d + R_g + \frac{aW}{g}$$

bu yerda,

m – jismning massasi (kg)

x – harakat yo'li (m)

t – vaqt (s)

W – jismning og'irligi (N)

g – erkin tushish tezlanishi (m/s²)

a – tezlanish (m/s²)

F_f – tortishish kuchi (haydovchi kuch) (N)

F_r – qarshilikka qarshi aylanish kuchi (N)

R_a – havo qarshiligi (N)

R_{rf} – yo'l ishqalanish qarshiligi (aylanish) (N)

R_{rr} – yotish qarshiligi (rolik/yatak ishqalanishi) (N)

R_d – transmissiya qarshiligi (N)

R_g – nishab (qiyalik) qarshiligi (N)

1. Old o'qdagi normal yuklama

$$W_f = \frac{Wl_2 \cos \theta_s - R_a h_a - haW/g - R_d h_d \pm Wh \sin \theta_s}{L} \quad \text{-----}(3)$$

Avtomobil qiyalikka ko'tarilayotganda, $Wh \sin \theta_s$ hadi uchun **manfiy ishora** (–) qo'llaniladi.

2. Orqa o'qdagi normal yuklama

Xuddi shuningdek, orqa o'qdagi normal yuklama B nuqta atrofidagi momentlar yig'indisidan aniqlanadi:

$$W_r = \frac{Wl_1 \cos \theta_s + R_a h_a + haW/g + R_d h_d \pm Wh \sin \theta_s}{L} \quad \text{-----}(4)$$

Yuqoridagi ifodada avtomobil qiyalikka ko'tarilayotganda, $Wh \sin \theta_s$ hadi uchun **musbat ishora** (+) qo'llaniladi.

Bu yerda:

W_f – old o'qdagi normal (vertikal) yuklama, N

W_r – orqa o'qdagi normal (vertikal) yuklama, N

W – avtomobilning og'irlik kuchi, N

l_1 – og'irlik markazidan orqa o'qqacha bo'lgan masofa, m

l_2 – og'irlik markazidan old o'qqacha bo'lgan masofa, m

R_a – havo qarshiligi kuchi, N

h_a – havo qarshiligi qo'llanilish balandligi, m

a – tezlanish, m/s^2

g – erkin tushish tezlanishi, m/s^2

R_d – transmissiya qarshiligi kuchi, N

h_d – transmissiya qarshiligi ta'sir balandligi, m

h – og'irlik markazi balandligi, m

θ_s – yo'lning qiyalik burchagi

L – avtomobilning g'ildirak bazasi, m

- Qiyalik burchagi kichik bo'lganda, $\cos\theta_s \approx 1$ deb qabul qilinadi.
- Yengil avtomobillar uchun aerodinamik qarshilik kuchining qo'llanilish balandligi h_a va transmissiya (tortish moslamasi) qarshiligining ta'sir balandligi h_d ni og'irlik markazi balandligi h ga yaqin deb qabul qilish mumkin.
- Ushbu soddalashtirish va taxminlarni hisobga olib, (3) va (4) tenglamalarni quyidagicha qayta yozish mumkin:

Old o'qdagi
normal yuklama

$$W_f = \frac{l_2}{L} W - \frac{h}{L} \left(R_a + \frac{aW}{g} + R_d \pm W \sin \theta_s \right) \quad (5)$$

Orqa o'qdagi
normal yuklama

$$W_r = \frac{l_1}{L} W + \frac{h}{L} \left(R_a + \frac{aW}{g} + R_d \pm W \sin \theta_s \right) \quad (6)$$

- Yuqoridagi tenglamalarga (2)-tenglamani qo'yish orqali keyingi ifodalar hosil qilinadi.

Belgilar izohi:

W_f – old o'qdagi normal (vertikal) yuklama
 W_r – orqa o'qdagi normal (vertikal) yuklama
 W – avtomobilning og'irlik kuchi
 l_1 – og'irlik markazidan orqa o'qqacha bo'lgan masofa
 l_2 – og'irlik markazidan old o'qqacha bo'lgan masofa
 L – avtomobilning g'ildirak bazasi

h – og'irlik markazi balandligi
 R_a – havo qarshiligi kuchi
 R_d – transmissiya (tortish moslamasi) qarshiligi kuchi
 a – tezlanish
 g – erkin tushish tezlanishi
 θ_s – yo'lning qiyalik burchagi

(5) va (6) tenglamalarga (2)-tenglamani qo'yish orqali quyidagi ifodalar olinadi:

**Old o'qdagi
normal yuklama**

$$W_f = \frac{l_2}{L} W - \frac{h}{L} (F - R_r) \quad \text{-----} \quad (7)$$

va

**Orqa o'qdagi
normal yuklama**

$$W_r = \frac{l_1}{L} W + \frac{h}{L} (F - R_r) \quad \text{-----} \quad (8)$$



- **E'tibor berish kerakki**, har bir tenglamaning o'ng tomonidagi birinchi had **avtomobil tekis (gorizontal) yo'lda tinch holatda turgandagi o'qqa tushadigan statik yuklamani** ifodalaydi.



- Har bir tenglamaning o'ng tomonidagi ikkinchi had **normal yuklamaning dinamik tarkibiy qismini yoki dinamik yuklama ko'chishini** ifodalaydi.

Bu yerda:

W_f – old o'qdagi normal (vertikal) yuklama

W_r – orqa o'qdagi normal (vertikal) yuklama

W – avtomobilning og'irlik kuchi

l_1 – og'irlik markazidan orqa o'qqacha bo'lgan masofa

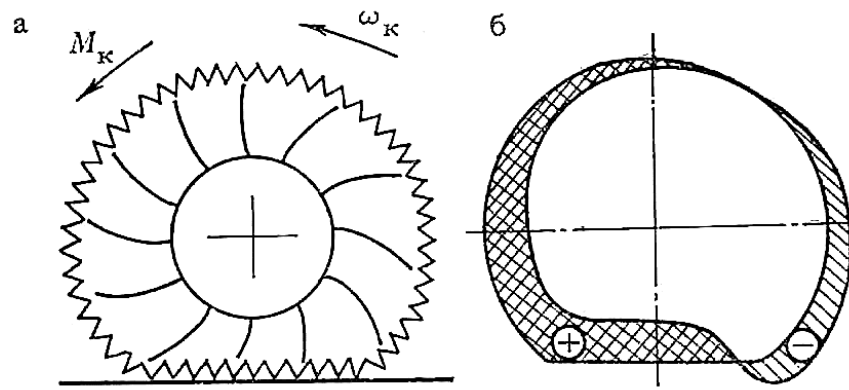
l_2 – og'irlik markazidan old o'qqacha bo'lgan masofa

L – avtomobilning g'ildirak bazasi

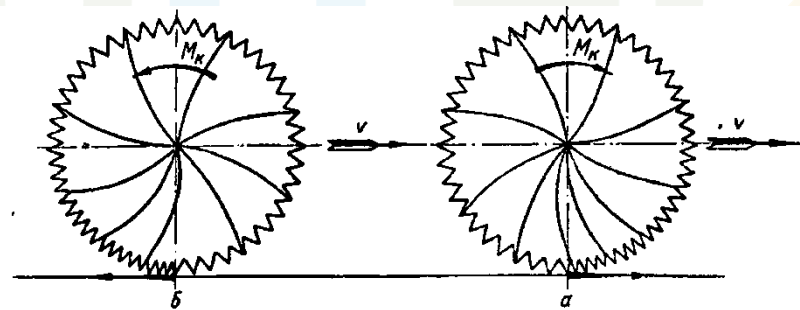
h – og'irlik markazi balandligi

F – tortish (tashqi) kuchi

R_r – rulash qarshiligi (yo'l qarshiligi) kuchi



Burovchi moment ta'sirida shina deformasiyasi (a) va epyurasi (b) :
 + - siqilish zonasi; - - cho'zilish zonasi



G'ildirakning a – tortish va b – tormozlanish jarayonida g'ildirash yuzasining deformasiyalanish sxemasi

G'ildirashga qarshilik kuchi

$$P_f = fR_z \cos \alpha = fG_k \cos \alpha$$

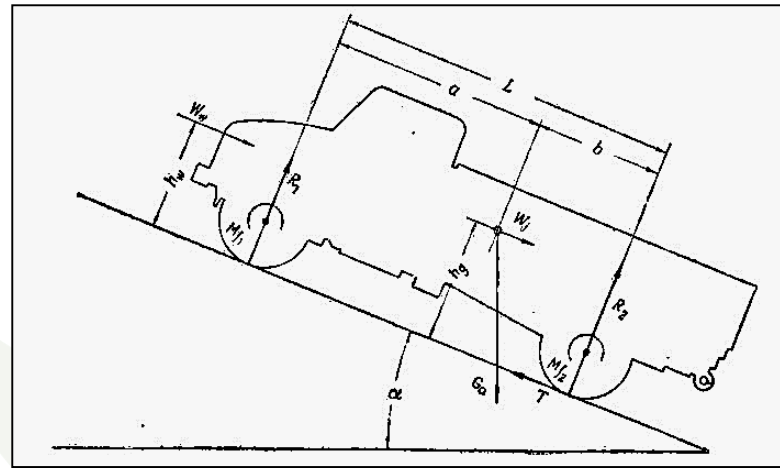
f – g'ildirashga qarshilik koeffisienti

$R_z \cos \alpha$ – g'ildirakni tayanch yuzaga bosayotgan tik vertikal - normal kuch

G_k – gorizontaal yerda g'ildirakka tushadigan og'irlik

$\cos \alpha$ – yo'l bo'ylama qiyalik burchagining kosinusi

Qiyalikning avtomobil' xarakatiga qarshilik kuchi



$$P_n = G_a \sin \alpha = G_a i = m_a g \sin \alpha$$

P_n – avtomobilning qiyalikka chiqishiga qarshilik kuchi

G_a – avtomobilning og'irlik kuchi

m_a – avtomobilning massasi

α – yo'lning bo'ylama qiyalik burchagi

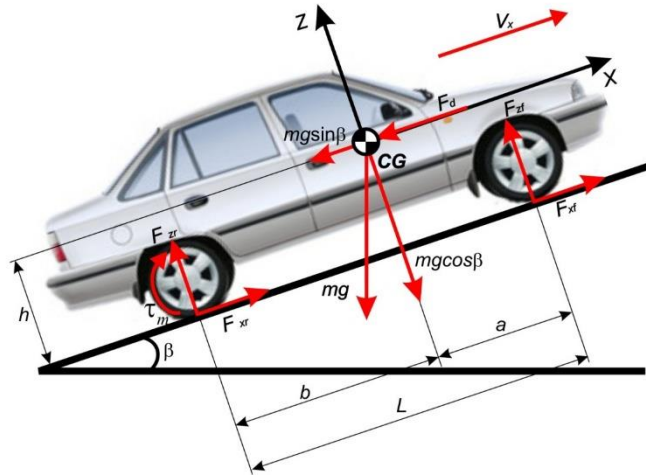
i – yo'l qiyaligi burchagining $\operatorname{tg} \alpha$ qiymati

Avtomobil' xarakatiga yo'lning qarshilik kuchi

$$P_{\psi} = P_f + P_n$$

$$P_{\psi} = fG_a \cos \alpha + G_a \sin \alpha = G_a (f \cos \alpha + \sin \alpha) = G_a \psi$$

$\Psi = (f \cos \alpha + \sin \alpha)$ – yo'lning avtomobil' xarakatiga qarshilik koeffisienti



E'tiboringiz uchun tashakkur!

