Bulk Materials Handling Engineering Principles

Introduction
Designers should use the following engineering principles in selecting the optimal belt conveyor drive for bulk handling applications. Refer to the latest edition of "Belt Conveyors for Bulk Materials," published by the Conveyor Equipment Manufacturers Association (CEMA) for a comprehensive design guide.

Design Parameters
Determine desired design parameters:
- product flow rate (Q)
- belt speed (V)
- belt width (w)
- conveyor length (L)
- product size
- lift height (H)
- type & thickness of belt
- type of belt support

Make the following control choices:
- continuous or intermittent flow
- fixed or variable belt speed
- conveyor duty cycle
- extremes of process flow
- ambient environment extremes
- applicable safety requirements

Optimize Belt Speed & Belt Width
Select Belt Width:
- with bulk density & belt speed fixed, select width to yield product flow rate, not exceeding CEMA "standard edge distance"
- width must be $\geq$ 3x max lump for 20° surcharge and $\geq$ 6x max lump for 30° surcharge
- width must be wide enough to prevent loading chute and skirtboard jamming (i.e. $\geq$ 3x to 5x max lump)

Select Belt Speed:
- with bulk density & width fixed, select speed to yield product flow rate, not exceeding CEMA "standard edge distance"
- for dusty material, select speed to minimize fugitive emissions
- for heavy sharp material, select speed to protect belt and chute lining

Calculate Power to Drive Belt
CEMA has empirically developed a variety of factors to simply the determination of belt pull. Some of these factors include: idler roller bearing friction (Kx,) belt and load flexure resistance (Ky,) and skirtboard friction (Tsb.) To determine required HP calculate required belt pull at specified belt speed as follows:
- with belt width and speed fixed, select conveyor components and calculate belt tension (Te) required to overcome gravity, friction, and momentum using:
  Te = LKt (Kx + KyWb + 0.015Wb)
  + Wm (LKy + H) + Tp + Tam + Tac
- calculate power required to drive belt using:
  HP = (TeV) / 33,000

Go to www.rulmecacorp.com for free "downloadable" conveyor design software incorporating equations above and a complete set of definitions for all pertinent terminology.

Select Drive & Check Geometry
Finally, select conveyor drive and check design using final parameters as follows:
- select Motorized Pulley to match design belt speed and required HP
- check selected pulley diameter verifying that wrap factor and belt life are acceptable
- recalculate required belt pull and HP using selected "actual belt speed"
- check material cross section on belt verifying that edge distance is acceptable
- check material trajectory verifying that transfer chute will not plug and material will drop at desired location

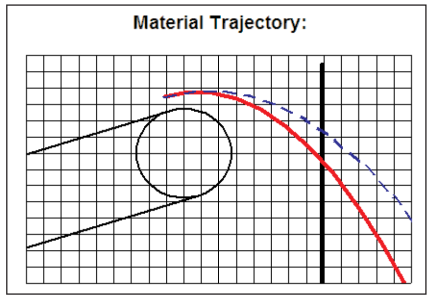
Go to www.rulmecacorp.com for free "downloadable" conveyor design software incorporating material cross section and trajectory plotting programs and pulley diameter check.

Special Loading Conditions
Certain loading are beyond the scope of the 5th Edition of the CEMA manual.

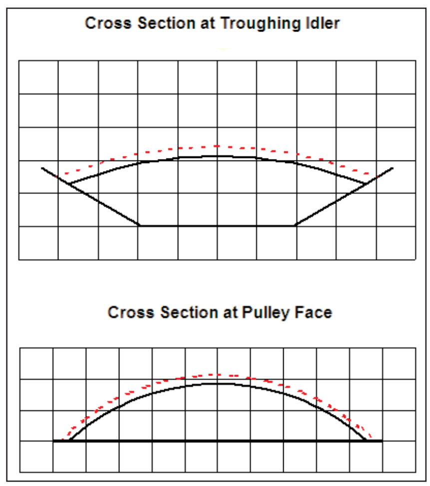
These include:
- hopper feeder conveyors
- slider bed conveyor supports
- cleated and/or sidewall belt

Go to www.rulmecacorp.com for free "downloadable" conveyor design software incorporating HP calculations for these special conditions.

Examples
The drawings below were generated by Rulmeca design software and illustrate how the programs can help designers avoid errors.



Trajectory plot shows that slower belt speed (solid line) will not plug chute while faster belt speed (dotted line) will. This is because trajectory of center of material mass impacts against vertical chute wall above horizontal centerline of pulley.



Plot shows that selected belt speed (dotted line) may cause material spillage because cross section exceeds CEMA recommendation (solid line.)