Calculation for Belt Conveyor G1.159

00	10.Sep.2020	Issue for Information	D.Bastani	L.Jafari	M.Firoozi
Rev	Date	Description	Prepared	Checked	Approved

محاسبات مربوط به نوار نقاله G1.158 ازپروژه افزایش ظرفیت گندله سازی شماره ۱ گلگهر

مقدمه :

در این مدرک نوارنقاله G1.158 از کارخانه گندله سازی شماره ۱ گلگهر مورد بررسی قرار می گیرد. این نوار نقاله وظیفه انتقال گندله از نوار نقاله G1.157 و بار برگشتی از نوار G2.174 را بر عهده دارد. اطلاعات اولیه نوار نقاله از جمله طرح مفهومی و محاسبات اولیه توسط شرکت NewFer تهیه شده است.لذا جهت هماهنگی با کل پروژه از اطلاعات در ج شده استفاده می شود (مانند نوع رولیک ، ریتم آن، عرض تسمه ، سرعت نوار و..) وپس از بررسی چنانچه مقادیر مناسب نباشد پیشنهاد جدید ارایه می گردد.

رفرنس اصلی برای جداول و ضرایب، کاتالوگ" **رولمکا" RULMECA** می باشد و برای چک مجدد از **CEMA** نیز استفاده شده است. خلاصه محاسبات نیز در جدولی ارایه می شود. این جدول در اکسل محاسبات را انجام می دهد لذا بدیهی است احتلافات جزیی بابت تفاوت گرد کردن ها و گاهی محاسبات فرموله شده داشته باشد. که در نهایت تاثیری در انتخاب ها نخواهد داشت.

نقشه مرجع : DWG No:0322-145-AA-M-DR-003

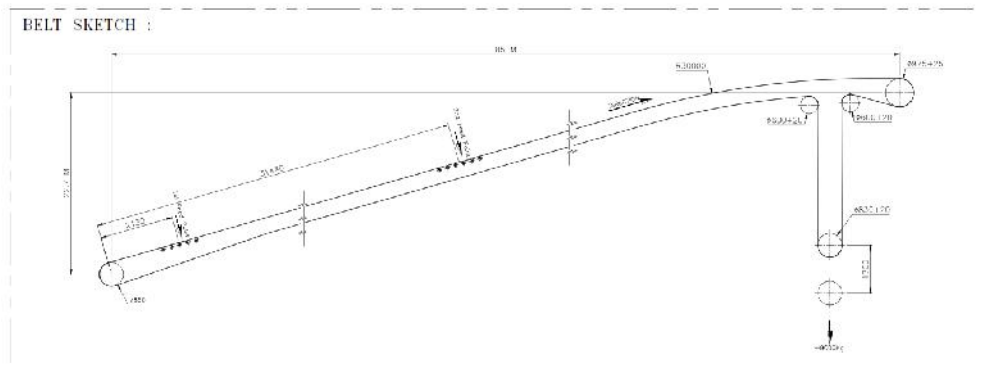
اطلاعات اولیه مرجع NewFer : 0399-145-AA-M-CA-001_R0 – Reports Page:16 .

General:

L: Length (center to center): 85.5m

H: Lift :22.7m

Lv (design): Load Capacity (Design):1200 t/h



Factors:

Cq: Fixed Resistance Coefficient [80m]:1.8

Ct: Passive Resistance Coefficient [t=-15◦]:1.13

f: Internal Friction of Rollers[difficult working condition]: 0.025

q_b: Belt Weight per linear meter:28.8 kg/m

q_G: Conveyed material load on the 1m of carrying belt:212kg/m

q_{RO}: Weight of Rotating Parts (up)[d133,B1200,a_o1000]:29.1 kg/m

q_{RU}: Weight of Rotating Parts (Return)[d133,B1200,a_u3000]:22.5 kg/m

a_o : Upper Troughing Set Pitch:1m

a_u : Return Troughing Set Pitch:3m

Tangential Force Calculation:

Fu= Fa + Fr

Fa: Force to move Upper Strand = $[L \times Cq \times Ct \times f(q_b + q_G + q_{RO}\, a_o) + (q_G + q_b) \times H] \times 9.81$

Fr: Force to move Lower Strand = $[L \times Cq \times Ct \times f(q_b + q_{RU/}\, a_u) + (q_G \times H) \times 9.81$

Fa=[85x1.8x1.13x0.025(28.8+212+29.1)+((212+28.8)x22.7)]x9.81=(1166.6+ 5466.1)x 9.81=65067N≈ 65.1KN

Fr=[85x1.8x1.13x0.025(28.8+22.5/3)+(28.8x22.7)]x9.81=(156.9+ 653.8)x 9.81=7952N≈ 7.9KN

Fu=73 KN

Cw: Wrap Factor [α=180°]:0.5

T_2=Fu x Cw

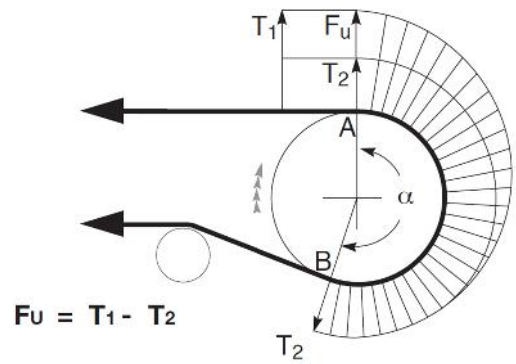
T_2=73 x 0.5=36.5 KN (operation)

T_1=T_2+Fu=36.5+73=109.5 KN (operation)

B : Belt Width m

Tu_{max}= T_{max}/W

Tu_{max}= 109.5/1.2=91.25 KN/m or N/mm



Belt Selection:

EP Selection: Tu_{max} x S_f : 91.25 x 10 :912.5 → EP 1000/4 6+3

(The thickness of the top and bottom should be selected according to the proposal of the belt supplier)

(Check the calculations again according to the belt supplier catalog)

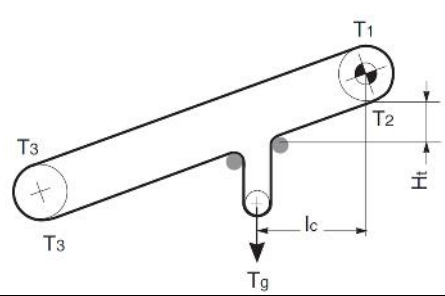
Minimum Pulley Diameter:

Belt breaking load: 912.5 N/mm → Drive Pulley diameter: min 1000 mm

Counterweight:

T_0=6.25($q_b + q_G$) x a_o x 9.81 = 6.25(28.8+212) x 1 x9.81=15.1 KN

- for 2% deflection is given 6.25



$T_3=T_2+Fr$ = 36.5+7.9 =44.4 KN

(when $T_3 > T_0$) : Tg : Counterweight force=$2T_2+2[(Ic \times Cq \times Ct \times f)(q_b + q_{RU})+(q_b \times H_t)]9.81$ N

Tg=73 KN ⟹ Wg: Mass for Counterweight =(73x1.05)/9.81=7.8 ton

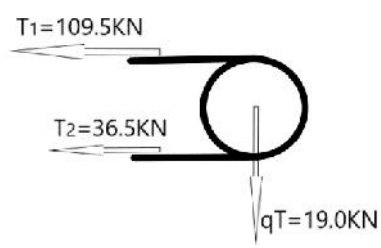
Driving Power:

η: Gear Box Efficiency: 0.9

n_2=30 RPM → V: Speed of Belt Conveyor:1.57 m/s

P:Fu x v / η = 73x1.57 / 0.9 = 127.3 KW ⟹ 137KW √

Drive pulley Shaft: (Safety factor Check)



qT: Weight of Drive Pulley= 1900 kg

R= $[(109.5+36.5)^2+(19)^2]^{1/2}$ ⟹ R=147.2 KN

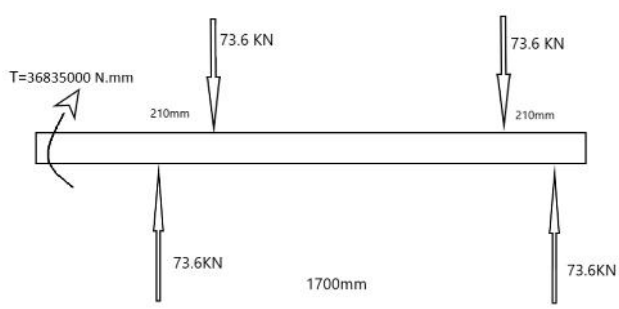
R/2 =73.6KN

D: Drive pulley Diameter :1000mm ⟹ r=500mm

d: Shaft Diameter :180mm

Material Ck45: Sy:310MPa, Sf*:280MPa

T: Torsional Moment: =P x 9549 / n = 127.3 x9549 /33= 36835 N.M = 36835000N.mm



$$D = \sqrt[3]{\frac{32FS}{\pi}\sqrt{\left(\frac{M}{S_f}\right)^2 + \frac{3}{4}\left(\frac{T}{S_y}\right)^2}}$$

M= Bending Moment: 73.6KN x 210mm= 15'456'000 N.mm

Fs= Factor of Safety

$D^3=(32/\pi)Fs[(M/S_f)^2+0.75(T/S_y)^2]^{1/2}$ ⟹ $Fs= D^3\pi / 32\ [(M/ S_f)^2+0.75(T/S_y)^2]^{1/2}$

S_f: Corrected shaft fatigue limit = $k_a\ k_b\ k_c\ k_d\ k_e\ k_f\ k_g\ S_f$*

k_a: surface factor: 0.8 for machined shaft

k_b: size factor :1.189$d^{-0.097}$: k_b=0.7183.8

k_c: reliability factor = 0.897 (CEMA)

k_d: temperature factor = 1

k_d: temperature factor =1

k_f : factor fatigue stress concentration : 0.63 (CEMA)

k_g: miscellaneous factor = 1.0 for normal conveyor service

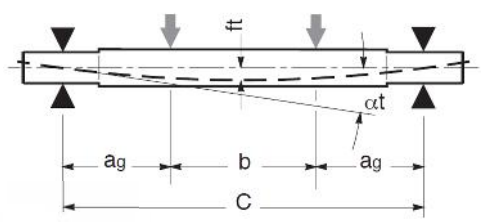
S_f =0.8x0.718x0.897x1x1x0.63x1=0.324x280=90.9MPa

$Fs= D^3\pi / (32\ [(M/ S_f)^2+0.75(T/Sy)^2]^{1/2})$

$Fs= 180^3 \times 3.1415 /(32\ [(15.5\times10^6/90.9)^2 +0.75(36.8\times10^6/310)^2]^{1/2}=2.875 > 1.5$(CEMA Suggestion)

: 180mm is OK

Shaft Sizing for Deflection:



$$\alpha = \frac{\frac{R}{2}}{2xExJ}\, a_g(c - a_g) : \frac{\frac{147.2\times1000}{2}}{2x207000x0.0491(180)^4}\ 210(1700-210) = 0.001079$$

- if R in N , α must be less than 0.01 : 0.01 > 0.001079 ⟹ **: 180mm is OK**

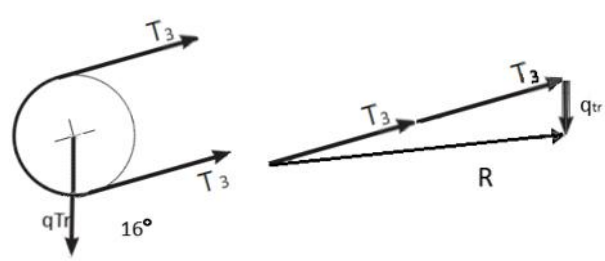
Tail pulley Shaft: (Safety factor Check)

qTr: Weight of Tail Pulley= 1100 kg =11KN

T3: 44.4 KN

R=86.4 KN ⟹ R/2=43.2KN

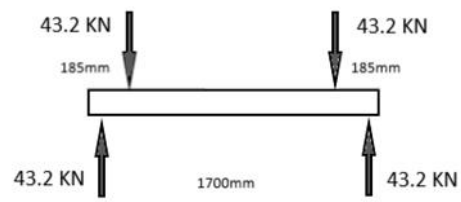
d: Shaft Diameter : 120mm



Material Ck45: Sy:310MPa, Sf*:280MPa

M= Bending Moment: 43.2KN x 185mm ≈7'999'000 N.mm

ag=185mm



$$Fs=\frac{d^3\pi}{32\,(M/\,Sf)}$$

Fs= (120^3 x 31.1415)/ 32 x (7.999 x 10^6 /90.9) = 1.93 **> 1.5** (CEMA Suggestion)

Shaft Sizing for Deflection:

$$\alpha = \frac{\frac{R}{2}}{2xExJ}\, a_g(c - a_g) : \frac{\frac{43.2\times1000}{2}}{2x207000x0.0491(120)^4}\, 185(1700 - 185) = 0.001436$$

if R in N , α must be less than 0.01 : 0.01 > 0.001436 : **120mm is OK**

Roller Check:

Carrying Idler: ϕ133 / 473 /6205 load Capacity 274dN

Impact Idler: ϕ133 / 473 /6205 load Capacity 274dN

Flat Return Idler: ϕ133 / 1400 /6205 load Capacity 201dN

V Return Idler: ϕ133 / 700 /6205 load Capacity 274dN

Factors:

Iv = belt load: 1200 t/h
v= belt Speed: 1.57 m/s
a_0 =Upper Troughing Set Pitch:max 1 m
a_u = Return Troughing Set Pitch: max 1 m
Fp = participation factor of roller under greatest stress: 0.65 (for caring)
Fp = participation factor of roller under greatest stress: 0.65 (for return)
Fd = impact factor: 1
Fs = service factor: 1.2
Fm = environment factor: 1.1
Fv = speed factor: 0.85

- **Upper Roller:**

Static Load Load on Upper Roller : $Ca=a_0 \times (q_b+\frac{lv}{3.6\,v})0.981$

Dynamic Load on Upper Roller: $Ca_1=Ca \times Fd \times Fs \times Fm$ [daN]

Load on Upper Roller: ca$=Ca_1 \times Fp$

Ca=1 x (28.8+1200/3.6x1.57)0.981=236**daN**

Ca_1 =236 x 1 x 1.2 x 1.1= 312.3 **daN**

ca =312.3 x0.65=<u>203 **daN < 274 daN**</u> ⟹ **Carrying Idler:** ϕ133 / 473 /6205 IS **OK**

- **Flat Return Roller**

Static Load Load on Return Roller : $Cr=a_u \times qb \times 0.981$

Dynamic Load on Upper Roller: $Cr_1=Cr \times Fs \times Fm \times Fv$ [daN]

Load on Upper Roller: cr$=Cr_1 \times Fp$

Cr=3 x 28.8 x 0.981=84.7**daN**

Cr_1 =84.7 x 1.2 x 1.1 x 0.85 = 95.1 **daN**

cr =95.1 x 1=<u>95.1 **daN < 201 daN**</u> ⟹ **Return Idler:** ϕ133 / 1400 /6205 IS **OK**

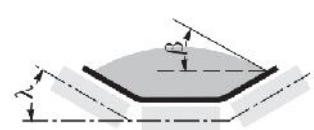
- **V Return Roller:**

Cr=3 x 28.8 x 0.981=84.7**daN**

Cr_1 =84.7 x 1.2 x 1.1 x 0.85 = 95.1 **daN**

cr =95.1 x 0.5=<u>47.5 **daN < 274 daN**</u> ⟹ **Return Idler:** ϕ133 / 700 /6205 IS **OK**

Loaded Volume Check:



B: Belt Width=1.2 m

λ :30° **β** :25°

Lvt: loaded volume is expressed relevant to the speed of 1 m/s =745.9 m3/h per 1m/s

lv: belt load= 1200 t/h

V: belt Speed= 1.57 m/s

q_s :Specific weigh= 2.2 t/m^3

L_M :full load Capacity = Lvt x v x **q_s** : **L_M** =745.9 x 1.57 x 2.2=2576.3 t/h > 1200 t/h

Re check by correction factor:

K: is the factor of inclination= 0.85

K1: Factor of feed irregularity=1

L_{MC}: L_M x K x K1 = 2576.3 x 0.85 x 1 = 2190 t/h > 1200 t/h ⟹ **B**=1.2 m ,**λ** :30°, **β** :25°, 1.57 m/s, are **OK**

AsooSanat

Design Data & Calculation for Belt Conveyor (According :DIN 22101)

Project: GeG 1 - CAPACITY INCREASE	Project No.: ...	Date :	99.08.17 ~99.09.08
Customer : Fara Tahghigh-SBR	Equipment Item: G1-158	Rev :	A

Conveyor Specification				RULMECA
Oprating Capacity	Iv = 1138	t/h		-
Load Capacity (Design)	Iv = 1200.59	t/h		-
Specific weight	qs = 2.2	t/m^3		-
Speed of Belt Conveyor	V = 1.57	m/s		P:23 T:3
Length(center to center)	L = 85	m		-
Height	H = 22.7	m		-
inclination	α = 14.95	°		-
	α = 0.26	Rad		-
Troughing set Angle	λ = 30	deg		P:27
Rollers no. in Troughing Set	N = 3	pcs		-
Upper Troughing Set Pitch	ao = 1	m		P:34 T:6
Return set Angle	λ = 0	deg		-
Return no. in Troughing Set	N = 1	pcs		-
Return Set Roller Pitch	au = 3	m		P:34 T:6
Gear Box Efficiency	η = 0.9			-
Handeled Material	Imixed Material			-
Material Grain Size	d = 0-25	mm		-
Material Moisture	8	%		-
Min. Operation Temp.	T_{min}= -15	°C		
Max. Operation Temp.	T_{max}= 45	°C		
Operation Time in 24hr	t= 24	hr		
Safty Factor(for motor)	SF = 1			-
Length of Skirt Board	l = 6	m		
Angle of Repose	γ= 36			p:20 T2
Calculation Factors				
Factor of Inclinatin	K = 0.85			P:31 T:8
Factor of feed irregularity	K1 = 1			P:31
Fixed Resistance Coefficient	Cq = 1.8		see note2	P:38 T:7
Passive Resistance Coefficient	Ct = 1.13			P:38 T:8
Belt Core Weight	qb = 24.0	kg/m^2		
Weight of Rotating Parts (up)	Pprs = 29.1	kg		P:39 T:11
Weight of Rotating Parts (low)	Ppri = 22.5	kg		P:39 T:11
Angle of Surcharge	ß = 25.0	°		P:19
Internal Friction of Rollers	f = 0.025			P:38 T:9
Dis from Drive Pulley & Counterwe	lc = 2.299	m		P:43
Dis from Counterweight & Slack side	Ht = 0.189	m		P:43
Wrap Factor	Cw = 0.5			P:41 T12
Diameter of Drive Pulley	D = 1000	mm		P:45 T:13
Diameter of Return Pulley	D = 850	mm		P:45 T:13
Weight of Drive Pulley	qT = 1900	kg		P:263
Distance of Drive Pully& Bearings	ag = 0.21	m		P:263
Distance of Bearings in Drive Pully	C= 1700	mm		P:47
Yeild stress	δ = 7.8	daN/mm^2		P:46
Weight of Return Pulley	qTr = 1100	kg		P:263
Distance of Tail Pully & Bearings	agr = 0.20	m		P:263
Impact Factor	Fd = 1			P:51 T:20
Service Factor	Fs = 1.2			P:51 T:18
Environment Factor	Fm = 1.1			P:51 T:19
Speed Factor	Fv = 0.85			P:51 T:21
Participation Factor	Fp = 0.65			P:50 T:17
Participation Factor (Return)	Fp = 1.00			P:50 T:17

Rollers of Belt Conveyor			
Static Load	Ca = 236.64	daN	P:52
Dynamic Load	Ca1 = 312.36	daN	P:52
Load on (Upper) Roller	ca = 203.03	daN	P:52
Static Load	Cr = 84.76	daN	P:52
Dynamic Load	Cr1 = 95.10	daN	P:52
Load on Return Roller	cr = 95.10	daN	P:52

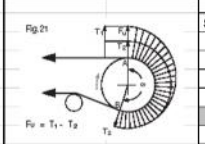
Drive System of Belt Conveyor			
Type of GearBox :	[illegible] Bevel Helical		
Transmitted pow er at Gearbox output	P2= 132	kW	Gear Cat.
SF GearBox	SF= 1.75		Gear Cat.
Total Service Factor	SF= 1.75		
Angular speed at gearbox output	n2= 30	rpm	
Actual Speed of Belt Conveyor	V = 1.57	m/s	
Teoretic load of Belt Conveyor	Iv = 408.71	m^3/h	
Actual Loaded Volume Checked	OK		P:26-30

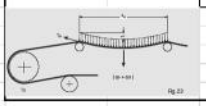
Belt Width & Speed			RULMECA
Load Capacity	IM = 545.72	m^3/h	-
Teoretic load of Belt Conveyor	M = 408.71	m^3/h	P:31
Active Load from Table	M = 748.85	m^3/h	see note 1
Belt Width	B = 1200	mm	

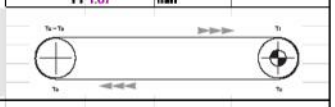
Tangential Force & Power of Motor			
Weight of Material per Linear	qG = 212.42	kg/m	P:23
Belt Core Weight	qb = 28.80	kg/m	
Weight of Rotating Parts (up)	qRO = 29.1	kg/m	P:39
Weight of Rotating Parts (low)	qRU = 7.50	kg/m	P:39
Force to move Upper Strand	Fa = 6519.05	daN	P:37
Force to move Lower Strand	Fr = 795.42	daN	P:37
Tangential Force	Fu = 7314.47	daN	P:37
Driving Power(absorbed power)	P = 128.43	kW	P:37
Driving Power(with safty factor)	P total = 128.43	kW	
Motor Power	P Motor = 132	kW	

Material load on the 1m of belt			
Conveyed material load on the 1m of carrying belt	q_G= 212	kg/m	q_G=M/(V*3.6)

Belt Tension			
	T2 = 3657.24	daN	P:41
	T1 = 10971.71	daN	P:41
	T3 = 4452.66	daN	P:41
	S (Carrying)= 7	mm	
	S (Return)= 7	mm	
	T max = 10971.71	daN	
	Tumax = 91.43	N/mm	P:43
	EP = 914.31	N/mm	P:43
	BeltType = EP 1000/4 6+3		از جدول
	Tg = 7334	daN	P:43
	W = 7849.47	kg	P:43
	R = 402.36	m	Min "R" tracking "Up"
	Back stop is Necessary		
	Ff 1.87	min	







Belt Conveyor Drive & Return Pulley Dimension			
Diameter of Drive Pulley	D = 1000	mm	
Diameter of Return Pulley	D = 850	mm	
Total Force (Drive Pulley)	Cp = 15230.20	daN	P:46
	Mf = 1599.17	daNm	P:46
r.p.m of Drive Pulley	n = 30.00	rpm	
Min r.p.m of Drive Pulley	n = 19.65	rpm	با واحد طراحی
Min Speed of Belt Conveyor	V = 1.03	m/s	هماهنگ شود .
	Mt = 4088.06	daNm	P:46
	Mif = 3884.78	daNm	P:46
Sectional Modules	W = 498048.96	mm^3	P:46
Shaft Diameter of Drive Pulley	d = 172	mm	P:46
Total Force (Return Pulley)	Cpr = 8686.75	daN	P:47
	Mf = 868.68	daNm	P:47
Sectional Modules	W = 111369.60	mm^3	P:47
Shaft Diameter of Return Pulley	d = 104	mm	P:47
Limit of Deflection(for Drive Pulley)	fl= 0.0015595	OK	P:47
sectional moment of inertia of the shaft	J= 85633477	mm^4	P:47
Limit of Deflection(for Drive Pulley)	ql= 0.0000008	OK	P:47

Idller spec.	Dia.(mm)	Length(mm)	Bearing	Life (hr)	Permisible load
Carrying	133	473	6205	36,867	274
Impact	133	473	6205	29,494	274
Return	133	1400	6205	133,341	197

Note :

* P:Page & T:Table in RULMECA catalogue.

note 1: This is only valid for trughing set with three (V shape) carying idllers. For other idllers arrangement see page 26 to 30 RULMECA catalogue.

note 2: For conveyours with 500m length or more, Cq is 1.03.

Designer : D.Bastani