一种高流速小河流人工流量测验装置与应用

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摘 要:在河宽较小的河流或渠道流量测验中,若遇流速较大时,采用人工桥测、走航式ADCP等方式施测流量极为不便。为解决小河流高流速情况下的人工流量测验问题,研制了一套由轨道基座、行车、刹车组、悬杆升降部件、计数器和悬杆固定架等组成的人工流量测验装置。该装置采用悬杆搭载流速仪,通过机械装置实现悬杆(测深杆)的水平移动和垂直移动,将流速仪精准传送到测流断面任意位置,实现小河道高流速监测。经牛栏江-滇池补水工程输水线路末端站两年多的实际应用,在高流速3~5m/s时,运行稳定可靠,使用方便。

关键词:流量;测验;高流速;小河流;研制;应用

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1 引言

在河宽较小的河道流量人工测验工作中,一般采用桥测(人工测深杆或测绳)或走航式ADCP进行测验[1-2]。当测验断面流速超过3m/s时,测深杆、测绳搭载的测验设备或走航式ADCP受水流冲击力太大,人工很难操控,存在较大的安全隐患。为解决小河流高流速条件下的人工流量测验问题,本文研制了一套由轨道基座、行车、刹车组、悬杆升降部件、计数器和悬杆固定架等组合而成的人工流量测验装置。该装置由悬杆搭载流速仪,通过人工推动行车控制悬杆(测深杆)水平移动,水平移动距离由轨道基座上标尺及起点距计数器控制;经人工摇动手轮带动机械装置控制悬杆(测深杆)垂直移动,将流速仪精准传送到测验断面任意位置,以实现测验断面上任意一点的流速监测。该装置操作方便、省力、省时,可为高流速小河流或渠道的人工流量测验提供参考。

2 装置简介

2.1 工作原理

小河流人工流量测验装置由轨道基座、行车、刹车组、悬杆升降部件、计数器和悬杆固定架等组成,具体结构如图1所示。工作时,轨道基座横跨在河流上,两端分别固定在两侧的河岸。行车平台可以顺着轨道移动,行车平台带动悬杆固定架横向移动,悬杆上安装的流速仪即能在河道断面上横向灵活移动;悬杆固定架与悬杆升降部件通过钢绳连接,摇动手轮,带动线轮将钢绳收起,钢绳再将悬杆往上拖,也连带流速仪一起上移,实现了流速仪的纵向灵活移动;其搭载的流速仪纵向、横向移动灵活,操作方便、省时省力。行车平台移动时,刹车组中的刹车盘不与轨道接触,防脱轮与滑轨下端接触,产生滚动摩擦,不妨碍行车平台移动,但可防止行车平台脱轨。若需行车平台停下静止不动,可转动刹车轮,通过螺纹配合将刹车盘上移,与轨道紧紧接触,就能固定行车平台位置。横梁上固定设置有刻度尺,刻度尺能定位行车平台的位置,以确定流速仪的横向起点距。悬杆上设置有明显的色差刻度,能清晰读出流速仪测点处的水深,且计数器连接悬杆升降部件,也能记录线轮放钢绳时旋转的圈数,精准计算流速仪测点水深。悬杆升降部件上的棘轮和棘爪能防止线轮反转,固定悬杆不动,以确保当流速仪放到某一测点水深时,固定好流速仪测点位置不动,精准到达所需测点的位置。导向鳍会将流速仪正对河流水流方向,保证流速仪的测量方向正确,以

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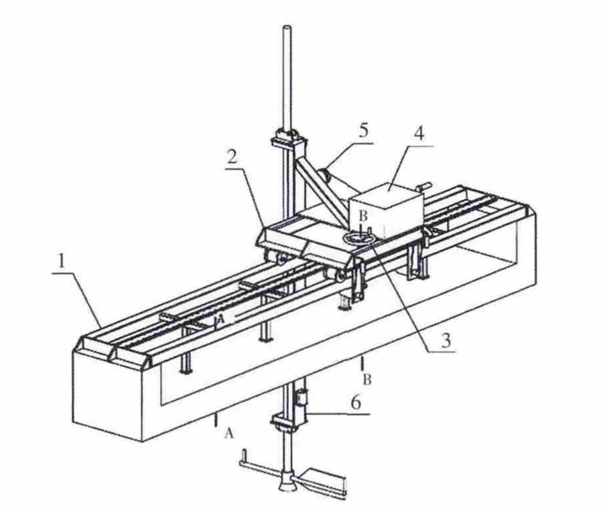
提高测验精度。

本装置结构简单、操作方便,搭载的流速仪能在测流断面横向纵向灵活移动, 可精准测量测流断面任意一点的水流流速。具有安装牢固、不易损坏、维修简单方便的特点。



图中:1-轨道基座,2-行车,3-刹车组,
4-悬杆升降部件,5-计数器,6-悬杆固定架

图 1　结构示意图

Fig.1　The structure schematic

2.2　部件构成

(1)轨道基座。系统的轨道基座包括石基、轨道、横梁和刻度尺,其中轨道设置在石基上,轨道之间设有横梁,横梁上固定设置刻度尺。轨道基座构造如图 2 所示。

(2)行车。行车由行车平台、车轮、防脱轮和把手组成,行车平台下方四个角处设置车轮,车轮在轨道上运行,行车平台上设置防脱轮和把手,防脱轮卡在轨道下方。行车结构如图 3 所示。

(3)刹车组。图 4 所示为系统的刹车组,其包括刹车轮、导管、螺纹管、螺母和刹车盘。刹车轮下方固定装配螺纹管,螺纹管外套导管,导管固定在行车平台上,导管下端设置有螺母,螺母与螺纹管工作配合,螺纹管下端固定有刹车盘,刹车盘在轨道下方。

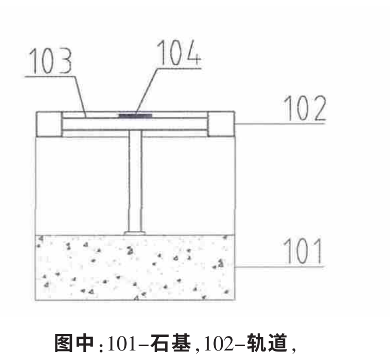
(4)悬杆升降部件。图 5 所示为悬杆升降部件,该装置固定在行车平台上。悬杆升降部件本身包括手轮、齿轮组、棘轮、棘爪、拨片和线轮等。线轮侧面设置有齿轮组,线轮和齿轮组之间通过转轴连接,转轴上配置棘轮、棘爪和拨片,齿轮组连接手轮。

(5)悬杆固定架。系统悬杆固定架如图 6 所示,其主要部件包括立轨、导轮架、导轮、悬杆、辅助轮、固线环、导向鳍和流速仪安装基座。立轨的一侧设置辅助轮,辅助轮与石基接触;立轨的另一侧两端固定导轮架。导轮架内置两个导轮,两个导轮之间安装悬杆,悬杆上设固线环,悬杆下设有流速仪安装基座,悬杆挨近流速仪安装基座处固定装配导向鳍。

3　应用

目前, 该装置在牛栏江-滇池补水工程输水线路末端站已安装应用了两年多,在高流速人工流量测验工作中,运行正常稳定。

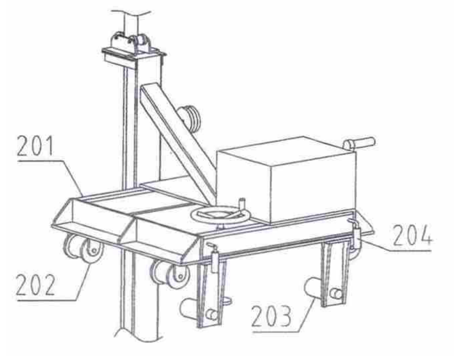
输水线路末端站为牛栏江—滇池补水工程从德泽水库调水入昆的第一个重要控制站,该站监测断面为三面光混凝土矩形渠道,宽 3.7m,深 4.3m;渠道设计



图中:101-石基,102-轨道,
103-横梁,104-刻度尺

图 2　轨道基座剖面图

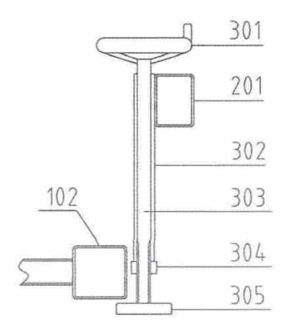
Fig.2　A-A profile



图中:201-车平台,202-车轮,
203-防脱轮,204-把手

图 3　行车结构示意图

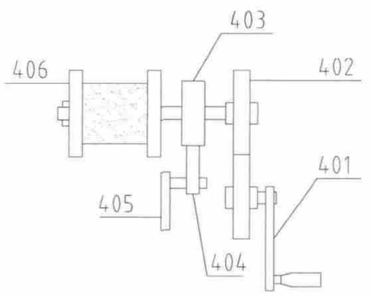
Fig.3　The lane structure



图中:102-轨道,201-车平台,
301-刹车轮,302-导管,
303-螺 纹管,304-螺 母,305-刹车盘。

图 4　B-B 剖面图

Fig.4　B-B profile



图中:401-手轮,402-齿轮组,403-棘轮,
404-棘爪,405-拨片,406-线轮。

图 5 悬杆升降部件结构示意图
Fig.5 The suspension lift parts structure

引水流量为 23 m^3/s,由德泽水库 3 台水泵机组提升后送到输水线路渠首,流经 115.85km 的输水线路,至输水线路末端站后,流入下游盘龙江汇入滇池[3]。

为精准监测牛栏江-滇池补水工程调水入滇池的水量,在输水线路末端站实施了超声波时差法等实时在线流量监测系统。同时,为了对实时在线流量监测系统提供人工精测法比对数据,在该站建设了本文研制的高流速人工流量测验装置。经两年多高、中、低水的实际使用,装置运行正常稳定,不同水位级运行情况见表 1[4]。

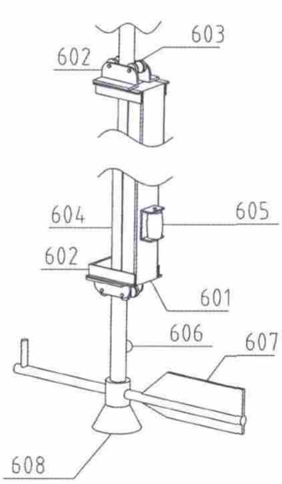
表1 本装置实际运行情况表
Table1 The appliance operation

水位级	水深 /m	中泓流速 /$m\cdot s^{-1}$	流量 /$m^3\cdot s^{-1}$	运行 /次	工作情况
高水	1.32~1.45	3.62~5.11	16.2~24.9	49	正常
中水	1.14~1.32	2.10~3.62	8.17~16.2	45	正常
低水	0.00~1.14	0.000~2.10	0.000~8.17	24	正常

从表 1 可见,本装置在输水线路末端站高、中、低水位级运行状态良好,在高流速 3~5m/s 情况下,运行正常稳定。

4 结语

(1)所研制的高流速小河流人工流量测验装置,由轨道基座、行车、刹车组、悬杆升降部件、计数器和悬杆固定架等主要部件组成。系统通过人工机械操控,实现



图中:601-立轨,602-导轮架,603-导轮,604-悬杆,
605-输助轮,606-固线环,607-导向鳍,608-流速仪安装基座。

图 6 悬杆固定架结构示意图
Fig.6 The loft retention structure

3~5m/s 水流流速条件下流速仪在河渠测验断面内横向纵向灵活移动,能精准测量河道断面内任一点的流速,具有省力省时、操作方便的特点。

(2)本装置经牛栏江-滇池补水工程输水线路末端站两年多的实际应用,运行正常、稳定、可靠。适用于河宽小于 10m 且流速小于 5m/s 的小河流或渠道流量测验。

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Study on Temporal-spatial Changes of Urban Runoff in Shaoxing City

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Abstract: To solve the quantitative problem of urban runoff at large scale, a distributed watershed hydrological model named soil and water assessment tool (SWAT) was employed to quantitatively simulate the urban runoff and analyze the temporal-spatial changes in Shaoxing City. The SWAT model was established by putting the Shaoxing City in a suitable scale watershed based on DEM analysis. And then the SWAT model was calibrated and validated using monitoring data from hydrological stations based on the parameter sensitivity analysis. The results show that the calibrated SWAT model perform well on modeling the annual and monthly runoff in both calibration and validation periods with an average relative error (from -5.29% to 8.81%), coefficient of determination (from 0.91 to 0.96) and coefficient of efficiency (from 0.90 to 0.94). Meanwhile, monthly runoff data from 1992 to 2011 at sub-watershed scale were obtained using the calibrated model. Besides, temporal-spatial changes of urban runoff was quantitatively analyzed and the critical source areas (CSAs) was finally gained by means of geo-statistic method (GSM), which will provide the scientific basis for water resources protection and utilization.
Key words: SWAT model; urban runoff; calibration and validation; temporal-spatial change

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Application of A High Flow Velocity Measuring Device for Small Rivers

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Abstract: In the flow hydrometry for small rivers or channels, if flow velocity is high, it is inconvenient to use manual bridge measurement or scoopfish ADCP. In order to solve this problem, we developed a flow measuring device composed of orbital base lifting, driving, brake set, hanging rod part, counter and suspension rod holder. The device using suspension rods equipped with flow meter, can horizontally and vertically move, so as to accurately reach the section to be monitored. This device has been used to the end of the Niulanjiang-Dianchi Water-Delivery Project for 2 years. The result shwo that the device operation is stable and reliable when the high flow velocity is 3-5m/s.
Key words: discharge; hydrometry; high-velocity; small river; development; application